

BEST PRACTICES

Oracle on Nutanix

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Nutanix, Inc.
1740 Technology Drive, Suite 150
San Jose, CA 95110

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1. Executive Summary

Nutanix software provides a complete datacenter infrastructure solution for your production and development Oracle Databases, eliminating the complexity of traditional IT infrastructure. Nutanix delivers predictable performance, linear scalability, and web-scale cost efficiency for your transactional and analytical Oracle Database environments. With powerful self-healing, data protection, and disaster recovery capabilities, Nutanix keeps your applications running and your critical data protected on VMware vSphere or Nutanix AHV. As a member of the Oracle PartnerNetwork (OPN) program, Nutanix is committed to your success.

Nutanix reduces operational costs by simplifying daily database management tasks with Nutanix Database Service (NDB). NDB streamlines and simplifies Oracle Database administration, helping you drive efficiency, agility, cost-effectiveness, and scalability. With one-click provisioning, patching, and cloning, NDB provides simplicity, security, and standardization on-premises and across clouds.

2. Introduction

Audience

This best practice guide is part of the Nutanix Solutions Library for Oracle. We wrote it for individuals designing and maintaining Nutanix solutions for single-instance Oracle Database servers or Real Application Clusters (RAC) deployments. Readers should be familiar with:

- Oracle Database administration.
 - Nutanix cluster administration (hypervisor, networking, storage).
 - Linux and Windows OS (guest OS that Oracle Database runs on).
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Purpose

This document provides design, configuration, and optimization guidelines for a single instance of Oracle Database and Oracle RAC running on Nutanix. In this document, we cover the following best practice topics:

- Overview of Nutanix AOS and Nutanix Database Service.
- Linux and Windows OS best practices for Oracle on Nutanix.
- Nutanix storage configuration.
- In-guest configuration.

Unless otherwise stated, the solution described in this document is valid on all supported AOS releases.

Document Version History

Version Number	Published	Notes
1.0	September 2014	Original publication.

Version Number	Published	Notes
2.0	February 2017	Updated with current Nutanix platform information.
2.1	May 2017	Updated provisioning recommendations and noted VMware ESXi 6.0.0 support for adding disks online in Oracle RAC environments.
2.2	January 2018	Updated the platform overview and the Nutanix Platform Guidance section.
3.0	November 2018	Updated product information and the Best Practices section.
3.1	December 2018	Updated the Best Practices section.
3.2	March 2019	Added the Nutanix Era section and updated the OLTP Scenario Detail and OLAP Scenario Detail tables.
4.0	June 2019	Major updates throughout.
4.1	April 2020	Updated the Nutanix Enterprise Cloud Overview section and added iSCSI configuration settings.
4.2	September 2020	Updated the Nutanix overview and ASM Settings sections.
5.0	April 2021	Consolidated Oracle guides and updated content.

Version Number	Published	Notes
5.1	August 2021	Minor updates to the Oracle Automatic Storage Management (ASM) Settings and vDisk Configuration sections.
5.2	November 2021	Updated the Volume Management for Oracle vDisks section.
5.3	March 2022	Minor update to the Volume Management for Oracle vDisks section.
5.4	August 2022	Updated Oracle Guest VM Configuration section and added other minor updates throughout.
5.5	February 2023	Minor updates to the vDisk Configuration and Volume Management for Oracle vDisks sections.

3. Nutanix Database Service

Nutanix Database Service (NDB) simplifies database management across hybrid multicloud environments for database engines like PostgreSQL, MySQL, Microsoft SQL Server, and Oracle Database, with powerful automation for provisioning, scaling, patching, protection, and cloning of database instances. NDB helps customers deliver Database-as-a-Service (DBaaS) and an easy-to-use self-service database experience on-premises and public cloud to their developers for both new and existing databases.

4. Oracle on Nutanix

Digital transformation demands that IT services become more agile, shorten application deployment time, and increase scalability. Designed to run any application, Nutanix software converges storage and compute, eliminating the complexity of separate standalone storage solutions. Nutanix supports VMware vSphere, Microsoft Hyper-V, and Nutanix AHV, allowing you to choose the right hypervisor for your needs.

