

SAP NetWeaver® Application Server ABAP/Java on Oracle Database Exadata Cloud Service Based on Oracle Exadata X7

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Revision History

The following revisions have been made to this white paper since its initial publication:

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February 28, 2019	<ul style="list-style-type: none"><li data-bbox="391 835 1281 867">• Adds information about Oracle Exadata X7<li data-bbox="391 877 1281 934">• Adds information about support for Oracle Database Release 18c with SAP for Exadata Cloud Service



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Scope and Assumptions

This technical white paper is a reference guide for deploying Oracle databases of the SAP NetWeaver® Application Server ABAP/Java platform on the Oracle Database Exadata Cloud Service, based on Oracle Exadata X7 hardware and using Oracle Linux 6, in Oracle Cloud Infrastructure, following suggested platform best practices. It also provides details about combining the different parts of Oracle Database Exadata Cloud Service, Oracle Linux, Oracle Virtualization, Oracle Grid Infrastructure instances, Oracle Database instances, and SAP Infrastructure components to run Oracle databases for software products based on SAP NetWeaver Application Server ABAP/Java on Oracle Database Exadata Cloud Service.

Note: We do not support using Oracle Database Exadata Cloud Service for SAP NetWeaver Application Server ABAP/Java instances except for SAP Central Services. SAP NetWeaver Application Server ABAP/Java Instances must be installed on separate servers within the Oracle Cloud Infrastructure, such as Oracle Cloud Infrastructure Compute instances (bare metal or virtual machine instances).

This white paper 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 landscape in the cloud in a supported and verified way.

This white paper assumes the following knowledge:

- You are familiar with the fundamentals of Oracle Database Exadata Cloud Service and Oracle Cloud Infrastructure. For information, see the following resources:
 - [Oracle Database Exadata Cloud Service](#)
 - [Oracle Cloud Infrastructure – Exadata DB Systems](#)
 - [Oracle Cloud Infrastructure](#)
- You have profound administrative skills in SAP NetWeaver Application Server ABAP/Java using Oracle Database and Oracle Linux. For more information, see the following resources:
 - <https://www.sap.com/products/netweaver-platform.html>
 - <https://www.sap.com/community/topic/oracle.html>
 - <http://docs.oracle.com/en/operating-systems/linux.html>
- You are familiar with the documentation for the following products:
 - Oracle Database 12c Release 1 and later
 - Oracle Linux 6
 - SAP NetWeaver 7.x



Overview of Oracle Database Exadata Cloud Service

The Oracle Database Exadata Cloud Service enables full-featured Oracle databases to run on the Exadata platform in the Oracle Public Cloud. Exadata Cloud Service instances come preconfigured according to best practices that have been proven at thousands of mission-critical Exadata sites around the world.

Depending on the subscription model, you can have full access to the features and operations available with Oracle Grid Infrastructure, Oracle Database including Oracle Real Application Clusters (RAC), Oracle Automatic Storage Management Cluster File System (Oracle ACFS), SAP Infrastructure components for installation (Software Provisioning Manager), Database Administration (BR*Tools), and SAP High Availability for SAP Central Services, but with Oracle owning and managing the Exadata infrastructure.

Oracle Database for SAP with Exadata Cloud Service

All options and features of Oracle Database 12c Release 1 (12.1.0.2), Oracle Database 12c Release 2 (12.2.0.1) and Oracle Database Release 18c, including Oracle RAC, Oracle Automatic Storage Management (ASM), and Oracle Database In-Memory supported for on-premises deployments of SAP NetWeaver, are supported and certified for Exadata Cloud Service.

Note: Oracle Database 11g Release 2 is not supported with SAP for Exadata Cloud Service.

Regions and Availability Domains

Oracle Cloud Infrastructure is physically hosted in [regions and availability domains](#). A *region* is a localized geographic area, and *availability domains* are one or more data centers located within a region. Most Oracle Cloud Infrastructure resources are bound either to a particular region, such as a virtual cloud network (VCN), or to an availability domain, such as a compute instance.

Availability domains are isolated from each other, fault tolerant, and unlikely to fail simultaneously. Because availability domains do not share infrastructure such as power or cooling, or the internal availability domain network, a failure at one availability domain is unlikely to impact the availability of the others.

All the availability domains in a region are connected to each other by a low-latency, high-bandwidth network. This connection makes it possible to provide high-availability connectivity to the internet and customer premises, and to build replicated systems in multiple availability domains for both high availability and disaster recovery.



Regions are completely independent of other regions and can be separated by vast distances. Generally, an application should be deployed in the region where it is most heavily used, because using nearby resources is faster than using distant resources.

For all SAP environments, compute nodes that are deployed as SAP Application Servers must be located in the same region, and preferably in the same availability domain, as the corresponding Exadata compute nodes.

Hybrid deployments between on-premises and cloud are not supported because of network latency.

Oracle Cloud Infrastructure Services

The following Oracle Cloud Infrastructure services are relevant to deploying Oracle databases of SAP NetWeaver Application Server ABAP/Java on the Oracle Database Exadata Cloud Service.

Identity and Access Management

Oracle Cloud Infrastructure provides [Identity and Access Management](#) (IAM) at no additional cost. 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 it is simple to define policies. IAM helps you set up administrators, users, and groups, and specify their permissions. It allows you to use a single model for authentication and authorization to securely control access and easily manage your IT resources across all Oracle Cloud Infrastructure.

Networking

[Oracle Cloud Infrastructure Networking](#) helps you set up virtual versions of traditional network components. You can extend your IT infrastructure with highly customizable VCNs and connectivity services that provide predictable and consistent performance, isolation, and availability.

A VCN is a customizable and private network in Oracle Cloud Infrastructure. Just like a traditional data center network, the VCN provides you with complete control over your network environment. You can assign your own private IP address space, create subnets and route tables, and configure security lists (firewall rules). A single tenant can have multiple VCNs, thereby providing grouping and isolation of related resources.

Security can be configured at several levels within a VCN. A subnet can be designated as public or private. A private subnet cannot have a public IP address. Security lists can control packet-level traffic into and out of a subnet or an instance. In addition, at the instance level, firewall rules can be implemented. Gateways and route tables provide control over traffic flow between the VCN and



outside destinations. Finally, IAM policies provide control over who can access and configure which resources.

For naming, each subnet can resolve names to the internet or within a VCN. In addition, an on-premises DNS server can be added to the search scope. A description of the choices for using DNS in your VCN are described in the [Oracle Cloud Infrastructure](#) documentation.

Oracle Cloud Infrastructure FastConnect is an alternative to using the public internet to connect your network to Oracle Cloud Infrastructure. FastConnect provides an easy, elastic, and economical way to create a dedicated and private connection with higher bandwidth options, and it provides a more reliable and consistent networking experience compared to internet-based connections.

Oracle Cloud Infrastructure's flat and fast network provides the latency and throughput of rack adjacency across the whole network, which allows synchronous replication and constant uptime. No network oversubscription also provides predictable bandwidth and performance. High-bandwidth network interconnect provides less than 100 μ s latency between any two hosts within an availability domain, and less than 1 ms between availability domains in a region.

Object Storage

[Oracle Cloud Infrastructure Object Storage](#) helps you manage data as objects stored in containers. Object Storage offers an unlimited amount of capacity, automatically replicating and healing data across multiple fault domains for high durability and data integrity. You can enhance the scale and performance of content-rich, analytic, and backup applications to serve more customers and achieve results faster.

Exadata Cloud Service Instances

Each Exadata Cloud Service instance is based on an Exadata system configuration that contains a predefined number of compute nodes (database servers) and a predefined number of Exadata Storage Servers, all connected by a high-speed, low-latency InfiniBand network and intelligent Exadata software. The number of compute nodes per shape cannot be modified after launching an Exadata Cloud Service instance.

Currently, Oracle offers the following Exadata configurations on Oracle Cloud Infrastructure:

System	Number of Compute Nodes	Number of Exadata Storage Servers
Quarter Rack X6	2 nodes (22 to 84 OCPUs and 1,440 GB RAM)	3
Half Rack X6	4 nodes (44 to 168 OCPUs and 2,880 GB RAM)	6
Full Rack X6	8 nodes (88 to 336 OCPUs and 5,760 GB RAM)	12

System	Number of Compute Nodes	Number of Exadata Storage Servers
Quarter Rack X7	2 nodes (2 to 92 OCPUs and 1,440 GB RAM)	3
Half Rack X7	4 nodes (4 to 184 OCPUs and 2,880 GB RAM)	6
Full Rack X7	8 nodes (8 to 368 OCPUs and 5,760 GB RAM)	12

At the time of publishing this paper, SAP might not yet have certified all of the preceding systems. For up-to-date information about certification status, see SAP note 2614028.

Exadata Cloud Service features infrastructure that is dedicated to each customer, to ensure that response times and throughput are predictable for critical business processes. Exadata Cloud Service also allows elastic scaling, which enables you to grow, and later shrink, your database server CPU capacity over your base subscription level to meet your peak or seasonal demands. With this feature, you can add database server OCPUs to achieve a total processor capacity up to the physical maximum of your chosen shape. You can make adjustments completely online as frequently as needed.

Each Exadata Cloud Service Exadata database server is configured as a virtual machine (VM), called DomU, running on an Oracle VM hypervisor on a dedicated physical server. You have root privileges for the Exadata database server DomU and DBA privileges on the Oracle databases. You can configure the Exadata database server according to your requirements and run additional agent software and SAP Infrastructure components on the Exadata database servers to conform to business standards or security monitoring requirements.

On an Exadata database server, you can create numerous database deployments for different SAP applications. Apart from the inherent storage and processing capacity of your Exadata configuration, there is no maximum for the number of database deployments that you can create.

Note: We do not support using Exadata compute 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), integrated lights-out management (ILOM) interfaces, or the Exadata Storage Servers, which are all administered by Oracle.



Exadata Cloud Service Licenses

Exadata Cloud Service is available through two flexible subscription offerings for SAP customers:

- License included
- Exadata Cloud Service Bring Your Own License (BYOL), which is also valid for SAP ASFU licenses

License Included

This subscription model includes all of the features of Oracle Database Enterprise Edition, plus all of the Oracle Database Enterprise Manager Packs and all Database Enterprise Edition Options. These industry-leading capabilities include Database In-Memory, Real Application Clusters (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. Also included in an Exadata Cloud Service PaaS subscription is Oracle Multitenant, which enables high consolidation density, rapid provisioning and cloning, efficient patching and upgrades, and significantly simplified database management.

