

# Oracle Database Deployment on AWS EC2 and FSx Best Practices

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# Oracle Database Deployment on AWS EC2 and FSx Best Practices

# WP-7357: Oracle Database Deployment on EC2 and FSx Best Practices Introduction

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Many mission-critical enterprise Oracle databases are still hosted on-premises, and many enterprises are looking to migrate these Oracle databases to a public cloud. Often, these Oracle databases are application centric and thus require user-specific configurations, a capability that is missing from many database-as-a-service public-cloud offerings. Therefore, the current database landscape calls for a public-cloud-based Oracle database solution built from a high-performance, scalable compute and storage service that can accommodate unique requirements. AWS EC2 compute instances and the AWS FSx storage service might be the missing pieces of this puzzle that you can leverage to build and migrate your mission critical Oracle database workloads to a public cloud.

Amazon Elastic Compute Cloud (Amazon EC2) is a web service that provides secure, resizable compute capacity in the cloud. It is designed to make web-scale cloud computing easier for enterprises. The simple Amazon EC2 web-service interface allows you to obtain and configure capacity with minimal friction. It provides you with complete control of your computing resources and lets you run on Amazon's proven computing environment.

Amazon FSx for ONTAP is an AWS storage service that uses industry-leading NetApp ONTAP block and file storage, which exposes NFS, SMB, and iSCSI. With such a powerful storage engine, it has never been easier to relocate mission-critical Oracle database apps to AWS with sub-millisecond response times, multiple GBps of throughput, and 100,000+ IOPS per database instance. Better yet, the FSx storage service comes with native replication capability that allows you to easily migrate your on-premises Oracle database to AWS or to replicate your mission critical Oracle database to a secondary AWS availability zone for HA or DR.

The goal of this documentation is to provide step-by-step processes, procedures, and best-practice guidance on how to deploy and configure an Oracle database with FSx storage and an EC2 instance that delivers performance similar to an on-premises system. NetApp also provides an automation toolkit that automates most of the tasks that are required for the deployment, configuration, and management of your Oracle database workload in the AWS public cloud.

To learn more about the solution and use case, take a look at following overview video:

Modernize your Oracle database with hybrid cloud in AWS and FSx ONTAP, Part1 - Use case and solution architecture

# Solution architecture

The following architecture diagram illustrates a highly available Oracle database deployment on an AWS EC2 instance with the FSx storage service. A similar deployment scheme but with the standby in a different region can be set up for disaster recovery.

Within the environment, the Oracle compute instance is deployed via an AWS EC2 instance console. There

are multiple EC2 instance types available from the console. NetApp recommends deploying a databaseoriented EC2 instance type such as an m5 Ami image with RedHat enterprise Linux 8 and up to 10Gps of network bandwidth.

Oracle database storage on FSx volumes on the other hand is deployed with the AWS FSx console or CLI. The Oracle binary, data, or log volumes are subsequently presented and mounted on an EC2 instance Linux host. Each data or log volume can have multiple LUNs allocated depending on the underlying storage protocol employed.



An FSx storage cluster is designed with double redundancy, so that both the primary and standby storage clusters are deployed in two different availability zones. Database volumes are replicated from a primary FSx cluster to a standby FSx cluster at a user-configurable interval for all Oracle binary, data, and log volumes.

This high availability Oracle environment is managed with an Ansible controller node and a SnapCenter backup server and UI tool. Oracle installation, configuration, and replication are automated using Ansible playbook-based tool kits. Any update to the Oracle EC2 instance kernel operating system or Oracle patching can be executed in parallel to keep the primary and standby in sync. In fact, the initial automation setup can be easily expanded to perform some repeating daily Oracle tasks if needed.

SnapCenter provides workflows for Oracle database point-in-time recovery or for database cloning at either the primary or standby zones if needed. Through the SnapCenter UI, you can configure Oracle database backup and replication to standby FSx storage for high availability or disaster recovery based on your RTO or RPO objectives.

The solution provides an alternative process that delivers capabilities similar to those available from Oracle RAC and Data Guard deployment.

# Factors to consider for Oracle database deployment

A public cloud provides many choices for compute and storage, and using the correct type of compute instance and storage engine is a good place to start for database deployment. You should also select compute and storage configurations that are optimized for Oracle databases.

The following sections describe the key considerations when deploying Oracle database in an AWS public cloud on an EC2 instance with FSx storage.

# VM performance

Selecting the right VM size is important for optimal performance of a relational database in a public cloud. For better performance, NetApp recommends using an EC2 M5 Series instance for Oracle deployment, which is optimized for database workloads. The same instance type is also used to power a RDS instance for Oracle by AWS.

- Choose the correct vCPU and RAM combination based on workload characteristics.
- Add swap space to a VM. The default EC2 instance deployment does not create a swap space, which is not optimal for a database.

# Storage layout and settings

NetApp recommends the following storage layout:

• For NFS storage, the recommended volume layout is three volumes: one for the Oracle binary; one for Oracle data and a duplicate control file; and one for the Oracle active log, archived log, and control file.



• For iSCSI storage, the recommended volume layout is three volumes: one for the Oracle binary; one for Oracle data and a duplicate control file; and one for the Oracle active log, archived log, and control file. However, each data and log volume ideally should contain four LUNs. The LUNs are ideally balanced on the HA cluster nodes.



- For storage IOPS and throughput, you can choose the threshold for provisioned IOPS and throughput for the FSx storage cluster, and these parameters can be adjusted on the fly anytime the workload changes.
  - The auto IOPS setting is three IOPS per GiB of allocated storage capacity or user defined storage up to 80,000.
  - The throughput level is incremented as follow: 128, 256, 512, 1024, 2045 MBps.

Review the Amazon FSx for NetApp ONTAP performance documentation when sizing throughput and IOPS.

# **NFS** configuration

Linux, the most common operating system, includes native NFS capabilities. Oracle offers the direct NFS (dNFS) client natively integrated into Oracle. Oracle has supported NFSv3 for over 20 years. dNFS is supported with NFSv3 with all versions of Oracle. NFSv4 is supported with all OS's that follow the NFSv4 standard. dNFS support for NFSv4 requires Oracle 12.1.0.2 or higher. NFSv4.1 requires specific OS support. Consult the NetApp Interoperability Matrix Tool (IMT) for supported OS's. dNFS support for NFSv4.1 requires Oracle version 19.3.0.0 or higher.

Automated Oracle deployment using the NetApp automation toolkit automatically configures dNFS on NFSv3.

Other factors to consider:

• TCP slot tables are the NFS equivalent of host-bus-adapter (HBA) queue depth. These tables control the number of NFS operations that can be outstanding at any one time. The default value is usually 16, which is far too low for optimum performance. The opposite problem occurs on newer Linux kernels, which can automatically increase the TCP slot table limit to a level that saturates the NFS server with requests.