Using the advanced storage functionality of Nutanix Volumes, your workloads get all the foundational Nutanix benefits, such as backup and recovery, disaster recovery, snapshots, clones, and high performance.

Running Oracle on Nutanix offers several advantages:

Simplicity

You can deploy your database in minutes with NDB, which means a shorter time to production. NDB also simplifies management with a single management pane and one-click life-cycle management (LCM) that includes database patching. With NDB, you don't have to worry about storage area network (SAN) management tasks such as multipathing, zoning, or masking.

Fault-tolerant platform

Nutanix uses high availability and data redundancy to withstand software and hardware failures, allowing your Oracle Database to stay up and running even if the underlying hardware has issues.

Enterprise-grade performance

Nutanix provides I/O latency of less than a millisecond and predictable performance, while supporting a wide range of transactional and analytical database workloads, including Oracle Automatic Storage Management (ASM) and Oracle RAC.

Scalability

With the Nutanix solution, you can start small and scale performance and capacity nondisruptively as your needs grow.

Enterprise-grade disaster recovery

In addition to Oracle's native data protection capabilities, Nutanix offers integrated snapshots, remote replication, and metro-level availability to protect the data.

5. Hardware Best Practices

Select hardware that meets your compute, storage, and networking requirements.

Nutanix Node Type

The Nutanix cloud platform OS runs on commodity servers from a wide variety of hardware vendors, and you can use the Acropolis Operating System (AOS) in two different modes: fully hyperconverged (HCI) or storage only. The following table describes the node types.

Table: Operating Modes of a Nutanix Node

Node Type	Guest VMs	Storage	Purpose
HCI	Yes	Yes	General purpose nodes
Storage only	No	Yes	Add storage to a cluster

HCI nodes host storage services and guest VMs running Oracle. Storage-only nodes are nonschedulable, so they only host storage services (no guest VMs), which can be useful from an Oracle licensing perspective. We designed storage-only nodes to expand the storage capacity of an existing Nutanix cluster.

Processor

Select a processor with a high clock speed and 12 or more cores per socket on dual-socket servers. We recommend that you select at least a 2.9 GHz CPU (with SPEC 55 or greater per core on the [SPEC CPU 2017](#) benchmark) for production Oracle Databases.

Memory

Use a balanced memory configuration. A balanced memory configuration delivers the highest bandwidth between the processor and memory and the best performance for CPU-intensive applications. The number of DIMMs required for balanced memory varies by model.

Storage

Use all-flash storage for Oracle Databases. You can reduce long-term storage costs for backups and archived data by using [Nutanix Objects](#) or [Files](#) on a separate hybrid storage cluster for cost efficiency.

Networking

In a cloud architecture, Ethernet handles the data previously handled by a SAN. High-performance networking is the key to good Oracle Database performance on Nutanix. Networking best practices include the following:

- Use redundant 25 GbE or faster uplinks from each Nutanix node.
- Enable LACP in an active-active configuration.
- Connect all the nodes in a Nutanix cluster to the same pair of switches.
- Use a dedicated VLAN for Oracle RAC Cache Fusion (heartbeat) networks on each Nutanix node.

For more information on networking, check out the following documents:

- [Nutanix Physical Networking Best Practices](#)
- [AHV Networking Best Practices](#)
- [VMware vSphere Networking Best Practices](#)

6. Nutanix Configuration

Controller VM

Nutanix Foundation provisions Controller VMs (CVMs) during the Nutanix cluster installation process. The number of vCPUs allocated to a CVM is based on the number of cores per socket in the server hardware.

Table: Recommended CVM vCPU and Memory Settings

Parameter	Default	Heavy Oracle Workload
vCPU	12	16
Memory	32 GB	64 GB

All vCPUs for a CVM must fit in a single socket; if you have more than 12 cores per socket you can increase the number of vCPUs assigned to the CVM. For heavy I/O workloads, increase the CVM memory to 64 GB to provide metadata caching space and reduce latency.