This subscription model is ideal for customers without existing Oracle Database licenses or for customers who are seeking to use Oracle Database features beyond what they currently have licenses for.

Exadata Cloud Service Bring Your Own License (BYOL)

Exadata Cloud Service 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 on Exadata Cloud Service. Standard Edition is not supported on any Exadata Cloud Service.

When a customer brings a Database Enterprise Edition license entitlement to Exadata Cloud Service, they are granted the rights to use Oracle Transparent Data Encryption (TDE), Diagnostics Pack, Tuning Pack, Data Masking and Subsetting Pack, and Real Application Testing without having on-premises license entitlements for those database options. The Exadata system software is also included in a BYOL subscription, so BYOL customers do not have to bring a license entitlement for the Exadata system software.

Within each Exadata configuration, you can create numerous database deployments for different SAP applications. Apart from the inherent storage and processing capacity of your Exadata configuration, there is no maximum for the number of database deployments that you can create.

Planning Your Exadata Cloud Service for SAP NetWeaver Application Server ABAP/Java

Use the information in this section to plan for using Exadata Cloud Service for SAP NetWeaver Application Server ABAP/Java deployment on Oracle Cloud Infrastructure.

Prerequisites

Request an Exadata Cloud Service for a region and availability domain. The service must be launched by using an Oracle Database 18c database in order to get Oracle Grid Infrastructure 18c installed that supports 12.1, 12.2, and 18c databases. Launching an Exadata Cloud Service on an Exadata X6 Quarter Rack takes up to four hours to deploy. Launching an Exadata Cloud Service on an Exadata X6 Half Rack (four nodes) or Exadata X6 Full Rack (eight nodes) takes respectively longer to deploy. The times required to deploy an X7-based system can differ.

Deployment Restrictions with SAP for Exadata Cloud Service

The following restrictions apply:

- Only Unicode deployments of SAP NetWeaver Application Server ABAP/Java are supported.
- Oracle Database 11g Release 2 is not supported.
- SAP Application Servers on Exadata compute nodes are not supported.
- Preconfigured databases of Exadata Cloud Service cannot be used.
- All databases need to be created by SAP Software Provisioning Manager (SWPM).
- Databases created by SWPM are *not* encrypted. Encryption *must* be enabled as a separate step after successful SAP installation.
- The strong password policy in Exadata Cloud Service must be changed for an SAP installation.

Licenses

If you have already bought Oracle Database licenses from SAP (ASFU), you can transfer them to Oracle Cloud Infrastructure. Notify SAP that you intend to bring your own license (BYOL).

The same applies for licenses that you have bought from Oracle (Full Use, FU). If you have enough licenses, you can also transfer them from on-premises to Oracle Cloud Infrastructure. To ensure that the number of shapes, processors, and cores is correct, we recommend that you check with



your Oracle sales manager or local license sales contact. They will help you set up the correct licensing.

Additionally, you can benefit from Oracle's Bring Your Own License (BYOL) to PaaS program for Exadata Cloud Service, with both ASFU and FU licenses.

For more information about Oracle's BYOL to PaaS program, see the following resources:

- <https://www.oracle.com/cloud/bring-your-own-license/faq/index.html>
- <http://www.oracle.com/us/corporate/contracts/paas-iaas-universal-credits-3940775.pdf>

Support

If you need technical support or help with Exadata Cloud Service, you can go to [My Oracle Support](#) and create a service request. If you encounter any problem with the SAP NetWeaver Application Server ABAP/Java deployment with Exadata Cloud Service, open a support message with SAP support and assign it to the support queue BC-OP-LNX-OLNX.

Customers must purchase the Exadata Cloud Service directly from Oracle to use the Exadata Cloud Service and get support for it. Details about the service provided to the customer are described in [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.
- Request a service limit increase.

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

Documentation

Determine the supported combination of Oracle Linux and Oracle Database for your planned SAP product by using the [SAP Product Availability Matrix](#) (PAM). 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 of the components of your stack: Oracle Cloud Infrastructure, Oracle Linux, Oracle Database, and SAP NetWeaver Application Server ABAP/Java.

Note: [SAP Note 2614028 - SAP NetWeaver on Oracle Database Exadata Cloud Service](#) defines all the technical prerequisites for deploying an SAP NetWeaver Application Server ABAP/Java system with Exadata Cloud Service. This note is updated regularly, so read it before you start any deployment. Information in the note takes precedence over information in this paper.

Workload Size

Estimate the size needed for your SAP installation with the SAP Quick Sizer tool, and calculate the Oracle Database Exadata Cloud Service configuration needed for your SAP workload. For SAPS numbers, consult [SAP Note 2614028](#), although the SAPS numbers listed there are only for a performance indication and have not been achieved by using a high-performance benchmark. The following table shows the current certified Instance Types by SAP. Check [SAP Note 2614028](#) for most current certification status.

Instance Type	OCPU	Memory	Total Usable Storage Capacity
Exadata.Quarter1.84	22–84	1440 GB	84 TB
Exadata.Quarter2.92	8–92	1440 GB	106 TB
Exadata.Half2.184	16–184	2880 GB	212 TB

To run an SAP NetWeaver workload, minimum numbers of OCPUs are needed.

Presales and consulting teams from Oracle will help you make a valid sizing for your planned SAP landscape in the cloud.

Planning the SAP Deployment

Use the information in this section to plan your SAP NetWeaver Application Server ABAP/Java deployment on Oracle Cloud Infrastructure.

This document designs a minimal SAP landscape that consists of an SAP database using Oracle Exadata Cloud Service connected to a single SAP Application Server (Primary Application Server, here referred to as PAS) on a separate Oracle Cloud Infrastructure host. A real-world SAP landscape consists of more than one SAP Application Server, deployed on one or more Oracle Cloud Infrastructure hosts of a certified Oracle Cloud Infrastructure shape.



What You Need

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

The Console is used to manage Oracle Cloud Infrastructure resources. Your account must be enabled to create resources.
- SSH key pairs

You need SSH key pairs to deploy and access Oracle Cloud Infrastructure resources, the Exadata Cloud Service, and at least one certified Oracle Cloud Infrastructure host. See [Creating a Key Pair](#). Password protection of key pairs is required.
- Oracle SAP Bundle Patches for Exadata

For information, see the “SAP Bundle Patch for Oracle Database Exadata Cloud Service: Life Cycle Management for SAP Databases” section in this white paper.
- SAP NetWeaver installation media

Required media and versions of SAP Software Provisioning Manager (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 file system.
- Passwords for various resources

Passwords are used to protect VNC server access, OS user accounts (for X-Windows), Exadata Cloud Service database accounts, and SSH private keys.

General Installation Overview

This section provides an overview of the installation and configuration steps outlined in this paper. Detailed steps follow in the later sections.

The first step is deploying resources in the [Oracle Cloud Infrastructure Console](#). In this use case, you use the Console to create a network that suits your needs, provision the Exadata Cloud Service plus SAP Application Server hosts, and, if necessary, create Object Storage containers. When this step is completed, you have the following items:

- At least one VCN that meets the requirements for deploying the Exadata Cloud Service, plus route tables and security lists
- Private and public IP addresses plus virtual IP addresses of all Exadata nodes

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- Host names, SCAN names, and SCAN IP addresses
 - Private and public IP addresses of all compute nodes, for example, for the SAP Application Servers
 - SSH-based access to all the deployed Compute resources

Before any of the nodes can be used for SAP software, you must perform numerous configuration steps to be able to install SAP software.

- On the Exadata Cloud Service compute nodes, there will be changes to hostname settings, time zones, and local and shared file systems, plus a few more. The tasks to be done there vary among the user accounts `root`, `grid`, `oracle`, and `opc`.
- On the Oracle Cloud Infrastructure compute nodes, there will be changes to hostname settings, time zones, local file systems, and network file systems, plus a few more, before SWPM can be executed to install SAP software.

SWPM must be run on each compute node, so shared access to SAP media simplifies installation.

These preparations are required to be able to run SWPM successfully.

The next major steps are as follows:

1. Install the SAP ABAP SAP Central Services (ASCS) instance, Oracle RAC Database, and the SAP ERS instance on the Exadata compute nodes.
 - Prepare the hosts for running SWPM.
 - Run SWPM on the Exadata compute nodes.
 - Install the SAP ASCS instance on a shared location on the Exadata compute nodes and complete post-configuration steps.
 - Create an Oracle RAC database on the Exadata compute nodes using SWPM.
 - Install SAP ERS on each Exadata compute node.
 - Verify that the database is Oracle RAC.
2. Install the Primary Application Server (PAS) instance on an SAP Application Server compute node.
 - Prepare the host for running SWPM.
 - Run SWPM to install PAS.
3. Configure the SAP GUI to verify that the SAP system is accessible.

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4. Run post-installation steps.
 - Set up Object Storage.
 - Verify readiness by using Object Storage.
 - Set up BR*Tools.
 - Integrate with SAPCTL.
 - Configure HA-NFS for `/sapmnt`.

Implementing the Deployment

This section provides the steps for implementing your planned deployment of SAP NetWeaver Application Server ABAP/Java in Oracle Cloud Infrastructure.

Get Your Oracle Cloud Infrastructure Account

To get your Oracle Cloud Infrastructure account, work with your Oracle account team. They can help you find the best option for structuring your subscription. Options include metered, nonmetered, and trial subscriptions. A convenient way to start immediately is to sign up for a free trial by using the instructions at [Signing Up for Oracle Cloud Infrastructure](#).

Deploy the Oracle Cloud Infrastructure Resources

Deploy the following resources on Oracle Cloud Infrastructure:

- Deploy the VCN
- Deploy the Exadata Cloud Service
- Deploy the Oracle Cloud Infrastructure Compute Instance

Deploy the VCN

1. Log in to the [Oracle Cloud Infrastructure Console](#).
2. Select the region in which you want to deploy your SAP application and provision the related resources.
3. Open the navigation menu, go to **Networking**, and then select **Virtual Cloud Networks**.

You must choose a compartment in which to define a VCN before you can create other resources (for example, compute instances).

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4. [Set up a VCN](#) with required subnets and security lists in a particular availability domain.