For optimum performance and to prevent performance problems, adjust the kernel parameters that control the TCP slot tables to 128.

sysctl -a | grep tcp.\*.slot table

File Type	Mount Options
<ul><li>Control files</li><li>Data files</li><li>Redo logs</li></ul>	<pre>rw,bg,hard,vers=3,proto=tcp,timeo=600,rsize=65536,wsize=6 5536</pre>
ORACLE_HOME     ORACLE_BASE	<pre>rw,bg,hard,vers=3,proto=tcp,timeo=600,rsize=65536,wsize=6 5536</pre>

• The following table provides recommended NFS mount options for Linux NFSv3 - single instance.

Before using dNFS, verify that the patches described in Oracle Doc 1495104.1 are installed. The NetApp Support matrix for NFSv3 and NFSv4 do not include specific operating systems. All OSs that obey the RFC are supported. When searching the online IMT for NFSv3 or NFSv4 support, do not select a specific OS because no matches will be displayed. All OSs are implicitly supported by the general policy.

# High availability

As indicated in the solution architecture, HA is built on storage-level replication. Therefore, the startup and availability of Oracle is contingent on how quickly the compute and storage can be brought up and recovered. See the following key factors:

- Have a standby compute instance ready and synced up with the primary through Ansible parallel update to both hosts.
- Replicate the binary volume from the primary for standby purposes so that you do not need to install Oracle at the last minute and figure out what needs to be installed and patched.
- Replication frequency dictates how fast the Oracle database can be recovered to make service available. There is a trade off between the replication frequency and storage consumption.
- Leverage automation to make recovery and switch over to standby quick and free of human error. NetApp provides an automation toolkit for this purpose.

# Step-by-Step Oracle Deployment Procedures on AWS EC2 and FSx

This section describes the deployment procedures of deploying Oracle RDS custom database with FSx storage.

# Deploy an EC2 Linux instance for Oracle via EC2 console

If you are new to AWS, you first need to set up an AWS environment. The documentation tab at the AWS website landing page provides EC2 instruction links on how to deploy a Linux EC2 instance that can be used to host your Oracle database via the AWS EC2 console. The following section is a summary of these steps. For details, see the linked AWS EC2-specific documentation.

### Setting up your AWS EC2 environment

You must create an AWS account to provision the necessary resources to run your Oracle environment on the EC2 and FSx service. The following AWS documentation provides the necessary details:

• Set up to use Amazon EC2

Key topics:

- Sign up for AWS.
- Create a key pair.
- Create a security group.

#### Enabling multiple availability zones in AWS account attributes

For an Oracle high availability configuration as demonstrated in the architecture diagram, you must enable at least four availability zones in a region. The multiple availability zones can also be situated in different regions to meet the required distances for disaster recovery.

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#### Creating and connecting to an EC2 instance for hosting Oracle database

See the tutorial Get started with Amazon EC2 Linux instances for step-by-step deployment procedures and best practices.

Key topics:

- Overview.
- Prerequisites.
- Step 1: Launch an instance.
- Step 2: Connect to your instance.
- Step 3: Clean up your instance.

The following screen shots demonstrate the deployment of an m5-type Linux instance with the EC2 console for running Oracle.

1. From the EC2 dashboard, click the yellow Launch Instance button to start the EC2 instance deployment workflow.

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2. In Step 1, select "Red Hat Enterprise Linux 8 (HVM), SSD Volume Type - ami-0b0af3577fe5e3532 (64-bit x86) / ami-01fc429821bf1f4b4 (64-bit Arm)."



3. In Step 2, select an m5 instance type with the appropriate CPU and memory allocation based on your Oracle database workload. Click "Next: Configure Instance Details."

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	m5	m5.xlarge	4	16	EBS only	Yes	Up to 10 Gigabit	Yes
	m5	m5.2xlarge	8	32	EBS only	Yes	Up to 10 Gigabit	Yes
	m5	m5.4xlarge	16	64	EBS only	Yes	Up to 10 Gigabit	Yes
	m5	m5.8xlarge	32	128	EBS only	Yes	10 Gigabit	Yes
	m5	m5.12xlarge	48	192	EBS only	Yes	10 Gigabit	Yes
	m5	m5.16xlarge	64	256	EBS only	Yes	20 Gigabit	Yes
	m5	m5.24xlarge	96	384	EBS only	Yes	25 Gigabit	Yes
	m5	m5.metal	96	384	EBS only	Yes	25 Gigabit	Yes

4. In Step 3, choose the VPC and subnet where the instance should be placed and enable public IP assignment. Click "Next: Add Storage."

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5. In Step 4, allocate enough space for the root disk. You may need the space to add a swap. By default, EC2 instance assign zero swap space, which is not optimal for running Oracle.

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6. In Step 5, add a tag for instance identification if needed.



7. In Step 6, select an existing security group or create a new one with the desired inbound and outbound policy for the instance.

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Step 6: Co A security group that allow unres	b is a set of firewall rules tricted access to the HT Assign a security	ity Group that control the traffic for IP and HTTPS ports. You group: O Create a new s @ Select an exis	your instance. Or can create a new security group <b>ting</b> security grou	n this page, you r security group p	can add rules to allow specifi or select from an existing one	traffic to reach your instance. For example, if you want to below. Learn more about Amazon EC2 security groups.	set up a web server an	d allow Ir	nternet traf	ffic to reach yo	our instance, add rules
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sg-0d746	a0908b897c48	AviOccm03112021OCCN	11635951256631-	-OCCMSecurity	Group-B3QFHUHJRUVW	NetApp OCCM Instance Exter	rnal Security Group				Copy to new
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					All	192.168.1.0/24					
All traffic		All									

8. In Step 7, review the instance configuration summary, and click Launch to start instance deployment. You are prompted to create a key pair or select a key pair for access to the instance.

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Instance Type							Edit instance type
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9. Log into EC2 instance using an SSH key pair. Make changes to your key name and instance IP address as appropriate.

ssh -i ora-db1v2.pem ec2-user@54.80.114.77

You need to create two EC2 instances as primary and standby Oracle servers in their designated availability

zone as demonstrated in the architecture diagram.

# Provision FSx for ONTAP file systems for Oracle database storage

EC2 instance deployment allocates an EBS root volume for the OS. FSx for ONTAP file systems provides Oracle database storage volumes, including the Oracle binary, data, and log volumes. The FSx storage NFS volumes can be either provisioned from the AWS FSx console or from Oracle installation, and configuration automation that allocates the volumes as the user configures in a automation parameter file.

#### Creating FSx for ONTAP file systems

Referred to this documentation Managing FSx for ONTAP file systems for creating FSx for ONTAP file systems.

Key considerations:

- SSD storage capacity. Minimum 1024 GiB, maximum 192 TiB.
- Provisioned SSD IOPS. Based on workload requirements, a maximum of 80,000 SSD IOPS per file system.
- Throughput capacity.
- Set administrator fsxadmin/vsadmin password. Required for FSx configuration automation.
- Backup and maintenance. Disable automatic daily backups; database storage backup is executed through SnapCenter scheduling.
- Retrieve the SVM management IP address as well as protocol-specific access addresses from SVM details page. Required for FSx configuration automation.