Cluster Resilience

Nutanix AOS supports two levels of fault tolerance (FT). Clusters with three or four nodes are FT1, and you can configure clusters with five or more nodes as FT1 or FT2. To achieve application fault tolerance, ensure that the cluster has enough free memory and vCPU capacity available for critical workloads to fail over to another node. With AHV you achieve application fault tolerance by enabling [high availability reservations](#). Replication factor 2 or 3 is defined per storage container.

Table: Minimum Number of Nodes Required for FT1 and FT2

Resiliency Level	Min. Cluster Nodes	Node Failure Redundancy
FT1	3	$n - 1$
FT2	5	$n - 2$

* n = total number of nodes in cluster

Storage Container

For Oracle Databases, create a storage container with replication factor 2 (FT1) or 3 (FT2 clusters only) with inline compression enabled. The following table details the recommended Nutanix storage configuration. When you configure the file system, use an allocation size of 1 MiB on Linux and 64 KiB or larger on Windows for best performance.

Table: Recommended Storage Container Configuration

Nutanix Feature	Property	Comments
Container	Create one for Oracle Databases	Standard practice for Oracle VM and Oracle data
Container compression	Enable, delay 0	Standard practice for space savings
Container erasure coding	Disable	Not recommended for Oracle Databases
Container deduplication	Disable	Not recommended for Oracle Databases

7. Oracle Guest VM Configuration

When you deploy an Oracle Database server VM on Nutanix, good performance is critical, so start with the following guidelines:

- Don't overcommit CPUs on the node running the database server VM.
- On ESXi, lock Oracle Database VM memory at a minimum reserve sufficient to cover both the system global area (SGA) HugePages and the Program Global Area (PGA).
- Don't set the AOS parameter num_vnuma_nodes (available in the aCLI).
- Configure HugePages to accommodate the combined SGAs of all databases running on the VM.

NDB automatically provisions Oracle Database VMs and Oracle Databases in accordance with these best practice guidelines. NDB considers compute, storage, networking, and Oracle Database parameters and offers a variety of Oracle Database and OS versions.

Most Oracle Database server VMs use multiple network interfaces. On ESXi, the recommendation is to use a VMXNET3 (VMXNET Generation 3), which is a virtual network adapter designed to deliver high performance in VMs running on vSphere. On AHV the best adapter type is automatically selected when you add a NIC.

Table: Common Network Setup for Oracle

vNIC	Purpose
eth0	guest-VM VLAN
eth1	Oracle RAC heartbeat and Cache Fusion
eth2	iSCSI (ESXi only)
eth3	SCAN IPs and SCAN Virtual IP

Database Settings for Oracle Single Instance and RAC

The following table shows the recommended settings for single-instance Oracle Databases and Oracle RAC.

Table: Recommended Oracle Instance Parameters

Setting	Value	Purpose
filesystemio_options	setall	This parameter allows direct I/O and async I/O when using a file system such as ext4 or XFS. It is not required when using Oracle ASM.
parallel_threads_per_cpu	1	Degree of parallelism. On Nutanix, it is 1 per vCPU.

Oracle Automatic Storage Management (ASM) Settings

Oracle ASM is a volume manager and file system for Oracle Database files that supports single-instance Oracle Database and Oracle RAC configurations on Linux and Windows. Oracle ASM is Oracle's recommended storage management solution and provides an alternative to conventional volume managers, file systems, and raw devices. Oracle ASM uses disk groups to store data files; an Oracle ASM disk group is a collection of disks that Oracle ASM manages as a unit. Within a disk group, Oracle ASM exposes a file system interface for Oracle Database files. The content of files stored in a disk group is evenly distributed to eliminate hot spots and provide uniform performance (comparable to the performance of raw devices) across the disks.

Nutanix supports Oracle ASM disks on Linux and Windows. On Linux you can use udev devices, ASMLib devices, or ASMD (ASM Filter Driver) devices.