In the VCN creation dialog box, we recommend choosing the option to create related resources like subnets and an internet gateway in a single step. Then, you would terminate the subnets for the availability domains where your Exadata Cloud Service is not provisioned and create the client and backup subnets in the same availability domain where your Exadata Cloud Service is provisioned. Your subsequent resources (for example, databases and compute instances) need to be deployed in that particular availability domain and client subnet. For more information, see [Overview of Networking](#) in the Oracle Cloud Infrastructure documentation.

Deploy the Exadata Cloud Service

1. In the Oracle Cloud Infrastructure Console, open the navigation menu and select **Bare Metal, VM, and Exadata**.
2. Ensure that you are in the correct compartment, and then click **Launch DB System**.
3. In the **DB System Information** section of the **Launch DB System** dialog box, provide the following information:
 - Choose an availability domain that you are provisioned to.
 - For the shape type, select **EXADATA**.
 - Select the shape that you want to deploy from the list of SAP certified shapes.
 - Choose the CPU count.
 - Paste your public SSH key.
 - Choose a data storage percentage based on whether you want to keep local backups.
4. In the **Network Information** section, select your new VCN along with the client and backup subnet names. Enter a short hostname prefix.
5. Provide the appropriate values in the **Database Information** section. To deploy the latest Oracle Grid Infrastructure software, the database version needs to be the latest (at least 18.0.0.0.0) deployed. The database will be disabled later and will *not* be used for SAP.
6. Click **Launch DB System**.

Important: After the DB system is provisioned, use the Console to create one additional database for each database version required. Because you launched the DB system with 18c and require a 12.2 or 12.1 database, create one additional database for each of them. This action creates the corresponding ORACLE_HOME for each database software version on each compute node. These databases will be disabled in Oracle Grid Infrastructure and will not be used for SAP, but you *must not delete* one of those databases because doing so would delete the associated ORACLE_HOME on all compute nodes. We recommend this procedure because SAP requires short hostnames with no domain names included. During the steps described in the next sections, you remove this domain name from the actual hostname. This makes it impossible to create additional databases from the Oracle Cloud Infrastructure Console unless the hostnames are changed back to contain domain names.

Deploy the Oracle Cloud Infrastructure Compute Instance

Deploy an Oracle Cloud Infrastructure Compute instance of a supported shape that will host the SAP Primary Application Server (PAS) in the same VCN as the Exadata compute nodes.

In the Oracle Cloud Infrastructure Console, navigate to the **Compute** tab. Supported shape types are referenced in [SAP Note 2474949](#). This white paper uses Oracle Linux 6.10 images.

After all deployments succeed, you can use SSH to log in to all three compute nodes (in the case of an Exadata Quarter Rack deployment). You can log in with the `opc` user and gain root access by using `sudo su -`. Additionally, with the same key as for the `opc` user, you can reach the Oracle account on the Exadata Cloud Service compute nodes.

To summarize:

- `ssh opc@node0` takes you to the `opc` user on Exadata compute node0.
- `ssh oracle@node0` (with the same key as for the `opc` user) takes you into the Oracle user account.

As a consequence, managing SSH keys properly is an important measure.

You have various choices of where to put the compute instances. Following are some possible scenarios:

- Separation of public subnet, management private subnet, and apps and database private subnet
- Same separation as above but also a different private subnet for apps and databases
- Separation of different SAP landscapes in different VCNs
- Separation into test, quality, and production VCNs
- Migration of your existing on-premises network to the cloud



A local firewall for each compute instance that comes from the operating system, and security lists that are part of the Oracle Cloud Infrastructure Networking service, allow and deny specific network traffic. For an SAP deployment, the local firewall must be disabled (which we'll do later in this paper), and only the [security lists](#) for the subnets must be managed. You can get an overview about the required ports for an SAP system from [SAP Help Ports](#).

Prepare Your Environment

You can set up all the resources by using the Oracle Cloud Infrastructure Console or by using automation. Automation provides the advantage of repeatability, while the Oracle Cloud Infrastructure Console provides immediate provisioning and a human-friendly user interface.

1. Set Up the Bastion Host
2. Set Up the ULN Proxy
3. Set Up the NFS Server
4. Set Up the VNC Server
5. Set Up the SAP Download Manager
6. Download Your SAP Software

Set Up the Bastion Host

Oracle recommends that you use Oracle Linux 7 on the bastion host. A bastion host *can* have the following roles:

- Provide a VNC server for graphical access and SSH server from outside. VNC or X-Windows is usually not required for newer versions of SAP SWPM or SAP SUM because they can be accessed from a web browser.
- Deliver graphical workspace for any related operations (for example, download, install, and access).
- Serve as an NFS server to provide SAP installation media, SAP patches, and SAP Bundle Patches for the Oracle Database.
- Work as a ULN Proxy.

Note: For performance reasons, bastion hosts should be located in the same availability domain as the compute nodes if used as NFS servers. The faster approach is to create an NFS file system in Oracle Cloud Infrastructure Console in the respective availability domain and to mount this file system on your compute nodes.



Set Up the ULN Proxy

To ensure that you have the latest operating system updates for Oracle Linux 6 and 7 available from Oracle, register the system with the Oracle Unbreakable Linux Network (ULN) and set up a ULN proxy. A proxy enables you to update compute instances with the latest packages even if the compute instance is not connected to the internet. A requirement for maintaining the proxy is to ensure that sufficient disk space is available to hold all the updates.

Register your Oracle Linux 7 system to ULN and follow the [ULN User's Guide](#) to configure a ULN proxy to mirror the needed local channels. Provide a block volume after you approximate the size of your needed channels.

Set Up the NFS Server

When the bastion host is configured as an NFS server, installation media can be shared securely with other compute instances that do not have internet access. When configuring the NFS server, consider the amount of disk space needed and the security rule configuration.

Configure an NFS server on the bastion host and follow the description in the [Oracle Linux Administrator's Guide for Release 7](#). Define directories for installation media, updates, and the shared SAP file systems after you create and attach the block volumes.

Set Up the VNC Server

GUI access at the operating-system level is needed to run any graphical tools. The native GUI can be accessed by enabling a VNC server on the bastion host. Ensure that security lists are maintained to allow access to only approved sources.

Configure a VNC server on the bastion host and follow the description in the [Oracle Linux Administrator's Guide for Release 7](#). Implement local firewall rules or entries into the security lists to allow access to the virtual cloud network (VCN) from your network outside.

Set Up the SAP Download Manager

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

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 additional Oracle RDBMS and Oracle Client media from the SAP marketplace before downloading all the media.

Prepare Exadata Compute Nodes

This section provides the necessary steps for preparing the Exadata compute nodes.

1. Provision SAP Monitoring
2. Shut Down the Firewall
3. Relax the Password Policies
4. Modify Hostnames
5. Create Additional Databases
6. Raise Values in the `limits.conf` File
7. Disable Unneeded Databases
8. Create a Decently Sized Oracle ACFS
9. Transfer Your SAP Installation Media
10. Adjust the Time Zone of the Compute Nodes
11. Increase the Swap Size
12. Add Users and Groups
13. Enter Virtual Host Names and Their Configuration in `/etc/hosts`

Provision SAP Monitoring

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

With Exadata Cloud Service, the SAP Host Agent needs to run on all the Exadata compute nodes. Installation of the SAP Host Agent either using SAP Software Provisioning Manager (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 - SAP on Linux with Oracle Exadata Cloud: Enhanced Monitoring](#).

For SAP monitoring, the SAP Host Agent consumes Exadata Cloud Service specific configuration and performance metrics collected by a Linux service called `oraescsol`. The `oraescsol` service needs to be installed and started on each Exadata compute node. It is shipped as a Linux RPM called `oraescsol.rpm`.

Part of the `oraescsol.rpm` package is a Python script called `oraecswatcher`, which ensures that updates of the package are applied automatically and that the `oraescsol` service is being started if it is not running. For this, `oraecswatcher` needs to be scheduled as a cronjob to run periodically.

Download the oraescsol Package

For Exadata Cloud Service releases later than 17.4.2.2, the required version of `oraescsol.rpm` is already available on the Exadata compute nodes after initial deployment. Perform the following steps:

1. As the root user, copy `oraescsol.rpm` from `/u02/opt/dbaas_images/oraescsol.rpm` to `/tmp`:

```
[root@nodeN] # cp /u02/opt/dbaas_images/oraescsol.rpm /tmp
```

2. Skip to “Install, Configure, and Start `oraescsol`.”

For Exadata Cloud Service release 17.4.2.2, download latest version of `oraescsol.rpm` from Oracle Cloud Infrastructure Object Storage. As the root user, run the following commands:

1. Move to the temporary directory where `oraescsol.rpm` will be downloaded:

```
[root@nodeN] # cd /tmp
```

2. Look for the latest version of the `oraescsol.rpm` package in Object Storage at <https://storage.us2.oraclecloud.com/v1/dbcswlibp-usoracle29538/SAP>:

```
[root@nodeN] curl -s -X GET https://storage.us2.oraclecloud.com/v1/dbcswlibp-usoracle29538/SAP | grep oraescsol
```

In this example, the command returns:

```
feb2018/oraecscol.rpm
feb2019/oraecscol.rpm
```

3. Pick the latest version and download it:

```
[root@nodeN] # curl -v -s -X GET -o oraecscol.rpm
https://storage.us2.oraclecloud.com/v1/dbcswlibp-
usoracle29538/SAP/feb2019/oraecscol.rpm
```

4. Continue to “Install, Configure, and Start oraecscol.”

Install, Configure, and Start oraecscol

This task assumes that `oraecscol.rpm` is located at `/tmp` and that your current work directory is also `/tmp`.

1. As the root user, issue the following commands:
 - A. Install `oraecscol.rpm`: `rpm -i oraecscol.rpm`
 - B. Enable the service: `chkconfig oraecscol on`
 - C. Start the `oraecscol` service: `service oraecscol start`
2. As the root user, add the following cronjob into the root user’s crontab:
 - A. Edit cron tab: `[root@nodeN] # crontab -e`
 - B. Add:

```
*/15 * * * * sudo /usr/bin/python /opt/oracle.oraecscol/oraecswatcher
```
 - C. Save crontab: `:wq`
3. Check if 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 oraescol are written to `/opt/oracle.oraescol.`

After finishing the whole installation and applying all recommended updates, support packages (SUM), and SAP notes (SAP and the SAP Host Agents are up and running), follow the instructions in [SAP Note 1409604 \(the link in section 1.3\) - Registering SAP NetWeaver Components and Hosts in CEN](#). This note describes how to use SAP transaction RZ21 to register the Exadata compute nodes for SAP central monitoring.