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Amazon FSx X	fsx (svm-005c6edf027866ca4)						Delete	Update
File systems Volumes Backups VONTAP Storage virtual machines V OpenZFS Snapshots V Windows File Server V Lustre Data repository tasks	Summary           SVM.ID           svm-005c6edf027866ca4           SVM name           fsx           fsx           UUID           1a07ea1F-7d6e-11ec-97a9-7df96ee2a64a           File system ID           fs-0a51ta3f08922224d5	Creation time 2022-01-24T18:02:24-05:00 Lifecycle state Subtype DEFAULT		Active Directory -				
FSx on Service Quotas [2]	Resource ARN am:aws:facus-east-1:759995470648:storage-virtual-machine/fs- Oa51a3f08922224d5/sym-005c6edf027866ca4 🗇 Endpoints Management DNS name sym-005c6edf027866ca4.fs-0a51a3f08922224d5.fsx.us-east-1.amazonaws.c NF5.DNS name iscsi.sym-005c6edf027866ca4.fs-0a51a3f08922224d5.fsx.us-east-1.amazonaws.c	om D aws.com D	Management IP address 198.19.255.68 <b>1</b> NFS IP address 198.19.255.68 <b>1</b> ISCSI IP addresses ISCSI IP addresses					

See the following step-by-step procedures for setting up either a primary or standby HA FSx cluster.

1. From the FSx console, click Create File System to start the FSx provision workflow.

aws Services Q Search for	services, features, blogs, docs, and more [Alt+S]	D. Q° 0. vi	rginia 🔻 allenc @ demo-tlven
🞯 Resource Groups & Tag Editor			
Amazon FSx X	F5x > File systems		
File systems Volumes Backups	Did you know? With Amazon FSx for Windows File Server, you can reduce storage costs by 50-60% using Data Deduplication. Learn how to easily enable this capability and others.		×
V ONTAP			
Storage virtual machines	File systems (1)	Attach Actions 🔻	Create file system
OpenZFS     Snapshots	Q. Filter file systems		< 1 > ③
Windows File Server	File system name         File system ID         The system Type         Storage         Storage         Storage         Storage	Throughput v capacity v	Creation time 🛛 🗢
<ul> <li>Lustre</li> <li>Data repository tasks</li> </ul>	O         rdscustomfs007         fs-0a51a3f08922224d5         ONTAP         Ø Available         Multi-AZ         SSD         1,500 GiB	128 MB/s	2022-01-24T18:31:55- 05:00
ESx on Service Quotes			

2. Select Amazon FSx for NetApp ONTAP. Then click Next.

ëe system type	Select file system type			
y file system denaits	File system options			
w and create	Amazon FSx for NetApp ONTAP FSX Amazon FSx for NetApp ONTAP	Amazon FSx for OpenZFS FSXZ= Amazon FSx for OpenZFS	C Anazon FSx for Windows File Server	Amazon FSx for Lustre
	Amazon FSx for NetApp ONTAP Amazon FSx for NetApp ONTAP provides featu • Broadly accessible from Linux, Windows, an • Provides ONTAP's popular data manageme • Delivers hundreds of thousands of IOPS wit • Offers highly-available and highly-durable • Automatically tiers infrequently-accessed d	re-rich, high-performance, and highly-reliable d macOS compute instances and containers (nu rt capabilities: like Snaphfors, Snaphforer (for d h consistent sub-milliecond latencies, and up multi-XZ SIS storage with support for cross-s atta to capacity pool storage, a fully elastic stor	storage built on NetApp's popular ONTAP file system an ming on AWS or on-premises) via industry-standard NF tata replication, FilexCloon (for data cloning), and data c to 3 GB/s of throughput. gion replication and built in, fully managed backups. age tier that can scale to petabytes in size and is cost-op	d fully managed by AWS. S, SMB, and ISCSI protocols. ompression / deduplication. stimized foc infrequently-accessed data.

3. Select Standard Create and, in File System Details, name your file system, Multi-AZ HA. Based on your database workload, choose either Automatic or User-Provisioned IOPS up to 80,000 SSD IOPS. FSx storage comes with up to 2TiB NVMe caching at the backend that can deliver even higher measured IOPS.

File system name - optional Info	
aws_ora_prod	
Maximum of 256 Unicode letters, whitespace, and numbers, plus + - = : /	
Deployment type Info	
O Multi-AZ	
○ Single-AZ	
SSD storage capacity Info	
1024	
Minimum 1024 GiB: Maximum 192 TiB	
Provisioned SSD IOPS Amazon FSx provides 3 IOPS per GiB of storage capacity. You can also provision needed.	additional SSD IOPS as
<ul> <li>Automatic (3 IOPS per GiB of SSD storage)</li> </ul>	
O User-provisioned	
40000	
Maximum 80,000 IOPS	
Throughput capacity Info The sustained speed at which the file server hosting your file system can serve burst to higher speeds for periods of time.	data. The file server can also
<ul> <li>Recommended throughput capacity 128 MB/s</li> </ul>	
Specify throughput capacity	
Throughput capacity	

4. In the Network & Security section, select the VPC, security group, and subnets. These should be created before FSx deployment. Based on the role of the FSx cluster (primary or standby), place the FSx storage nodes in the appropriate zones.

Network & security	
Virtual Private Cloud (VPC) Info Specify the VPC from which your file system is accessible.	
vpc-0474064fc537e5182	
VPC Security Groups Info Specify VPC Security Groups to associate with your file system's network interfaces.	
Choose VPC security group(s)	
sg-08148ca915189ac87 (default) X Preferred subnet Info Specify the preferred subnet for your file system.	
subnet-08c952541f4ab282d (us-east-1a)	
Standby subnet	
subnet-0a84d6eeeb0f4e5c0 (us-east-1b)	
VPC route tables Specify the VPC route tables associated with your file system.	
VPC's default route table	
Select one or more VPC route tables Endpoint IP address range Specify the IP address range in which the endpoints to access your file system will be created	
No preference	

5. In the Security & Encryption section, accept the default, and enter the fsxadmin password.

ncryption key Info WS Key Management Service (KMS) encryption key that protects y	our file system data at rest.	
aws/fsx (default)		•
Description	Account	KMS key ID
Default master key that protects my FSx resources when no other key is defined	759995470648	5b31feff-6759-4306-a852- 9c99a743982a
ile system administrative password assword for this file system's "fsxadmin" user, which you can use to Don't specify a password	access the ONTAP CLI or R	EST API.
ile system administrative password assword for this file system's "fsxadmin" user, which you can use to Don't specify a password Specify a password	o access the ONTAP CLI or R	EST API.
File system administrative password Password for this file system's "fsxadmin" user, which you can use to Don't specify a password Specify a password Password	access the ONTAP CLI or R	EST API.
Tile system administrative password Tassword for this file system's "fsxadmin" user, which you can use to Don't specify a password Specify a password Password	access the ONTAP CLI or R	EST API.