- Udev (userspace /dev) is a device manager for the Linux kernel. Udev primarily manages device nodes in the /dev directory and handles all user space events raised when you add hardware to or remove hardware from the system.

- ASMLib simplifies the configuration and management of block disk devices by eliminating the need to rebind block disk devices used with Oracle ASM each time the system restarts. With Oracle ASMLib, you define the range of disks you want to make available as Oracle ASM disks. Oracle ASMLib maintains permissions and disk labels that are persistent on the storage device so that the label is available even after an operating system upgrade.

Note: ASMLib is available with Oracle versions 11g and newer.

- ASMFd is a kernel module that resides in the I/O path of the Oracle ASM disks. Oracle ASMFd simplifies the configuration and management of disk devices by eliminating the need to rebind disk devices used with Oracle ASM each time you restart the system. The ASMFd feature rejects write I/O requests that aren't issued by Oracle software. This filter ensures that users with administrative privileges can't inadvertently overwrite Oracle ASM disks, which prevents corruption in those disks and files in the disk groups.

Nutanix performance testing shows that ASMFd and udev yield similar results, so you can deploy whichever device you're most comfortable with on your Nutanix cluster. Refer to [Oracle documentation](#) for more information on how to deploy Oracle ASM.

Note: ASMLib wasn't part of this performance study.

The following table shows the recommended settings for all ASM disk groups. For information on setting these parameters, refer to the Automatic Storage Management Administrator's Guide for your version of [Oracle](#).

Table: Recommended Settings for Oracle ASM Disk Groups

Settings	Values
ASM Allocation Unit (AU) size (AU_SIZE)	1 MB
ASM OCR disk group redundancy	Normal/High
ASM DATA disk group redundancy	External
ASM FRA disk group redundancy	External

Configure Linux for ASM on Nutanix

When a node leaves the cluster because of a reboot or network issue, the disk timeout 200 isn't considered. Instead, the Oracle RAC uses misscount and reboottime parameters (misscount - reboottime) to calculate short disk timeout (SDTO).

In this example, the misscount is 30 and reboottime is 3, so the disk timeout is 27 seconds. When a Nutanix node reboots, it may take more than 27 seconds to rehost the vDisk, which means there's a chance the Oracle RAC may miss the disk heartbeat. There are two steps you can take to configure an Oracle VM on Nutanix to tolerate this time: increase the SCSI timeout in the Oracle VM and increase the Oracle CSS misscount parameter.

Increase SCSI Timeout on the Oracle Server VM

- Make sure the SCSI timeout is 60 seconds for the ASM disk devices:

```
# cat /sys/block/<device-name>/device/timeout
```

- If the timeout isn't at least 60 seconds, make the timeout persistent across reboots by configuring the timeout using udev rules.
 - › Open `/etc/udev/rules.d/50-udev.rules` and add the following lines:

```
ACTION=="add", SUBSYSTEMS=="scsi", ATTRS{vendor}=="NUTANIX ",  
ATTRS{model}=="VDISK", RUN+="/bin/sh -c 'echo 60 >/sys$DEVPATH/device/timeout'"
```

Configure Oracle RAC misscount Parameter

Check the current settings for misscount and reboottime:

```
# $CRS_HOME/bin/crctl get css misscount  
-> Successful get misscount 30 for Cluster Synchronization Services.  
  
# $CRS_HOME/bin/crctl get css reboottime  
-> Successful get reboottime 3 for Cluster Synchronization Services.
```

If required, update the CSS misscount setting:

- Shut down Oracle Clusterware or Grid Infrastructure except one node.
- Sign in as the root user on the active node and set the CSS misscount interval to 60 seconds:


```
# $CRS_HOME/bin/crctl set css misscount 60
```
- Restart Oracle Clusterware or Grid Infrastructure.