Shut Down the Firewall

On each Exadata compute node, shut down the firewall and keep it down. As the root user, run the following command:

```
[root@nodeN] # /etc/init.d/iptables stop ; chkconfig iptables off
```

If your SSH session stops responding after this step, close it and restart it.

Relax the Password Policies

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

Run the following command as root on each cluster node:

```
[root@nodeN] # /opt/oracle.cellos/host_access_control pam-auth --deny 10 --lock
60 --passwdqc 5,5,5,5,5 --remember 0
```

With this approach, you still cannot run `su - <someuser>` from the `opc` account because of PAM policy, and you must still switch to root via `sudo su - first`.

Modify Hostnames

By default, the hostname command returns an FQDN. However, SAP requires a short hostname with a maximum length of 13 characters.

1. As the root user, open the `/etc/sysconfig/network` file for editing, and shorten the hostname. For example, change `HOSTNAME=node0.exaclient.vcn07200444.oraclevcn.com` to `HOSTNAME=node0`.
2. Save and exit the file.
3. Repeat these steps for all hosts on the cluster with their respective hostnames.

This process is documented in [SAP Note 1996481 - Using correct hostnames for Oracle Exadata Database Nodes](#).

Create Additional Databases

If you need more databases than just the initial one, you can create them. Each database comes with a freshly cloned `ORACLE_HOME`. Follow the steps described in [Managing Exadata DB Systems](#).

Raise Values in the limits.conf File

On each compute node, perform the following steps as the root user:

1. Open `/etc/security/limits.conf` for editing.
2. Add the following lines under the `oracle` entries:

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

3. Save and exit the file.

Disable Unneeded Databases

You might not want or need the preconfigured database or those that are created through additional `ORACLE_HOMES`. Disabling them reduces the runtime footprint (especially disk space on binaries on internal disk drives) of each Exadata Cloud Service compute node.

As the root user, run the following commands:

```
[root@node0] . oraenv [+ASM1]
[root@node0] $ srvctl stop database -d <database name>
[root@node0] $ srvctl disable database -d <database name>
```

Later, you might consider deleting unwanted database files from ASM with the grid account using ASMCMD.

Warning: Do *not* delete databases using `dbaasapi` because this deletes the corresponding ORACLE_HOMEs.

Create a Decently Sized Oracle ACFS

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

```
[opc@node0] sudo su -
[root@node0] su - grid
[grid@node0] asmcmd
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_v1-128
State: ENABLED
Size (MB): 1048576
Resize Unit (MB): 512
Redundancy: HIGH
Stripe Columns: 8
Stripe Width (K): 1024
Usage:
Mountpath:

[grid@node0] $ /sbin/mkfs -t acfs /dev/asm/sapshare_v1-128
mkfs.acfs: version = 12.2.0.1.0
mkfs.acfs: on-disk version = 46.0
mkfs.acfs: volume = /dev/asm/sapshare_v1-128
mkfs.acfs: volume size = 1099511627776 ( 1.00 TB )
mkfs.acfs: Format complete.
[grid@node0] $ exit
[root@node0] $ /sbin/acfsutil registry -a /dev/asm/sapshare_v1-128
/sapshare
```

The preceding commands create a 1-TB cluster file system 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@node0] # mkdir /sapshare/trans
[root@node0] # mkdir /sapshare/sapmnt
[root@node0] # mkdir /sapshare/sapbins
```

3. On each compute node, run the following commands as root (this avoids the `/usr/sap` directory being in the boot partition):

```
[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 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.

If you want to mount an NFS share on each compute node, run `start` as root:

```
[root@nodeN] # service rpcbind start ; service nfs start
```

Adjust the Time Zone of the Compute Nodes

If you intend to keep UTC as the time zone, no change is required. Skip to the next section.

This task requires a reboot of each node. Time zones need to be identical on all Exadata compute nodes, as described in this section, as well as on all SAP Application Servers, as described later during PAS installation. The default time zone after deployment is UTC.

On each Exadata compute node, perform the following steps:

1. As root on each compute node, set the environment (`. oraenv`), putting the respective ASM instance there (for example, `+ASM1`).

```
[root@nodeN] # . oraenv [+ASM[n]]
[root@nodeN] # crsctl stop crs ; crsctl disable crs
```

2. Create a backup copy of the `/opt/oracle/cellos` file.

```
[root@nodeN] # cd /opt/oracle/cellos ; cp -p cell.conf cell.conf.original
```

3. Edit `/opt/oracle/cellos/cell.conf` to change the time zone. For example, change `<Timezone>UTC</Timezone>` to `<Timezone>Europe/Berlin</Timezone>`.

4. Run the following command:

```
[root@nodeN] # cd /etc/sysconfig ; cp -p clock clock.original
```

5. Edit `/etc/sysconfig/clock` to change time zone. For example, change `ZONE="UTC"` to `ZONE="Europe/Berlin"`.
6. Edit `<GI_HOME>/crs/install/s_crsconfig_<hostname>_env.txt` and change the time zone. By default, `GI_HOME` translates to `/u01/app/18.1.0.0 /grid`. For example, change `TZ=UTC` to `TZ=Europe/Berlin`.
7. Run the following commands:

```
[root@nodeN] # cp -p /etc/localtime /etc/localtime.orig
[root@nodeN] # rm /etc/localtime ;
```

8. Soft-link the desired time zone files towards `/etc/localtime`. For example:

```
[root@nodeN] # ln -s /usr/share/zoneinfo/Europe/Berlin /etc/localtime ;
date
[root@nodeN] # crsctl enable crs
[root@nodeN] # reboot
```

Maintaining accurate time is a key requirement for maintaining secure communications because the current time is used when encrypting data. Oracle Cloud Infrastructure provides a private NTP server without the need for a dedicated connection to the internet. It is crucial to have the correct time in an SAP system and the database system so your compute instances are always synchronized. All compute instances of an SAP system have to be in the same time zone.

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 Users and Groups

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

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

Enter Virtual Host Names and Their Configuration in `/etc/hosts`

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

1. For these three resources (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. Edit the `/etc/hosts` file as root and add the following lines. Substitute your SAPSID for mfg.

```
10.0.1.241 ascsmfg
10.0.1.242 ersmfg
10.0.1.243 hanfs
```

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

Next, register these IP addresses with the VCN.

4. Follow the instructions in [Required Keys and OCIDs](#) to create an API key and put the private key into the proper location, for example, `/home/opc/.oci` as shown in step 6. Ensure that the private key file has 600 permissions (`-rw-----`).
5. As root, download the script `addviptovcn.sh` from *one* of the following locations to a temporary directory and change file permissions to `wx` for the user.

```
https://swiftobjectstorage.us-phoenix-
1.oraclecloud.com/v1/exadata/patches/dbaas_patch/sap/tools/addviptovcn.sh

https://swiftobjectstorage.us-ashburn-
1.oraclecloud.com/v1/exadata/patches/dbaas_patch/sap/tools/addviptovcn.sh

https://swiftobjectstorage.eu-frankfurt-
1.oraclecloud.com/v1/exadata/patches/dbaas_patch/sap/tools/addviptovcn.sh

https://swiftobjectstorage.uk-london-
1.oraclecloud.com/v1/exadata/patches/dbaas_patch/sap/tools/addviptovcn.sh
```

For example:

```
cd /tmp
curl -v -s -X GET -o addviptovnc.sh https://swiftobjectstorage.us-phoenix-
1.oraclecloud.com/v1/exadata/patches/dbaas_patch/sap/tools/addviptovcn.sh
chmod +wx addviptovcn.sh
```

6. As root, edit `addviptovcn.sh` and update the following lines with your individual values. The tenancy OCID is located on the [tenancy details page](#) in the Oracle Cloud Infrastructure Console. For example:

```
authUserId="ocid1.user.oc1..exampleuniqueID";
tenancyId="ocid1.tenancy.oc1..exampleuniqueID";
keyFingerprint="47:96:b2:ff:d9:83:7c:51:ec:ee:f5:53:ea:fb:89:44";
privateKeyPath="/home/opc/.oci/oci_api_key.pem";
```

7. Save and exit the file.

8. As root, run the following command:

```
[root@nodeN] # /opt/exacloud/sap/addviptovcn.sh
```

9. Add all of the preceding IP addresses. You need to do this on one host only.

```
Trying to identify API Servers
Identified Region API Host:  iaas.us-phoenix-1.oraclecloud.com

Following Metadata about VNICs is available:
[ {
  "vnicId" : "ocidl.vnic.oc1.phx.exampleuniqueID",
  "privateIp" : "10.0.1.73",
  "vlanTag" : 0,
  "macAddr" : "00:10:7a:fb:db:a0",
  "virtualRouterIp" : "10.0.1.1",
  "subnetCidrBlock" : "10.0.1.0/24",
  "nicIndex" : 0
} ]

Please specify the VNIC OCID to add or delete a VIP
VNIC: ocidl.vnic.oc1.phx.exampleuniqueID >
```

10. Press **Enter**.

The following output is expected:

```
Following IPs exist on the VNIC:
VNIC: ocidl.vnic.oc1.exampleuniqueID

  "ipAddress" : "10.0.1.84",
  "ipAddress" : "10.0.1.73",
  "ipAddress" : "10.0.1.77",

1) Create
2) Delete
3) List
4) Full
5) Quit
Create / Delete / List VIP?
```

Creation of virtual IP addresses prompts for the virtual IP hostname and its IP address. Use numbers 1 through 5 to navigate within the `addviptovcn.sh` menu.

Install SAP NetWeaver Application Server ABAP/Java

This section describes the steps for installing SAP NetWeaver Application Server ABAP/Java, which includes host preparation steps, 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).