6. Enter the SVM name and the vsadmin password.

Storage virtual machine name
fsxora_prod
SVM administrative password Password for this SVM's "vsadmin" user, which you can use to access the ONTAP CLI or REST API.
O Don't specify a password
Specify a password
Password
Confirm password
Active Directory
Joining an Active Directory enables access from Windows and MacOS clients over the SMB protoc
O not join an Active Directory
Join an Active Directory

7. Leave the volume configuration blank; you do not need to create a volume at this point.

/olume name			
vol1			
faximum of 203 alphanumeric characters, plus			
unction path			
/vol1			
he location within your file system where your volume will be mounted.			
1024	1		
linimum 20 MiB; Maximum 104857600 MiB			
storage efficiency elect whether you would like to enable ONTAP storage efficiencies on your volume: deduplication, ompression, and compaction.			
Enabled (recommended)			
Disabled			
apacity pool tiering policy ou can optionally enable automatic tiering of your data to lower-cost capacity pool storage.			
Auto			
<ul> <li>Backup and maintenance - optional</li> </ul>			
Tage entional			

8. Review the Summary page, and click Create File System to complete FSx file system provision.

Services Q Search fo	or services, features, blogs, docs, and more	2 [Alt+S]	
Resource Groups & Tag Editor			
Step 1 Select file system type	Create file system		
Step 2 Specify file system details	Summary Verify the following attributes before proceeding		
Step 3 Review and create	Attribute	Value	Editable afte creation
	File system type	Amazon FSx for NetApp ONTAP	
	File system name	aws_ora_prod	$\odot$
	Deployment type	Multi-AZ	
	Storage type	SSD	
	SSD storage capacity	1,024 GiB	$\odot$
	Minimum SSD IOPS	40000 IOPS	$\odot$
	Throughput capacity	512 MB/s	$\odot$
	Virtual Private Cloud (VPC)	vpc-0474064fc537e5182	
	VPC Security Groups	sg-08148ca915189ac87	$\odot$
	Preferred subnet	subnet-08c952541f4ab282d	
	Standby subnet	subnet-0a84d6eeeb0f4e5c0	
	VPC route tables	VPC's default route table	
	Endpoint IP address range	No preference	
	KMS key ID	arn:aws:kms:us-east-1:759995470648:key/5b31feff-6759- 4306-a852-9c99a743982a	
	Daily automatic backup window	No preference	$\odot$
	Automatic backup	7 dav(s)	Ø

#### Provisioning of database volumes for Oracle database

See Managing FSx for ONTAP volumes - creating a volume for details.

Key considerations:

- · Sizing the database volumes appropriately.
- Disabling capacity pool tiering policy for performance configuration.
- Enabling Oracle dNFS for NFS storage volumes.
- Setting up multipath for iSCSI storage volumes.

#### Create database volume from FSx console

From the AWS FSx console, you can create three volumes for Oracle database file storage: one for the Oracle binary, one for the Oracle data, and one for the Oracle log. Make sure that volume naming matches the Oracle host name (defined in the hosts file in the automation toolkit) for proper identification. In this example, we use db1 as the EC2 Oracle host name instead of a typical IP-address-based host name for an EC2 instance.

# Create volume

#### File system

#### ONTAP | fs-0a51a3f08922224d5 | rdscustomfs007

#### Storage virtual machine

svm-005c6edf027866ca4 | fsx

#### Volume name

db1\_bin

Maximum of 203 alphanumeric characters, plus \_ .

#### Junction path

/db1\_bin

The location within your file system where your volume will be mounted.

#### Volume size

51200

Minimum 20 MiB; Maximum 104857600 MiB

#### Storage efficiency

Select whether you would like to enable ONTAP storage efficiencies on your volume: deduplication, compression, and compaction.

×

w

W

Enabled (recommended) Disabled		
Capacity pool tiering policy You can optionally enable automatic tiering of you	r data to lower-cost capacity pool	storage.
None		
	Concel	and the second

Create	vo	lume
cicate		unic

#### File system

#### ONTAP | fs-0a51a3f08922224d5 | rdscustomfs007

Storage virtual machine

svm-005c6edf027866ca4 | fsx

Volume name

db1\_data

Maximum of 203 alphanumeric characters, plus \_ .

#### Junction path

/db1\_data

The location within your file system where your volume will be mounted.

#### Volume size

512000

Minimum 20 MiB; Maximum 104857600 MiB

#### Storage efficiency

Select whether you would like to enable ONTAP storage efficiencies on your volume: deduplication, compression, and compaction.

<ul> <li>Enabled (recommended)</li> </ul>		
O Disabled		
Capacity pool tiering policy You can optionally enable automatic tiering of your d	ata to lower-cost capacity pool	storage.
None		
	Cancel	Confirm

х

Create	vo	lume
CICULL		curric.

#### File system

#### ONTAP | fs-0a51a3f08922224d5 | rdscustomfs007

#### Storage virtual machine

svm-005c6edf027866ca4 | fsx

Volume name

db1\_log

Maximum of 203 alphanumeric characters, plus \_ .

#### Junction path

/db1\_log

The location within your file system where your volume will be mounted.

Vol	lume	size	

256000

Minimum 20 MiB; Maximum 104857600 MiB

#### Storage efficiency

Select whether you would like to enable ONTAP storage efficiencies on your volume: deduplication, compression, and compaction.

<ul> <li>Enabled (recommended)</li> </ul>	
Disabled	
Capacity pool tiering policy You can optionally enable automatic	tiering of your data to lower-cost capacity pool storage.
None	•
	Cancel Confirm

(

Creating iSCSI LUNs is not currently supported by the FSx console. For iSCSI LUNs deployment for Oracle, the volumes and LUNs can be created by using automation for ONTAP with the NetApp Automation Toolkit.

х

## Install and configure Oracle on an EC2 instance with FSx database volumes

The NetApp automation team provide an automation kit to run Oracle installation and configuration on EC2 instances according to best practices. The current version of the automation kit supports Oracle 19c on NFS with the default RU patch 19.8. The automation kit can be easily adapted for other RU patches if needed.

#### Prepare a Ansible controller to run automation

Follow the instruction in the section "Creating and connecting to an EC2 instance for hosting Oracle database" to provision a small EC2 Linux instance to run the Ansible controller. Rather than using RedHat, Amazon Linux t2.large with 2vCPU and 8G RAM should be sufficient.