- Verify that you updated the setting:

```
# $CRS_HOME/bin/crsctl get css misscount
-> Successful get misscount 60 for Cluster Synchronization Services.
```

For more details on setting the misscount parameter, refer to the Oracle [Clusterware Administration and Deployment Guide](#).

vDisk Configuration

To achieve the best I/O performance when you run Oracle on Nutanix, follow these recommendations:

- Use Oracle ASM or an OS volume manager to stripe performance-critical file systems across four or more vDisks.
- On ESXi, place the vDisks in each stripe across multiple PVSCSI controllers.
- On ESXi, use a VMXNET3 adapter for iSCSI traffic and ensure that the iSCSI interface is on the same subnet as the CVM.
- When using Volume Groups on AHV, create separate groups for database files and redo logs, archive logs, backup files, and Oracle Cluster Ready Services (CRS) disks.

Table: Number of vDisks for Each Data Type

Number of vDisks	Purpose
3	Boot, grid home, Oracle home
4-8	Database files and redo log files
4	Database archive log files
4	Database RMAN backup files
3	Oracle CRS voting disks, RAC only

Note: iSCSI vDisks are automatically load-balanced across the Nutanix cluster.

ESXi Settings

The following table lists the recommended settings for Oracle Database VMs on ESXi.

Table: Recommended Settings for Oracle Database VMs on ESXi

Parameter	Configuration
Network adapter	VMXNET3
Storage adapter	Minimum of 3 PVSCSI (OS + DB + redo), 4 for larger or high-performance databases
OS and app disks	Thin-provisioned, disk mode = dependent
Database (ASM) disks for standalone	Thin-provisioned, disk mode = independent persistent
Database (ASM) disks for RAC	Thick-provisioned, eager-zeroed, disk mode = independent persistent (VMware KB 1034165)
VMware tools	Latest installed
VM memory	Locked (preferred) or Memory Reservation enabled
Advanced VM config: Disk.ENABLEUUID	In the VMX file, set disk.EnableUUID=True for the VM (VMware KB 52815)
Advanced VM config: ethernetX.coalescingScheme	Recommended value: disabled

Guest VM Affinity and High Availability Admission Control

Use AHV or ESXi affinity rules to control the placement of Oracle Database server VMs. You can use affinity and anti-affinity rules to:

- Control the number of CPU cores available to Oracle.
- Keep the Oracle Database VM on the correct hardware (in a cluster with mixed nodes).
- Keep production VMs on separate physical hosts for the best performance.

- Make sure that two RAC VMs don't end up on the same physical host.
- Control VM placement to ensure performance under regular conditions and during a high availability event.

On ESXi, use admission control to ensure that sufficient resources are available to provide failover protection. For more information see [vSphere HA Admission Control Settings for Nutanix Environment](#).

Note: Use a percentage value for high availability admission control. When you use VMware vSphere, obtain this percentage value by dividing 1 by the number of hosts per cluster.

In-Guest Configuration Specifications

Nutanix supports all Oracle-supported Linux kernels and Windows OS. Set Linux kernel parameters in accordance with Oracle documentation.

Table: In-Guest Nutanix-Specific Oracle Best Practices for Linux

Hypervisor	Single Instance (SI) and RAC	Configuration	How to Set
AHV, ESXi	SI and RAC	Enable blk_mq for supported Linux kernels	Linux on Nutanix AHV
AHV, ESXi	SI and RAC	Set max_sectors_kb=1024	Linux on Nutanix AHV
AHV, ESXi	RAC only	Set CSS misscount	See Configure Linux for ASM on Nutanix section
AHV, ESXi	RAC only	Set SCSI disk timeout to 60 sec via udev rule	See Configure Linux for ASM on Nutanix section
ESXi	SI and RAC	If you use ASMlib and iSCSI (volume group), change iSCSI discovery	

Hypervisor	Single Instance (SI) Configuration and RAC		How to Set
ESXi + PVSCSI	SI and RAC	Set pvscsi ring pages and queue depth: vmw_pvscsi.cmd_per_lun=254; vmw_pvscsi.ring_pages=32	VMware KB article 2053145
AHV, ESXI	RAC only	On a Linux-based Oracle VM, add NOZEROCONF=yes to the /etc/sysconfig/network file.	
ESXi	RAC only	This configuration only applies to in-guest iSCSI. If you enable DM-multipath on Linux and use multipath devices to configure Oracle data disks, populate multipath.conf with "fast_io_fail_tmo 120"	

Volume Management for Oracle vDisks

For the best I/O performance, we recommend that you use Oracle ASM. If you use more than one file system, stripe each database file system over multiple vDisks. On Linux, use the Logical Volume Manager (LVM) to stripe the database file systems.