1. Change the Root Password on Each Exadata Compute Node
2. About Running SAP SWPM on Compute Nodes
3. Prepare all Exadata Compute Nodes Using SWPM
4. Install the ASCS Instance
5. Move /usr/sap/<SID> to the Shared
6. Install the Enqueue Replication Server
7. Verify the /oracle/<SAPSID> Directory and Create Soft Links for ORACLE_HOMES
8. Patch Oracle Homes Before Installing the Database
9. Relink ORACLE_HOME
10. Install the Database Instance
11. Configure Object Storage
12. Finish the Database Installation

Change the Root Password on Each Exadata Compute Node

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

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

About Running SAP SWPM on Compute Nodes

During the following steps, you run SWPM several times to perform configurations. Current versions of SWPM run in browser mode. To access the SWPM user interface with your browser, you must enable the respective port reported by SWPM in the VCN's security list via the Oracle Cloud Infrastructure Console, such as source=0.0.0.0/0 (restrict if you can for outside access), source ports=any, IP protocol=TCP, and destination port=4237 (the port from the `sapinst` URL).

Following is an example of SWPM's console output:

```
*****
Open your browser and paste the following URL address to access the GUI
https://123.123.123.123:4237/sapinst/docs/index.html
Logon users: [root]
*****
```



When opening the URL in your browser, replace the hostname with the IP address of the host.

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

To avoid the issue of `sapinst` not starting properly because of a missing shared library (see [SAP Note 2195019](#)) please execute the following commands on each compute node), run the following commands:

```
[root@nodeN] # mkdir -p /usr/sap/lib
[root@nodeN] # ln -s /opt/rh/SAP/lib64/compat-sap-c++.so
/usr/sap/lib/libstdc++.so.6
```

Prepare all Exadata Compute 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 wanted to run preparations for Kernel 7.50, you would navigate to **Generic Options > Oracle > Database Tools > RAC/ASM /Exadata Database Instance Preparation ABAP – Kernel 7.50**

Note the following guidelines during the preparation:

- Do *not* provide a `stack.xml` file for host preparations.
- At any SWPM instance, never use the FQDN option.
- All hostnames must be short.
- At the local listener configuration, don't change anything.
- No Oracle 18.1 client is currently available, so use Oracle Client 12.2.
- For the grid installation, choose `/u01/app/18.1.0.0/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 Infrastructure Console (use the short name).
- Verify and, if needed, adjust the hostnames of the cluster member.
- Set up a VCN security list to allow access to SWPM and, later on, SUM from your client where you run your web browser.

After you complete instance preparation on all the compute nodes, on the first node, as the user root, remove all files and directories under the `/usr/sap/MFG/SYS/exe/uc/linuxx86_64` directory and keep the empty directory.

```
[root@node0] # rm -rf /usr/sap/MFG/SYS/exe/uc/linuxx86_64/*
```

Install the ASCS Instance

Run the installation of the ASCS instance on the first compute node. The ASCS instance installation is on a shared resource for later SAPCTL preparation. Previously, in “Enter Virtual Host Names and Their Configuration in `/etc/hosts`,” you registered the ASCS virtual IP address (10.0.1.241). Now you need to start it.

1. Log in as root into the first node and run the following commands:

```
[root@node0] # . oraenv [+ASM1]
[root@node0] # appvipcfg create -network=1 -ip=10.0.1.241 -vipname=tmp -
user=root
[root@node0] # crsctl start res tmp ; crsctl stat res -t
```

2. Check the host location of the resource `tmp`. If it's not located on the first node, relocate it appropriately:

```
[root@node0] # crsctl stat res -t
[root@node0] # 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. For later HA awareness of the ASCS instance, follow [SAP Note 1877857](#). HA-aware ASCS installations need to be on a shared location, namely `/usr/sap/<SAPSID>`. Here you consume `/sapshare` for this, and put this under `/sapshare` from the first host. Ideally, you'd use a separate Oracle ACFS or other shared file system.

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

```
[root@node0] # mkdir -p /usr/sap/tmp ; export TMP=/usr/sap/tmp
```

4. Invoke SWPM on first the compute node using the virtual hostname for ASCS by running `./sapinst SAPINST_USE_HOSTNAME=ascsmfg` 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 during the installation:

- At any SWPM instance, never use the FQDN option.
- All hostnames must be short.

- At the local listener configuration, don't change anything.
- No Oracle 18.1 client is currently available, so use Oracle Client 12.2.
- For the grid installation, choose `/u01/app/18.1.0.0/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 Infrastructure Console (use the short name).
- Verify and, if needed, adjust the hostnames of the cluster member.

Move `/usr/sap/<SID>` to the Shared File System

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

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

```
[root@node0] # cd /usr/sap ; tar -cvf MFG.tar MFG
[root@node0] # 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

Still in the context of [SAP Note 1877857](#), install the Enqueue Replication Server (ERS) on all compute 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 installation is completed on the first node, run the following commands as `SIDADM`:

```
node0: mfgadm> sapcontrol -nr 00 -function Stop
node0: mfgadm> sapcontrol -nr 00 -function StopService
```

3. As root, stop `saphostctrl` and edit the `sapinit` script.

```
[root@node0]# /etc/init.d/sapinit stop
```

Edit the `/etc/init.d/sapinit` file to comment out the following lines (usually 446-452), according to the white paper at [SAP Note 1877857](#). The lines should look as follows:

```
#   for index in `${SEQ_CMD} 0 ${!#g_commands[@]} - 1)`
#   do
#       vv=`sh -c "${g_commands[index]}"`
#       if [ -n "$vv" ]; then
#           echo "failed to start ${g_commands[index]}: $vv"
#       fi
#   done
```

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 <currentnodename>
```

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

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

3. As root, stop `saphostctrl` and edit the `sapinit` script:

```
[root@nodeN]# /etc/init.d/sapinit stop
```

Edit the `/etc/init.d/sapinit` file to comment out the following lines (usually 446-452), according to the white paper at [SAP Note 1877857](#). The lines should look as follows:

```
#   for index in `${SEQ_CMD} 0 ${!#g_commands[@]} - 1)`
#   do
#       vv=`sh -c "${g_commands[index]}"`
#       if [ -n "$vv" ]; then
#           echo "failed to start ${g_commands[index]}: $vv"
#       fi
#   done
```

4. Start `saphostctrl` and the ASCS instance:

```
[root@nodeN]# /etc/init.d/sapinit start
[root@nodeN]# su - mfgadm
nodeN: mfgadm> sapcontrol -nr 00 -function StartService MFG
nodeN: mfgadm> sapcontrol -nr 00 -function Start
```

5. Install the ERS instance.

6. Stop the ASCS instance:

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

After completing installation of ERS on all nodes, perform the following steps:

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

```
[root@node0]# . oraenv
+ASM1
[root@node0]# crsctl relocate res tmp -n <currentnodename>
```

2. As root, restart `sapinit`:

```
# /etc/init.d/sapinit start
```

3. Start the ASCS services manually for the subsequent SAP Database Instance installation:

```
node0: mfgadm> sapcontrol -nr 00 -function StartService MFG
node0: mfgadm> sapcontrol -nr 00 -function Start
node0: mfgadm> sapcontrol -nr 00 -function GetProcessList
```

At this point, you are finished with the contents of [SAP Note 1877857](#). You will finish HA integration later.

Verify the `/oracle/<SAPSID>` Directory and Create Soft Links for `ORACLE_HOME`s

SAP distinguishes between an *installation* `ORACLE_HOME` (called `IHRDBMS` in this context) and a *runtime* `ORACLE_HOME` (called `OHRDBMS` in this context). The `OHRDBMS` is usually defined as a soft link named `<VERSION>` (for example, 18) under `/oracle/<SAPSID>/` that points to the `IHRDBMS` where the Oracle Database software has been installed.

On an engineered system, you do not install Oracle RDBMS software; instead, you use the existing and preinstalled RDBMS 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_HOME` (`OHRDBMS`).

For example:

- `OHRDBMS` is located at `/u02/app/oracle/product/18.0.0.0/dbhome_2`.
- `IHRDBMS` is located at `/oracle/MFG/18` (where 18 is a symbolic link to `OHRDBMS`).
- The `ORACLE_HOME` environment variable equals `/oracle/MFG/18`.

Perform the following steps:

1. On each compute node, verify whether one of the following paths exists:

- `/oracle/<SAPSID>/121`
- `/oracle/<SAPSID>/122`

- /oracle/<SAPSID>/18

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

2. As root on each compute node, run the following commands:

```
[root@nodeN] # mv /oracle/<SAPSID>/121 /oracle/<SAPSID>/was.121
[root@nodeN] # mv /oracle/<SAPSID>/122 /oracle/<SAPSID>/was.122
[root@nodeN] # mv /oracle/<SAPSID>/18 /oracle/<SAPSID>/was.18
```

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

```
MFG:/oracle/MFG/18:N
```

4. As the oracle user on each compute node, create a soft link for the respective ORACLE_HOME.

- For an 18 ORACLE_HOME:

```
[oracle@nodeN] $ ln -s /u02/app/oracle/product/18.0.0.0/dbhome_2
/oracle/<SAPSID>/18
```

- For a 12.2 ORACLE_HOME:

```
[oracle@nodeN] $ ln -s /u02/app/oracle/product/12.2.0/dbhome_2
/oracle/<SAPSID>/122
```

- For a 12.1 ORACLE_HOME:

```
[oracle@nodeN] $ ln -s /u02/app/oracle/product/12.1.0/dbhome_2
/oracle/<SAPSID>/121
```

Patch Oracle Homes Before Installing the Database

Before you can install the SAP database instance, you must patch the Grid Infrastructure and RDBMS software. For instruction, see “Installation of Patches for Oracle Grid Infrastructure Software and the Oracle RDBMS Software.” This applies to all compute nodes.

You also need to perform the post-installation steps in “Run the RDBMS Post-Installation Steps from Patching.” This applies to all compute nodes.

Relink ORACLE_HOME

Note: If you do not perform this step, you cannot create a database for SAP.

On all compute nodes, as the `oracle` user with the proper `ORACLE_HOME` set (`/oracle/<SAPSID>/121` for a 12.1 home, `/oracle/<SAPSID>/122` for a 12.2 home, or `/oracle/<SAPSID>/18` for an 18.x home), run the following command:

```
[oracle@nodeN] $ cd $ORACLE_HOME/rdbms/lib ; make -f ins_rdbms.mk cloud_off
ioracle
```

Install the Database Instance

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