#### Retrieve NetApp Oracle deployment automation toolkit

Log into the EC2 Ansible controller instance provisioned from step 1 as ec2-user and from the ec2-user home directory, execute the git clone command to clone a copy of the automation code.

```
git clone https://github.com/NetApp-Automation/na_oracle19c_deploy.git
```

```
git clone https://github.com/NetApp-
Automation/na rds fsx oranfs config.git
```

#### Execute automated Oracle 19c deployment using automation toolkit

See these detailed instruction CLI deployment Oracle 19c Database to deploy Oracle 19c with CLI automation. There is a small change in command syntax for playbook execution because you are using an SSH key pair instead of a password for host access authentication. The following list is a high level summary:

- By default, an EC2 instance uses an SSH key pair for access authentication. From Ansible controller automation root directories /home/ec2-user/na\_oracle19c\_deploy, and /home/ec2user/na\_rds\_fsx\_oranfs\_config, make a copy of the SSH key accesststkey.pem for the Oracle host deployed in the step "Creating and connecting to an EC2 instance for hosting Oracle database."
- 2. Log into the EC2 instance DB host as ec2-user, and install the python3 library.

sudo yum install python3

- 3. Create a 16G swap space from the root disk drive. By default, an EC2 instance creates zero swap space. Follow this AWS documentation: How do I allocate memory to work as swap space in an Amazon EC2 instance by using a swap file?.
- 4. Return to the Ansible controller (cd /home/ec2-user/na\_rds\_fsx\_oranfs\_config), and execute the preclone playbook with the appropriate requirements and linux\_config tags.

```
ansible-playbook -i hosts rds_preclone_config.yml -u ec2-user --private
-key accesststkey.pem -e @vars/fsx vars.yml -t requirements config
```

```
ansible-playbook -i hosts rds_preclone_config.yml -u ec2-user --private
-key accesststkey.pem -e @vars/fsx vars.yml -t linux config
```

5. Switch to the /home/ec2-user/na\_oracle19c\_deploy-master directory, read the README file, and populate the global vars.yml file with the relevant global parameters.

- 6. Populate the host name.yml file with the relevant parameters in the host vars directory.
- 7. Execute the playbook for Linux, and press Enter when prompted for the vsadmin password.

```
ansible-playbook -i hosts all_playbook.yml -u ec2-user --private-key
accesststkey.pem -t linux config -e @vars/vars.yml
```

8. Execute the playbook for Oracle, and press enter when prompted for the vsadmin password.

```
ansible-playbook -i hosts all_playbook.yml -u ec2-user --private-key
accesststkey.pem -t oracle_config -e @vars/vars.yml
```

Change the permission bit on the SSH key file to 400 if needed. Change the Oracle host (ansible\_host in the host vars file) IP address to your EC2 instance public address.

#### Setting up SnapMirror between primary and standby FSx HA cluster

For high availability and disaster recovery, you can set up SnapMirror replication between the primary and standby FSx storage cluster. Unlike other cloud storage services, FSx enables a user to control and manage storage replication at a desired frequency and replication throughput. It also enables users to test HA/DR without any effect on availability.

The following steps show how to set up replication between a primary and standby FSx storage cluster.

1. Setup primary and standby cluster peering. Log into the primary cluster as the fsxadmin user and execute the following command. This reciprocal create process executes the create command on both the primary cluster and the standby cluster. Replace standby\_cluster\_name with the appropriate name for your environment.

```
cluster peer create -peer-addrs
standby_cluster_name,inter_cluster_ip_address -username fsxadmin
-initial-allowed-vserver-peers *
```

 Set up vServer peering between the primary and standby cluster. Log into the primary cluster as the vsadmin user and execute the following command. Replace primary\_vserver\_name, standby\_vserver\_name, standby\_cluster\_name with the appropriate names for your environment.

```
vserver peer create -vserver primary_vserver_name -peer-vserver
standby_vserver_name -peer-cluster standby_cluster_name -applications
snapmirror
```

3. Verify that the cluster and vserver peerings are set up correctly.

FsxId00164 Peer Clust	4454fac5591e ter Name	6::> cluster Cluster	peer show Serial Number	Availab	ility Aut	hentication
FsxId0b6a	95149d07aa82	e 1-80-000	011	Availab	le ok	
FsxId00164	1454fac5591e	6::> vserver	peer show			
	Peer	Peer			Peering	Remote
Vserver	Vserver	State	Peer Clust	er	Application	s Vserver
svm_r5xora	svm FSxOr	aTarget				
	-	peered	FsxId0b6a9	5149d07a	a82e	
					snapmirror	svm_FSxOraTarget
E	4545-5504-	💼				
Laxid0010.	1424T9C22AT6	0::>				

4. Create target NFS volumes at the standby FSx cluster for each source volume at the primary FSx cluster. Replace the volume name as appropriate for your environment.

vol create -volume dr\_db1\_bin -aggregate aggr1 -size 50G -state online -policy default -type DP

vol create -volume dr\_db1\_data -aggregate aggr1 -size 500G -state online -policy default -type DP

vol create -volume dr\_db1\_log -aggregate aggr1 -size 250G -state online -policy default -type DP

 You can also create iSCSI volumes and LUNs for the Oracle binary, Oracle data, and the Oracle log if the iSCSI protocol is employed for data access. Leave approximately 10% free space in the volumes for snapshots.

vol create -volume dr\_db1\_bin -aggregate aggr1 -size 50G -state online -policy default -unix-permissions ---rwxr-xr-x -type RW

lun create -path /vol/dr\_db1\_bin/dr\_db1\_bin\_01 -size 45G -ostype linux

vol create -volume dr\_db1\_data -aggregate aggr1 -size 500G -state online -policy default -unix-permissions ---rwxr-xr-x -type RW

```
lun create -path /vol/dr_db1_data/dr_db1_data_01 -size 100G -ostype
linux
```

lun create -path /vol/dr\_db1\_data/dr\_db1\_data\_02 -size 100G -ostype
linux

lun create -path /vol/dr\_db1\_data/dr\_db1\_data\_03 -size 100G -ostype
linux

lun create -path /vol/dr\_db1\_data/dr\_db1\_data\_04 -size 100G -ostype
linux

vol create -volume dr\_db1\_log -aggregate aggr1 -size 250G -state online -policy default -unix-permissions ---rwxr-xr-x -type RW

lun create -path /vol/dr db1 log/dr db1 log 01 -size 45G -ostype linux

lun create -path /vol/dr db1 log/dr db1 log 02 -size 45G -ostype linux

lun create -path /vol/dr\_db1\_log/dr\_db1\_log\_03 -size 45G -ostype linux

lun create -path /vol/dr db1 log/dr db1 log 04 -size 45G -ostype linux

6. For iSCSI LUNs, create mapping for the Oracle host initiator for each LUN, using the binary LUN as an example. Replace the igroup with an appropriate name for your environment, and increment the lun-id for each additional LUN.

```
lun mapping create -path /vol/dr_db1_bin/dr_db1_bin_01 -igroup ip-10-0-
1-136 -lun-id 0
```

lun mapping create -path /vol/dr\_db1\_data/dr\_db1\_data\_01 -igroup ip-10-0-1-136 -lun-id 1