Table: Volume Setting Recommendations for Linux

OS	Volume Type	Configuration Notes
Linux	LVM-striped volume with ext4 or XFS file system	Physical extent size: 1,024 KB

8. Disaster Recovery and Backup

Nutanix gives you a choice of replication methods: use Oracle Database replication or Nutanix storage replication, depending on your requirements.

Data Replication

Nutanix Replication

Nutanix offers three types of data replication:

1. Metro Availability: synchronous replication, ESXi only.
2. Asynchronous replication: recovery point objective (RPO) of 60 minutes or more.
3. NearSync: RPO between 1 and 15 minutes.

[Metro Availability](#) requires a maximum transmission latency of 5 ms. If the latency is more than 5 ms, we recommend that you use [asynchronous or NearSync replication](#). You can add a third-site witness VM to automate Metro Availability failover.

Oracle Replication

You can use Oracle replication options such as [Data Guard](#) and [GoldenGate](#) to replicate Oracle Databases on Nutanix.

Choose a Replication Technology

You can use any of these technologies to help protect your Oracle databases. The best replication technology to use depends on your requirements, but database replication tools usually provide the fastest failover and most efficient replication because they have highly granular insight into database changes. Nutanix asynchronous replication may work well if you have network latency or batch or development databases that don't have replication capabilities.

Backup

The best backup method depends on the size of the database, the data change rate, and whether you can use an online or an offline backup. With NDB, you can choose to use NDB's backup software or third-party backup software. Nutanix supports using RMAN and third-party backup software including [HYCU](#), [Veeam](#), [Commvault](#), and [Veritas](#) to back up Oracle Databases.

NDB provides an excellent method for managing application-consistent backups of multiterabyte Oracle Databases. NDB backs up mission-critical databases using a combination of application-consistent snapshots and archive logs and provides an excellent workflow for this process. For more details, refer to [NDB documentation](#) and the [Nutanix Database Service Database Data Protection tech note](#).

9. Database Maintenance

Patching Oracle Databases

Oracle recommends that you apply security patches every quarter or when a critical patch is available. NDB automates Oracle Patch Set Updates (PSU), which uses automated workflows to reduce the time and effort required to patch multiple Oracle Database servers with minimal downtime. For more details, refer to [NDB documentation](#).

Database Version Upgrade

NDB enables you to seamlessly perform out-of-place Oracle Database upgrades with minimal or no downtime. This feature helps you keep your Oracle server maintenance up to date. For more details, refer to [NDB documentation](#).

10. Conclusion

Nutanix web-scale engineering streamlines Oracle Database deployments with high-performance, low-latency storage, linear scalability, high availability, multicloud support, and simplified management through NDB. Nutanix takes care of the underlying compute and storage architecture so database administrators can focus on higher value tasks, such as application enhancements accelerating time to production.

Engage with Nutanix experts on the [Nutanix .NEXT Community](#) or on Twitter [@nutanix](#) to learn more about the benefits of the Nutanix cloud platform for Oracle Databases, Nutanix Database Service for Oracle, and other business-critical applications. Send us an email at info@nutanix.com to set up your own customized briefing that includes sizing, TCO analysis, data protection, and disaster recovery design.

About Nutanix

Nutanix is a global leader in cloud software and a pioneer in hyperconverged infrastructure solutions, making clouds invisible and freeing customers to focus on their business outcomes. Organizations around the world use Nutanix software to leverage a single platform to manage any app at any location for their hybrid multicloud environments. Learn more at www.nutanix.com or follow us on Twitter [@nutanix](https://twitter.com/nutanix).