```
[root@leo-ilmsv1 ~]# . oraenv
ORACLE_SID = [+ASM1] ? +ASM1
The Oracle base remains unchanged with value /u01/app/grid
[root@abc-defgh1 ~]# srvctl config scan
SCAN name: abc-defgh-scan.xxxxx.xxxxx.oraclevcn.com, Network: 1
Subnet IPv4: 10.0.1.0/255.255.255.0/bondeth0, static
Subnet IPv6:
SCAN 1 IPv4 VIP: 10.0.1.33
SCAN VIP is enabled.
SCAN VIP is individually enabled on nodes:
SCAN VIP is individually disabled on nodes:
SCAN 2 IPv4 VIP: 10.0.1.32
SCAN VIP is enabled.
SCAN VIP is individually enabled on nodes:
SCAN VIP is individually disabled on nodes:
SCAN 3 IPv4 VIP: 10.0.1.31
SCAN VIP is enabled.
SCAN VIP is individually enabled on nodes:
SCAN VIP is individually disabled on nodes:
[root@abc-defgh1 ~]# srvctl config vip -node `hostname -s`
VIP exists: network number 1, hosting node abc-defgh1
VIP Name: abc-defgh1-vip.xxxxx.xxxxx.oraclevcn.com
VIP IPv4 Address: 10.0.1.29
VIP IPv6 Address:
VIP is enabled.
VIP is individually enabled on nodes:
VIP is individually disabled on nodes:
[root@abc-defgh2 ~]# srvctl config vip -node `hostname -s`
VIP exists: network number 1, hosting node abc-defgh2
VIP Name: abc-defgh2-vip.xxxxx.xxxxx.oraclevcn.com
VIP IPv4 Address: 10.0.1.30
VIP IPv6 Address:
VIP is enabled.
VIP is individually enabled on nodes:
VIP is individually disabled on nodes:
```

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

Adjust SAPDBHOST

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

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

Run orabtt

As the `oracle` user, run the `orabtt` script on each compute node, having the proper environment set. In this example, `MFG` is used as the `SAPSID`. Adjust `SAPSID` according to your environment.

```
[oracle@nodeN] $ export ORACLE_HOME=/oracle/MFG/18 or
[oracle@nodeN] $ export ORACLE_HOME=/oracle/MFG/122 or
[oracle@nodeN] $ export ORACLE_HOME=/oracle/MFG/121
[oracle@nodeN] $ORACLE_HOME/sap/orabtt/orabtt.sh -add -dbsid MFG
```

Verify as follows:

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

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

Check /etc/oratab

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

```
+ASM1:/u01/app/18.1.0.0/grid:N for the first node
+ASM2:/u01/app/18.1.0.0/grid:N for the second node, and so on
```

Ensure That ASCS Is Up at node0

As the `root` user, ensure that the `tmp` resource is at `node0`:

```
[root@node0] # . oraenv [+ASM1]
[root@node0] # crsctl relocate res tmp -n <node0>
```

As the `SIDADM` user, run the following command:

```
node0: mfgadm> sapcontrol -nr 00 -function GetProcessList
```

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

```
node0: mfgadm> sapcontrol -nr 00 -function StartService MFG
node0: mfgadm> sapcontrol -nr 00 -function Start
node0: mfgadm> sapcontrol -nr 00 -function GetProcessList
```

Invoke SWPM as the Root User

Run the following command:

```
[root@node0] # export TMP=/usr/sap/tmp
[root@node0] # </path/to/SWPM/>sapinst
```

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

For disk groups, choose `+DATAC1` and `+RECO1`.

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 = node0-vip:1521
MFG002.local_listener = node1-vip:1521
```

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

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 sequent compute nodes later on.

The database is left in a shutdown state. Start it before running `catsbp` in the next step. For example:

```
[root@node0 ~]# su - oracle
[oracle@node0 ~]$ . oraenv MFG
ORACLE_SID = [oracle] ? MFG
The Oracle base has been set to /u02/app/oracle
[oracle@node0 ~]$ export ORACLE_SID=MFG001
[oracle@node0 ~]$ sqlplus / as sysdba

SQL*Plus: Release 18.0.0.0.0 - Production on Tue Jan 29 08:32:32 2019
Version 18.4.0.0.0

Copyright (c) 1982, 2018, Oracle. All rights reserved.

Connected to an idle instance.

SQL> startup
ORACLE instance started.

Total System Global Area 3.7407E+10 bytes
```

```
Fixed Size          29900600 bytes
Variable Size       1.9059E+10 bytes
Database Buffers    1.8119E+10 bytes
Redo Buffers        199069696 bytes
Database mounted.
Database opened.
```

Run the RDBMS Post-Installation Steps from Patching

From the SAP Bundle Patch README, run `cat.sbp` after setting the required environment variables.

Configure Object Storage

Oracle Cloud Infrastructure Object Storage can be consumed as a durable, efficient, and fast destination for backups, and consequently, a restore and recovery source. In contrast to classic file systems, the interface to Object Storage is provided by an SBT_LIBRARY to Recovery Manager (RMAN). Step-by-step instructions for non-SAP databases are at [Backing Up a Database](#), and at least Java 7 is required to install. This creates the auto-open wallet with the default location of the oracle OS user, `~oracle/hsbtwallet/cwallet.sso`.

A link is established between a Swift Object Store password and the auto-open wallet.

Note: Do *not* run TDE when an auto-open wallet is also present.

This link has the following effects:

- If your `cwallet.sso` is lost and you can't restore it for any reason, re-create it with the Swift password.
- If you lose your Swift password, get a new one and re-create the `cwallet.sso`.
- If you lose both your `cwallet.sso` and your Swift password, create a new Swift password and re-create the wallet.
- You must delete old, unused, unknown Swift passwords.
- You can back up multiple databases into a bucket.
- You can have multiple buckets configured. Consider changing the configuration file (`config_db_name`, the `/lib` storage, and the wallet directory). Before you perform any operation, you must adjust RMAN's configuration as follows:

```
CONFIGURE CHANNEL DEVICE TYPE 'SBT_TAPE' PARMS
'SBT_LIBRARY=/home/oracle/lib/libopc.so,
SBT_PARMS=(OPC_PFILE=/home/oracle/config2)';
```

Using Oracle Exadata Cloud Service, you can consume Object Storage as a backup target and source for restore and recovery. However, with SAP databases, you cannot use the method provided at [Backing Up an Exadata Database](#). Instead, you must follow the following method:

- [Configure an auth token](#) in the Oracle Cloud Infrastructure Console for an account name (impersonalization).
- Configure an Object Storage bucket.

Perform the following steps:

1. Install the needed drivers for RMAN, and then perform this action on each compute node as the oracle user:

```
[oracle@nodeN] $ mkdir cloud_backup ; cd
/var/opt/oracle/ocde/assistants/bkup
[oracle@nodeN] $ cp opc_installer.zip.local ~oracle/cloud_backup
[oracle@nodeN] $ cd ~/cloud_backup ; unzip opc_installer.zip.local
[oracle@nodeN] $ mkdir ~/hsbtwallet ; mkdir ~/lib
```

2. Check the installation options for `opc_install.jar` (java is in your `$PATH` at user oracle):

```
[oracle@nodeN] $ java -jar opc_install.jar
```

3. Invoke the installer with your tenant, user, bucket, and auth token on each node as the oracle user:

```
[oracle@node0] $ java -jar opc_install.jar -opcId 'user@domain' -opcPass
'authtoken' -container <exabackup> -host https://swiftobjectstorage.us-
phoenix-1.oraclecloud.com/v1/<my_tenancy> -walletDir ~/hsbtwallet -libDir
~/lib -configfile ~/config
```

4. Configure RMAN to consume the object storage (have the proper environment for your DBSID set):

```
[oracle@node0] $ rman target /
RMAN> CONFIGURE CHANNEL DEVICE TYPE 'SBT_TAPE' PARMS
'SBT_LIBRARY=/home/oracle/lib/libopc.so,
SBT_PARMS=(OPC_PFILE=/home/oracle/config)';
RMAN> CONFIGURE DEFAULT DEVICE TYPE TO SBT_TAPE;
RMAN> CONFIGURE BACKUP OPTIMIZATION ON;
RMAN> CONFIGURE CONTROLFILE AUTOBACKUP ON;
RMAN> CONFIGURE CONTROLFILE AUTOBACKUP FORMAT FOR DEVICE TYPE SBT_TAPE TO
'%F';
RMAN> CONFIGURE ENCRYPTION FOR DATABASE ON;
```

5. Set parallelism, which speeds up backup and restore activities:

```
RMAN> CONFIGURE DEVICE TYPE 'SBT_TAPE' PARALLELISM 16;
```

At this stage you are almost ready to run a backup. The following step is a test. Setting encryption is mandatory. This command indicates that you're on a non-TDE database.

```
RMAN> set encryption identified by "Oracle123" only;

RMAN> BACKUP INCREMENTAL LEVEL 0 SECTION SIZE 512M DATABASE PLUS
ARCHIVELOG;
RMAN> set decryption identified by "Oracle123";
RMAN> restore database validate check logical;
```

6. On the remaining hosts, confirm their settings after connecting with RMAN, and adjust parameters if needed:

```
RMAN> show all;
```

Now you can perform RMAN backups.

Finish the Database Installation

Perform the following steps to finish the database installation:

1. Verify SIDADM and ORASID Shell Environments
2. Configure Database Linux Huge Pages
3. Adjust Database Parameters
4. Configure HA-NFS for /sapmnt
5. Prepare for SAP BR*Tools
6. Set High Availability for SAP Central Services

Verify SIDADM and ORASID Shell Environments

Because of a bug in SWPM, it is possible that shell environment variables are not properly set. Especially check if `ORACLE_SID` is set properly and reflects the correct thread number for Oracle RAC (for example, `ORACLE_SID=MFG001` for node 1, `MFG002` for node 2, and so on).

For each compute node, log in as the SIDADM user and verify the correct settings for the Oracle-related settings. For example:

```
nodeN: mfgadm> env | grep ORACLE
```

If needed, adjust in the corresponding profiles.

For each compute node, log in as the ORASID user and verify the correct settings for the Oracle-related settings. For example:

```
nodeN: oramfg > env | grep ORACLE
```

If needed, adjust in the corresponding profiles.

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 up and running and all not-required databases are down. Adjust the value for `vm.nr_hugepages` in the `/etc/sysctl.conf` file for each compute 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` if all huge pages have been allocated by the database instance.