7. Create a SnapMirror relationship between the primary and standby database volumes. Replace the appropriate SVM name for your environment.s

snapmirror create -source-path svm\_FSxOraSource:db1\_bin -destination
-path svm\_FSxOraTarget:dr\_db1\_bin -vserver svm\_FSxOraTarget -throttle
unlimited -identity-preserve false -policy MirrorAllSnapshots -type DP

```
snapmirror create -source-path svm_FSxOraSource:db1_data -destination
-path svm_FSxOraTarget:dr_db1_data -vserver svm_FSxOraTarget -throttle
unlimited -identity-preserve false -policy MirrorAllSnapshots -type DP
```

```
snapmirror create -source-path svm_FSxOraSource:db1_log -destination
-path svm_FSxOraTarget:dr_db1_log -vserver svm_FSxOraTarget -throttle
unlimited -identity-preserve false -policy MirrorAllSnapshots -type DP
```

This SnapMirror setup can be automated with a NetApp Automation Toolkit for NFS database volumes. The toolkit is available for download from the NetApp public GitHub site.

```
git clone https://github.com/NetApp-
Automation/na_ora_hadr_failover_resync.git
```

Read the README instructions carefully before attempting setup and failover testing.



Replicating the Oracle binary from the primary to a standby cluster might have Oracle license implications. Contact your Oracle license representative for clarification. The alternative is to have Oracle installed and configured at the time of recovery and failover.

## **SnapCenter Deployment**

#### SnapCenter installation

Follow Installing the SnapCenter Server to install SnapCenter server. This documentation covers how to install a standalone SnapCenter server. A SaaS version of SnapCenter is in beta review and could be available shortly. Check with your NetApp representative for availability if needed.

#### Configure SnapCenter plugin for EC2 Oracle host

1. After automated SnapCenter installation, log into SnapCenter as an administrative user for the Window host on which the SnapCenter server is installed.

II N	etApp		A	
SnapCen	ter <sup>®</sup>			
Username	rdscustomval\administrator	0		
Password				
	Sign In			

2. From the left-side menu, click Settings, and then Credential and New to add ec2-user credentials for SnapCenter plugin installation.

	NetApp Snap	Center®		0-	L rdscustornval\administrator	SnapCe	nterAdmin	🖉 Sign Out
<		Global Settings Policies	Users and Access Roles Credential Software					
ш	Dashboard	Search by Credential Name				See.	. Second	
	Resources	Credential Name	Authentication Mode	Details				
-	Monitor	244rdscustomdb	SQL	Userid:a	dmin			
		42rdscustomdb	SQL	Userid:a	ámin			
1	Reports	admin	SQL	Userid:a	imin			
*	Hosts	administrator	Windows	Useridia	iministrator			
50	Storage Systems	ec2-user	Linux	Useridie	2-user			
		onpremSQL	Windows.	Useridore	Iscustomval\administrator			
#	Settings	rdsdb2	Windows	Useridia	iministrator			
▲	Alerts	rdsdb244	Windows	Useridia	iministrator			
		rdssql	Windows	Userida	iministrator			
		tst244	SQL	Userid:a	śmin			
		tstcredfordemo	Windows	Useridia	iministrator			

- 3. Reset the ec2-user password and enable password SSH authentication by editing the /etc/ssh/sshd config file on the EC2 instance host.
- 4. Verify that the "Use sudo privileges" checkbox is selected. You just reset the ec2-user password in the previous step.

Credential		×
Credential Name	ec2-user	
Authentication Mode	Linux	
Username	ec2-user	0
Password	•••••	
Use sudo privileges	1	
	Cancel	ОК

5. Add the SnapCenter server name and the IP address to the EC2 instance host file for name resolution.

[ec2-user@ip-10-	-0-0-151 ~]\$ sudo vi /et	c/hosts
[ec2-user@ip-10	-0-0-151 ~]\$ cat /etc/ho	sts
127.0.0.1 loca	alhost localhost.localdo	main localhost4
localhost4.loca	ldomain4	
::1 loca	alhost localhost.localdo	main localhost6
localhost6.loca	ldomain6	
10.0.1.233 rds	customvalsc.rdscustomval	.com rdscustomvalsc

6. On the SnapCenter server Windows host, add the EC2 instance host IP address to the Windows host file C:\Windows\System32\drivers\etc\hosts.

10.0.0.151 ip-10-0-0-151.ec2.internal

7. In the left-side menu, select Hosts > Managed Hosts, and then click Add to add the EC2 instance host to SnapCenter.

	n NetApp SnapCenter® 🔹 🚱 Irdscustomval\administrator SnapCenterAdmin 🗊 Si												🖡 Sign Out
<		Mar	naged Hosts Disks	Shares	Initiator Gr	oups iSCSI	Session						
	Dashboard	Se	earch by Name	V						Add		Refresh	More
<b>V</b>	Resources		Name		IE.	Туре	System	Plug	;-in		Version	Overall St	atus
•	Monitor		RDSAMAZ-VJ0DQK0			Windows	Stand- alone	Micr SQL	rosoft Windo Server	ws Server, Microsoft	4.5	Host of	down
<b>M</b>	Reports		rdscustommssql1.rd	lscustomval.co	m	Windows	Stand- alone	Micr SQL	osoft Windo Server	ows Server, Microsoft	4.5	Runni	ing
Å.	Hosts												
ł.	Storage Systems												
	Settings												
	Alerts												

Check Oracle Database, and, before you submit, click More Options.

				<b>9-</b>	L rdscustomval\administrator	SnapCenterAdmin	🖡 Sign Out	
							×	
Add Host								
Host Type	Linux			•				
Host Name	10.0.0.151							
Credentials	ec2-user			•	+ 0			
Select Plug-ins to Inst	all SnapCenter Plug-ins Package Oracle Database SAP HANA rt, Install Path, Custom Plug-Ins	4.5 P2	for Linu	IX				
Submit Cancel	]							

Check Skip Preinstall Checks. Confirm Skipping Preinstall Checks, and then click Submit After Save.

More Options		×					
Port	8145						
Installation Path /opt/NetApp/snapcenter							
	Skip preinstall checks						
Custom Plug-ins ——	Choose a File						
	Browse Upload						
	No plug-ins found.	*					
	Save	ancel					

You are prompted with Confirm Fingerprint, and then click Confirm and Submit.

Confirm Finge	erp <mark>r</mark> int		×
Authenticity of the	e host can	not be determined 🜖	
Host name	1E	Fingerprint	Valid
ip-10-0-0- 151.ec2.internal		ssh-rsa 2048 97:6F:3C:7D:38:42:F6:54:B7:AF:E3:61:61:BA:2E:6F	
		Confirm and Submit	Close

After successful plugin configuration, the managed host's overall status show as Running.

Man	aged Hosts	Disks	Shares	Initiator Grou	ups iSCSI Se	ession					
Se	arch by Name		T					Add		Refresh	More
	Name			45	Туре	System	Plug-in		Version	Overa	ll Status
	i <u>p-10-0-0-1</u>	51.ec2.inte	ernal		Linux	Stand- alone	UNIX, Oracle Database		4.5	RL	unning

#### Configure backup policy for Oracle database

Refer to this section Setup database backup policy in SnapCenter for details on configuring the Oracle database backup policy.