Adjust Database Parameters

In addition to the parameters set during installation and patching, adjust your database parameters according to [SAP Note 2660007 – Oracle Database Parameter 12.2 / 18c](#), [SAP Note 2470718 - Oracle Database Parameter \(12.2\)](#), or [SAP Note 2378252 - Oracle Database Initialization Parameters for SAP NetWeaver Systems \(for Oracle 12.1\)](#).

Configure HA-NFS for /sapmnt

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

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

```
[root@nodeN] # /etc/init.d/rpcbind start ; /etc/init.d/nfs start
[root@nodeN] # chkconfig rpcbind on ; chkconfig nfs on
[root@nodeN] # chkconfig --list | grep "nfs\|rpcbind"
```

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

```
[root@node0] # srvctl add havip -id hanfsvip_id -address hanfs -netnum 1 -
description "hanfs"
[root@node0] # srvctl add exportfs -id hanfsvip_id -path /sapmnt -name
hanfs -options "rw,sync,no_root_squash"
[root@node0] # srvctl start havip -id hanfsvip_id
```

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

```
[root@node0] # srvctl status exportfs -id hanfsvip_id
export file system hanfs is enabled
export file system hanfs is exported on node node0

[root@nodeN] # srvctl config havip
```

Prepare for SAP BR*Tools

A previous section described how to integrate Oracle RMAN with Oracle Cloud Infrastructure Object Storage. This section describes how to integrate 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 following unique changes on each compute node:

```
rman_channels = 16
backup_dev_type = rman_disk
rman_sectionsize = 512M
rman_parms =
"SBT_LIBRARY=/home/oracle/lib/libopc.so, SBT_PARMS=(OPC_PFILE=/home/oracle/
config)"
```

Note: 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; connections made with `/` won't work.

For ExaCS where there is a grid user, directories created by SAP BR*Tools require an 775 umask instead of 755 to allow the Oracle ASM instance to copy files to directories owned by `oracle:oinstall`. For this, 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 compute 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 `node0`, `initMFG002.ora` on `node1`, and so on. The content of the `init<DBSID><index>.ora` file is always identical:

```
#Generate initsid.ora for ASM spfile
spfile = (+DATAAC1/MFG/spfileMFG.ora)
```

3. At the same location for each node, as the `oracle` user, you need a password file, `orapw`. Set the environment to the current DBSID, and then run the following commands, replacing `MFG` with the correct ID. The following example demonstrates Oracle 18.5; if you are in an `ORACLE_HOME` running Oracle 12.2 or 12.1, replace 18 with 122 or 121.

```
[oracle@node0] $ cp /oracle/MFG/18/dbs/orapwMFG /oracle/MFG/18/dbs/orapw
[oracle@node0] $ scp /oracle/MFG/18/dbs/orapw
node1:/oracle/MFG/18/dbs/orapw
```

4. Repeat the `scp` commands for additional compute nodes if needed.
5. Ensure that all database instances can be started up properly using `srvctl`.

```
[root@node0 dbs]# su - oracle
[oracle@node0 ~]$ . oraenv
ORACLE_SID = [oracle] ? MFG
The Oracle base has been set to /u02/app/oracle
[oracle@node0 ~]$ srvctl stop database -db MFG
[oracle@node0 ~]$ 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 compute nodes in order 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/rsecssfs ; cd
security/rsecssfs
[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 compute node, run the following command:

```
nodeN: mfgadm> brconnect -u / -c -f chpass -o 'BRT$ADM' -p
'somestrongpassword'

BR0801I BRCONNECT 7.40 (32)

BR0280I BRCONNECT time stamp: 2018-03-08 11:30:09
BR0828I Changing password for database user BRT$ADM ...

BR0280I BRCONNECT time stamp: 2018-03-08 11:30:10
BR0829I Password changed successfully in database for user BRT$ADM

BR0280I BRCONNECT time stamp: 2018-03-08 11:30:10
BR1525I Setting password for user BRT$ADM in secure storage
/oracle/MFG/security/rsecssfs/data/SSFS_MFG.DAT ...

BR0280I BRCONNECT time stamp: 2018-03-08 11:30:16
BR1526I Password set successfully for user BRT$ADM in secure storage
/oracle/MFG/security/rsecssfs/data/SSFS_MFG.DAT

BR0280I BRCONNECT time stamp: 2018-03-08 11:30:16
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> brarchive -u // -q
```

Set High Availability for SAP Central Services

Use the latest `sapctl` package from [SAP Note 1496927](#), which is version 9.0 Patch 1 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@node0] # . oraenv [+ASM1]
[root@node0] # crsctl stop res tmp
[root@node0] # 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:

```
[root@node0] # /usr/sap/sapctl/bin/sapctl create -sapsid MFG -if bondeth0 -nm
255.255.255.0 -net 10.0.1.0 -nodes node0,node1 -abapenq ASCS00 -abapvip
10.0.1.241 -abapmsport 3900 -abaprep ERS01 -aersvip 10.0.1.242
```

```
[root@node0] # /usr/sap/sapctl/bin/sapctl start all -sapsid MFG
```

Install the Primary Application Server

This section provides instructions for installing the SAP Primary Application Server (PAS).

1. Relax the Password Policy
2. Edit `/etc/hosts`
3. Use Block Storage or Local NVMe Storage
4. Ensure that `/usr/sap` Is Not in the Boot Partition
5. Stop the Local Firewall
6. Mount `/sapmnt` from HA-NFS
7. Install Additional Software Packages
8. Start the `uidd` Daemon
9. Provide a Strong Password for the `opc` User
10. Start `vncserver`
11. Install the Compatibility Package as Needed
12. Install SAP PAS
13. Configure the SAP GUI

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.



Make the following changes to the `/etc/pam.d/system-auth` file:

- Comment out the line that starts with `"password requisite pam_cracklib.so"`.
- 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 IPs for the following:

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

For example:

```
10.0.1.26 sape2eappl
10.0.1.19 node0
10.0.1.20 node1
10.0.1.21 node0-vip
10.0.1.22 node1-vip
10.0.1.23 scan-vip
10.0.1.24 scan-vip
10.0.1.25 scan-vip
10.0.1.241 ascsmfg
10.0.1.242 ersmfg
10.0.1.243 hanfs
```

Use Block Storage or Local NVMe Storage

Supported Oracle Cloud Infrastructure shapes need some file system storage in which to store SAP software. In the smallest supported shape, only [Oracle Cloud Infrastructure Block Volume storage](#) is available. Create one or more file systems according to the Linux documentation.

Ensure that `/usr/sap` Is Not in the Boot Partition

Earlier in this document, when setting up the Exadata compute nodes, you created a file system `/u02`, and then linked `/usr/sap` to `/u02/sap`. Do the same for the primary application server 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] # /etc/init.d/iptables stop ; chkconfig iptables off
```

Mount /sapmnt from HA-NFS

1. Run the following command:

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

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

```
hanfs:/sapshare/sapmnt /sapmnt nfs rw,bg,nosuid 0 0
```

3. Save and exit the file.

Install Additional Software Packages

Run the following commands:

```
[root@pas] # yum -y groupinstall "Base" "Compatibiliy Libraries" "Debugging Tools" "Directory Client" "Hardware Monitoring Utilities" "Large Systems Performance" "Perl support" "Storage Availability Tools" "X window system" "Development tools"
```

```
[root@pas] # yum -y install tigervnc-server liberation-mono-fonts gnome-session gnome-terminal gnome-screensaver gnome-panel compat-libstdc++-33 compat-libcap1 libaio-devel ksh uidd vim parted xorg-x11-xauth xclock
```

Start the uidd Daemon

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

```
[root@pas] # /etc/init.d/uidd start ; chkconfig uidd on
```

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 and start ntpd.

- A. Edit /etc/sysconfig/clock and replace the default time zone with the time zone required, if necessary. For example, change ZONE="GMT" to ZONE="Europe/Berlin".

- B. Link /etc/localtime to your OS time zone file:

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

- C. Start ntpd and configure it to start automatically:

```
[root@pas] # service ntpd start ; chkconfig ntpd on
```

- D. Reboot.

Provide a Strong Password for the opc User

This step is required only if you plan to use X-Windows on the PAS compute node (for example, for SAPPlatinGUI). To work with X-Windows, the `opc` user should require a strong password to unlock the X screensaver.

Run the following command and set a strong password:

```
[opc@pas] $ passwd
```

Note the password and keep it handy.

Start vncserver

This step is required only if you plan to use X-Windows with VNC server on the PAS compute node (for example, for SAPPlatinGUI).

1. According to the least-privilege scheme, as the `opc` user, start a `vncserver`:

```
[opc@pas] $ vncpasswd ; vncserver -geometry 1280x1024 ; sudo su -
```

2. As root, add an entry to `/etc/sysconfig/vncservers`:

```
VNCSERVERS="2:opc"  
VNCSERVERARGS[2]="-geometry 1280x1024 -nolisten tcp -localhost"
```

Here, the local port becomes 5902.

3. Save and exit the file.
4. Make `vncserver` start with the OS startup, as root:

```
[root@pas] # chkconfig vncserver on
```

Install the Compatibility Package as Needed

This step is only for Oracle Linux 6.

Check [SAP Note 2195019 - Linux: Using SAP kernel 748 and higher or SAPinst 749 and higher on RHEL 6, OL6 and SLES 11](#) and install the required package from the ULN channel as indicated in the note. Then, create the symbolic link as follows:

```
[root@pas] # mkdir /usr/sap/lib ; ln -s /opt/rh/SAP/lib64/compat-sap-c++.so  
/usr/sap/lib/libstdc++.so.6
```

Install SAP PAS

1. As root, change the password for yourself on each compute node. SWPM will ask for authentication:

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

Current versions of SWPM run in browser mode. To access the SWPM user interface with your browser, you must enable the respective port reported to you in the VCN's security list via the Oracle Cloud Infrastructure Console, such as `source=0.0.0.0/0` (restrict if you can for outside access), `source ports=any`, `IP protocol=TCP`, and `destination port=4237` (the port from the `sapinst` URL).

2. Run SWPM:

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

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

This displays the URL for your browser.

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 user `root` and its password.
6. When you are prompted to run a script as the `oracle` user on the Exadata compute nodes, 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 execute the script.
7. In SWPM, click to continue the installation of PAS.

Configure the SAP GUI

Install and configure SAP GUI for Java on the bastion host that is running Oracle Linux. With the unified SAP front end, you can connect to SAP NetWeaver ABAP installations. Details are described in SAP Note 146505 and on the [SAP Community Wiki](#).

SAP GUI for Java needs configuration information about your SAP environment, such as the names and addresses of your SAP servers. Based on this information, a connection directory is created that contains all available connections that can be selected in the SAP logon list. This directory can be centrally stored on a web server, and only a URL needs to be configured in SAP GUI for Java. Preset configuration and options can be distributed as templates during the initial installation process, so that a manual configuration after a first installation of SAP GUI for Java is not required. Access to the SAP ports for the connection needs to be created in the security lists.

Revert Changes on the Exadata Compute Nodes and the SAP Application Servers

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

- 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`.
- If you added SSH keys that were needed for installation purposes only to the `authorized_keys` file or `key` files, delete them, and take extra care doing so.
- Modify your VCN's security lists to close routes that were needed solely for installation. For example, remove destination port 4237 used for `sapinst` HTTPS installation.

Enable Transparent Data Encryption for All Tablespaces

To protect your database in the cloud, you must enable tablespace encryption. In this example, we use a file-based encryption wallet located on Oracle ASM to share it across all database instances.

Relink Oracle Home

On all compute nodes, as the `oracle` user with the proper Oracle home set (`/oracle/<SAPSID>/121` for a 12.1 home, `/oracle/<SAPSID>/122` for a 12.2 home, or `/oracle/<SAPSID>/18` for an 18.x home), stop the databases and run the following command:

```
[oracle@nodeN] $ cd $ORACLE_HOME/rdbms/lib ; make -f ins_rdbms.mk cloud_on  
ioracle
```

Oracle Database Release 18c

Starting with Oracle Database Release 18c, we recommend that you specify the storage location for your encryption wallet by using the Oracle initialization parameter `wallet_root` and specify the Oracle initialization parameter `tde_configuration` to specify the type of keystore.

For example:

1. Create the directories on ASM to store the encryption wallet:

```
[root@node0] # . oraenv [+ASM1]
[root@node0] # asmcmd
ASMCMDB> mkdir +DATAAC1/MFG/orawallet
ASMCMDB> mkdir +DATAAC1/MFG/orawallet/tde
```

2. Set `tde_configuration` and `wallet_root` on the first compute node as user `mfgadm`.

```
> sqlplus / as sysdba

alter system set tde_configuration="KESTORE_CONFIGURATION=FILE"
SCOPE=spfile;
alter system set wallet_root='+DATAAC1/MFG/orawallet'
```

Note: When you use `wallet_root`, the subdirectory `/tde` is added automatically by Oracle.

3. Restart the database:

```
srvctl stop database -db MFG -stopoption immediate -force
srvctl start database -db MFG
```

To finish setting up TDE and tablespace encryption, follow SAP Note 2591575.

Oracle Database Release 12c

For Oracle Database 12c, we recommend that you follow SAP Note 2591575. If you choose to create a file-based encryption wallet, we recommend that you configure a location on Oracle ASM, too, as shown earlier.

For example, specify your encryption wallet location in `SQLNET.ORA` on the client *and* server.

```
ENCRYPTION_WALLET_LOCATION =
( SOURCE=
( METHOD=FILE )
( METHOD_DATA=
( DIRECTORY=+DATAAC1/MFG/orawallet/tde )))
```



SAP Bundle Patch for Oracle Database Exadata Cloud Service: Life Cycle Management for SAP Databases

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

- Oracle RDBMS software
- Oracle Grid Infrastructure software
- Oracle Database Exadata Cloud Service tooling
- Exadata Image (OS)

This section describes how to install patches for the preceding components of an Exadata Cloud Service instance running databases for SAP applications. For more general information about Exadata Cloud Service versions and patches, see My Oracle Support Note 2333222.1 (“Exadata Cloud Service Software Versions”).

Note that some components of the Exadata Cloud Service are managed by Oracle:

- Exadata Storage Server hardware (Cell), firmware, and software
- Exadata Database Server hardware, firmware, and the Oracle Virtualization Server (OVS) management domain (DOM0)
- InfiniBand (IB) switch hardware and firmware
- Power distribution units (PDU)

In all but exceptional circumstances, you will 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 virtual machine environment, Oracle will also provide notification about these. You cannot opt out of updates. For more information, see My Oracle Support Note 2124174.1 (“Oracle Database Cloud Exadata Service Supported Software Versions and Planning for Updates”).

Any updates to the preceding components are done by Oracle 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 Service databases. Oracle therefore strongly recommends shutting down any SAP applications during an update of these components, provided that the update requires the shutdown of nodes of your Exadata Cloud Service instance.



Installation of Patches for Oracle Grid Infrastructure Software and the Oracle RDBMS Software

An Oracle Database Exadata Cloud Service instance requires the following bundle patch for an update of its Grid Infrastructure and RDBMS components (the patch versions shown are current at the time of this writing):

- SAP Bundle Patch 18.5.0.0.0 – 201902 for Exadata Cloud Service
- SAP Bundle Patch 12.2.0.1.0 - 201902 for Exadata Cloud Service
- SAP Bundle Patch 12.1.0.2.0 - 201902 for Exadata Cloud Service

Oracle tests and certifies these patches and their successors for SAP databases on a regular basis and makes them available for SAP customers on My Oracle Support or the SAP Service Marketplace. You can find up-to-date release information about the patches and their download locations in [SAP Note 2660062 - Oracle Exadata Cloud Service: Patches for 18.5.0.0](#), [SAP Note 2618837 - Oracle Exadata Cloud Service: Patches for 12.2.0.1](#) and [SAP Note 2618881 - Oracle Exadata Cloud Service: Patches for 12.1.0.2](#).

Notes:

During the deployment of an Exadata Cloud Service instance, a particular Database Bundle Patch or Database Release Update is used for the Grid Infrastructure homes and the RDBMS homes. You must choose SAP Bundle Patches based on the Database Bundle Patch or Database Release Update that are equal to or later than this version.

Do *not* use the `exadbcpatchmulti` utility from the Exadata Cloud Service tooling to install any Grid Infrastructure or RDBMS patches. Install them following the instructions from the SAP Bundle Patch readme instead.

Ensure that the operating system environment requirements are fulfilled on all nodes of the Exadata Cloud Service 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 SAP Bundle Patch for Exadata Cloud Service. This process usually includes the following steps:

- Install the latest OPatch and MOPatch utilities.
- Install the Grid Infrastructure patches in the grid homes.
- Install the RDBMS patches in the RDBMS homes.
- Run post-installation instructions, most notably the `catsbp` script.



Note: Depending on the content of the SAP Bundle Patch, its installation can be non-RAC-rolling. See the SAP Bundle Patch readme for more information.

Installation of Patches for the Oracle Database Exadata Cloud Service Tooling

Follow the [steps described in the Oracle Cloud Infrastructure documentation](#) to patch the Oracle Database Exadata Cloud Service Tooling.

Installation of Operating System Patches

Use the tools and methods provided by the operating system to prepare and populate the yum repository with Exadata channel content. [The method is outlined in the Oracle Cloud Infrastructure documentation.](#)

High Availability with Oracle Data Guard

Oracle Data Guard provides additional high availability for the Oracle Database of an SAP installation with Exadata Cloud Service. 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 fulfils the same SAP system requirements as the primary database, for example, identical operating system 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 reconnect of the SAP instances to the standby database.

For more information about using Oracle Data Guard in Exadata Cloud Service, see the [Exadata Cloud Service 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](#)

SAP Notes

- [2614028 - SAP NetWeaver on Oracle Database Exadata Cloud Service](#)
- [2614080 - SAP on Linux with Oracle Database Exadata Cloud Service: Enhanced Monitoring](#)
- [2474949 - SAP NetWeaver on Oracle Cloud Infrastructure](#)
- [2660007 - Oracle Database Parameter 12.2 / 18c](#)
- [2470718 - Oracle Database Parameter \(12.2\)](#)
- [2378252 - Oracle Database Initialization Parameters for SAP NetWeaver Systems](#)
- [2520061 - SAP on Oracle Cloud Infrastructure: Support prerequisites](#)
- [1565179 - SAP software and Oracle Linux](#)
- [2195019 - Linux: Using SAP kernel 7.48 and higher or SAPinst 7.49 and higher on RHEL6, OL6 and SLES11](#)
- [1877857 - Installation and Configuration SAP HA ASCS/ERS on ODA](#)
- [1635808 - Oracle Linux 6.x: SAP-Installation and Upgrade](#)
- [1597355 - Swap-space recommendation for Linux](#)
- [1770532 - HugePages on Linux for Oracle Database](#)
- [1672954 - Oracle 11g and 12c: Usage of hugepages on Linux](#)
- [1871318 - Linux: Disable Transparent HugePages for Oracle Database](#)

- 
- [146505 - SAP GUI for the Java Environment](#)
 - [1914631 - Central Technical Note for Oracle Database 12c Release 1 \(12.1\)](#)
 - [2470660 - Oracle Database Central Technical Note for 12c Release 2 \(12.2\)](#)
 - [2660020 - Central Technical Note for Oracle Database 18c](#)
 - [1868094 - Overview: Oracle Security SAP Notes](#)
 - [1996481 - Using correct hostnames for Oracle Exadata Database Nodes](#)
 - [1496927 - Protection of SAP instances through Oracle Clusterware](#)
 - [2591575 - Using Oracle Transparent Data Encryption \(TDE\) with SAP Netweaver](#)
 - [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](#)
 - [2618837 - Oracle Exadata Cloud Service: Patches for 12.2.0.1](#)
 - [2618881 - Oracle Exadata Cloud Service: Patches for 12.1.0.2](#)
 - [2660062 - Oracle Exadata Cloud Service: Patches for Oracle 18c](#)

Oracle

- [Oracle Database Exadata Cloud Service](#)
- [Oracle Cloud Infrastructure – Exadata DB Systems](#)
- [Oracle Cloud Hosting and Delivery Policies](#)
- [Oracle Database](#)
- [Oracle Linux](#)
- [Oracle-SAP Solutions site](#)
- [MOS 1934030.1 - ODA \(Oracle Database Appliance\): HowTo export ACFS \(cloudfs\) using HANFS](#)



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Integrated Cloud Applications & Platform Services

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