Generally you need create a policy for the full snapshot Oracle database backup and a policy for the Oracle archive-log-only snapshot backup.



You can enable Oracle archive log pruning in the backup policy to control log-archive space. Check "Update SnapMirror after creating a local Snapshot copy" in "Select secondary replication option" as you need to replicate to a standby location for HA or DR.

#### Configure Oracle database backup and scheduling

Database backup in SnapCenter is user configurable and can be set up either individually or as a group in a resource group. The backup interval depends on the RTO and RPO objectives. NetApp recommends that you run a full database backup every few hours and archive the log backup at a higher frequency such as 10-15 mins for quick recovery.

Refer to the Oracle section of Implement backup policy to protect database for a detailed step-by-step processes for implementing the backup policy created in the section Configure backup policy for Oracle database and for backup job scheduling.

The following image provides an example of the resources groups that are set up to back up an Oracle database.

	NetApp Snap	Center	8					•	0- 1	ethoushierwel-administration	SnupCont	in Almin	Synout
<		Onte	Database	-									
	Dubboard	.Viter	Ostabase	* Seach ite	sten 🛛						-	÷	<u>+</u>
	Annorm		Name	Oracle Database Type	Host/Cluster	Resource Group	Policies			Last	lackup	Overall Sta	atus
ø	Monitar		ORC1.	tingle ventation	ip-10-0-151.ec2.veenul	ord full brup	Oracle full backup Oracle ing backup			03/24/2022 8-4008	NV 🖻	flackup to	coefed
-	Reports												
۸	Hereite												
-	Storage Systems												
-	Settings												
4	Nes												

# EC2 and FSx Oracle database management

In addition to the AWS EC2 and FSx management console, the Ansible control node and the SnapCenter UI tool are deployed for database management in this Oracle environment.

An Ansible control node can be used to manage Oracle environment configuration, with parallel updates that keep primary and standby instances in sync for kernel or patch updates. Failover, resync, and failback can be automated with the NetApp Automation Toolkit to archive fast application recovery and availability with Ansible. Some repeatable database management tasks can be executed using a playbook to reduce human errors.

The SnapCenter UI tool can perform database snapshot backup, point-in-time recovery, database cloning, and so on with the SnapCenter plugin for Oracle databases. For more information about Oracle plugin features, see the SnapCenter Plug-in for Oracle Database overview.

The following sections provide details on how key functions of Oracle database management are fulfilled with the SnapCenter UI:

- Database snapshot backups
- Database point-in-time restore
- Database clone creation

Database cloning creates a replica of a primary database on a separate EC2 host for data recovery in the event of logical data error or corruption, and clones can also be used for application testing, debugging, patch

validation, and so on.

# Taking a snapshot

An EC2/FSx Oracle database is regularly backed up at intervals configured by the user. A user can also take a one-off snapshot backup at any time. This applies to both full-database snapshot backups as well as archive-log-only snapshot backups.

#### Taking a full database snapshot

A full database snapshot includes all Oracle files, including data files, control files, and archive log files.

1. Log into the SnapCenter UI and click Resources in the left-side menu. From the View dropdown, change to the Resource Group view.

	T NetApp SnapCenter®											
<		Oracle Database 👻										
	Dashboard	View Resource Group	Search resource	groul V								
0	Resources	Name	Resources	Tags	Policies							
	Monitor	orcl_full_bkup	1	ora_fullbkup	Oracle full backup							
-	Reports	orcl_log_bkup	1	ora_logbkup	Oracle log backup							
	Reports											
•	Hosts											
20	Storage Systems											
舞	Settings											
A	Alerts											

2. Click the full backup resource name, and then click the Backup Now icon to initiate an add-hoc backup.

	letApp SnapCenter®				۰	•	<b>8-</b> .	rdscustomval\administr	ator SnapCe	enterAdmin	🛿 Sign Out
>	Oracle Database 👻										
	Search resource groups	search						Modify Resource Group	Back up Now	Maintenance	Delete
0	Name	Resource Name	Туре	Host							
	orcl_full_bkup	ORCL	Oracle Database	ip-10-0-0-151.ec2.internal							
<b>a</b>	orcl_log_bkup										
A											
ł											
韴											
▲											

3. Click Backup and then confirm the backup to start a full database backup.

Backup											
Create a backup	for the selected resourc	e group									
Resource Group orcl_full_bkup											
Policy	Oracle full backup	- 0									
🗌 Verify after backt	qu										
		Cancel Bac	kup								

From the Resource view for the database, open the database Managed Backup Copies page to verify that the one-off backup completed successfully. A full database backup creates two snapshots: one for the data volume and one for the log volume.

E N	etApp Snap(	lenter®				٠	- 0- 1	L rdsoudorwalladministra	tor Snaple	nter Aan	n ¥SignOi	ut
> Ⅲ	Oracle Delabor	ains (	Conc. Tupology									A Contraction of the local distance of the l
	11 14	Name Offici	Manage Copies D Boolingers Local rapes					Summary CA 20 Beckge 2 Data Back 18 Ling Becks 0 Clanes	and apt pt			
•			(ment) V Rackap Name whomosti constant (Marchael 1	Court	Type	If End Date	Verified	0 2 Mounted 8	MAN Cataloge		* 3 50N 1711264	1000
			10-10-00-0111_01-25-2022_00-34-201-8441_0	(1)	Data	00/25/2022 12:34:31 AM 8	Applicable Unverified	False	Not Catalog	init .	1733220	

#### Taking an archive log snapshot

An archive log snapshot is only taken for the Oracle archive log volume.

1. Log into the SnapCenter UI and click the Resources tab in the left-side menu bar. From the View dropdown, change to the Resource Group view.

	NetApp SnapCenter®											
<		Oracle Database 👻										
	Dashboard	View Resource Group	Search resource	irce groui V								
0	Resources	Name	Resources	Tags	Policies							
•	Monitor	orcl_full_bkup	1	ora_fullbkup	Oracle full backup							
<b>a</b>	Reports	orcl_log_bkup	1	ora_logbkup	Oracle log backup							
Å	Hosts											
ł.	Storage Systems											
部	Settings											
A	Alerts											

2. Click the log backup resource name, and then click the Backup Now icon to initiate an add-hoc backup for archive logs.

	Ne	tApp SnapCenter®				٠	0-	1 rdscustomval\administrat	or SnapCe	nterAdmin	🖡 Sign Out
>		Oracle Database 👻	orcl_log_bkup Details								
		Search resource groups	search					Modify Resource Group	Back up Now	Maintenance	Delete
C		Name	Resource Name	Туре	Host						
9		orcl_full_bkup	ORCL	Oracle Database	ip-10-0-0-151.ec2.internal						
		ord_log_bkup									
â	1										
2											
5											
=	5										
4	5										

3. Click Backup and then confirm the backup to start an archive log backup.

Backup			×
Create a backup	for the selected resource	e group	
Resource Group	orcl_log_bkup		
Policy	Oracle log backup	- 0	
		Cancel	Backup
		1	

From the Resource view for the database, open the database Managed Backup Copies page to verify that the one-off archive log backup completed successfully. An archive log backup creates one snapshot for the log volume.

<b>T</b> IN	VetApp SnapCenter®					NO.	= 0·	L choustometadministrator SnapC	enter Admin	#SgsDut
> 	Oracle Dutabase	ORCL Topology						=		E.
0 0 4 1	UF 19 Name OKL	Manage Copies 27 Badup a Clares cocal copies						Summary Card 27 Becom 2 Data Becogn 25 long Becogn 11 Comms		
4		Primary Backup(s)	Trans.	Tata .	100	Put Pois	Vertiliert	<u></u>		* (T
		@ 36.0 6 191 03.76 2029 01 59 38.0738 1	t	Log	.0	19/05/2022 1 59:46 AME	Not Applicable	Falter Not Catal	ged .	1731201

## Restoring to a point in time

SnapCenter-based restore to a point in time is executed on the same EC2 instance host. Complete the following steps to perform the restore:

1. From the SnapCenter Resources tab > Database view, click the database name to open the database backup.

n	NetApp Snap	Center	8				• •	0. 1 nitrouterwallactmentator Sraph	enterAttein 🛛 Sign Di
<		Oracle	Cutitute -						
	Outboard	View	Detabase	Stardt da	abaias 🛛 🝸				* +
0	Bennyrces	-	Name	Oracle Database Type	HaspClaster	Resource Group	Policies	Last Backup	Overall Status
۲	Montor .		ORCL	Single instance	g-10-0-0-151.ec2.mmmal	orti, fult, bikupi orti, fog, tikupi	Grade tuit backup Grade tog backup	0105/00211009PM B	Balkup succeeded
4	Reports								
٨	Heats								
	Dorage Systems								
12	Settings								
	Ains								

Select the database backup copy and the desired point in time to be restored. Also mark down the corresponding SCN number for the point in time. The point-in-time restore can be performed using either the time or the SCN.

	tApp Sna	apCenter®				0	= 0· 1	cheust meetetre	estrator SnapCenterA	dmin 🛙 Sign O
	Oracle Data	nbatter 💽	DBL hendegy							
	Search R	vtatokovs.								2 5
0	<i>U</i> (*	Name	Manage Copies							
8 4 5			27 Elicibios © Corre Local copies					Summar 78 Backops 5 Data 1 73 Log fe O Clones	y Card Wokups Wikups	
=			Primary Backup(s)							
			( seed) ( V					0 1	<u>a</u> <u>n</u> <u>n</u>	· · · · · ·
			Backup Name	Court	Type	LF End Date	Verified	Mounted	RMAN Cataloged	SCN
			ip-10-0-0-151_03-25-2022_12-46.01.1098_1	1	Lig	E3/25/2022 12:40/01 PM	Not Applicable	False	fact Catalogest	1754(293
			sp-10-0-0-151_03-25-2022_12-25.01.0080_1	10	Log	83/25/2022 12/25/09 PM 🖨	Not Applicable	False	Not Cataloged	1283383
			tp-10-0-0-151_03-25-2022_12.10-01.1097_1		LOE	03/25/2022 12:10:09 PM	Not Applicable	False	Not Cataloged	1792417
			·p-10-0-6-151_03-25-2022_11-35.01.0500_1	1	Lig.	090500021135.09AM	Not Applicable	False	Net Cataloged	1787160
			w to o 6 thi (0-25-2022, 11-6601,0023, 1		Lig	03/25/2022 11:40:09 AM	Not Applicable	Falter	Note Callahuged	1200268
			10-10-0-6-151_00-25-2022_11-25-01-0400_1	1	Lig	03/25/2022 11:25:09 AM	Not Applicable	False	Not Cataloged	1779368
			10-10-0-6-111 (0)-25-2022 [11.16-01.1501].5	ж.	Lúg :	03/25/2022 11:15:17 AM	Not Applicable	False	Not Cataloged	1778546
			9-10-00 TS1-03-25-2022, 11:16-01.1503(0	1	Data	03/25/20211:15:11 AM	Unverliet	Tabe .	Not Cataloget	1778004
			ep-10-0-0-151_03125-2022_11_10.01_1884_1	1	Ling	EV25/20221110:09 AM	Application	Faise	Not Cataloged	1728184

3. Highlight the log volume snapshot and click the Mount button to mount the volume.

Manage Copies								
78 Backups						Summar	y Card	
O Clottes						78 Backups		
Local copies						5 Data B	lackups	
						73 Log B	eckups.	
						0 Clones		
Primary Backup(s)								
(seach 🛛 🖞						e t		A
Backup Name	Count	Туре	17	End Date	Verified	Mounted	RMAN Cataloged	SCN
ip-10-0-0-151_03-25-2022_12.40.01,1098_1	3	Log	34	03/25/2022 12:40:09 PM 🗖	Not Applicable	False	Not Cataloged	1784293
Ip-10-0-0-151_03-25-2022_12-25-01-0080_1	1	Log	1	03/25/2022 12:25:09 PM 🗖	Not Applicable	False	Not Cataloged	1783383
lp-10-0-0-151_03-25-2022_12.10.01.1097_1	1	Log	1	03/25/2022 12:10:09 PM 🗖	Not Applicable	False	Not Cataloged	1782417
1p-10-0-0-151_03-25-2022_11.55.01.0500_1		Log	1	03/25/2022 11:55:09 AM 🛱	Not Applicable	False	Not Cataloged	1781160
4p-10-0-0-151_03-25-2022_11.40.01.0323_1	1	Log	21	09/25/2022 11:40:09 AM	Not Applicable	False	Not Cataloged	1780268
Ip-10-0-0-151_03-25-2022_11.25.01.0430_1	98	Log	1	03/25/202211:25:09 AM 🛱	Not Applicable	False	Not Cataloged	1779368
tp-10-0-0-151_03-25-2022_11,15:01.1503_1	<u>#</u>	Log	li.	23/25/2022 11:13:17 AM	Not Applicable	False	Not Cataloged	1778540
ip-10-0-0-151_03-25-2022_11.15.01.1503_0	1	Data	1	23/25/2022 11:15:11 AM	Unvertified	False	Not Cataloged	1778504
Ip-10-0-0-151_03-25-2022_11.10.01.1834_1	1	Log	3	03/25/2022-11:10:09 AM 🗖	Not Applicable	False	Not Cataloged	1778184

4. Choose the primary EC2 instance to mount the log volume.

Mount backup	5		×
Choose the host to mount the backup	ip-10-0-0-151.ec2.internal		
Mount path :	/var/opt/snapcenter/sco/backup_mount	/lp-10-0-0-151_03-25-2022_11.15.01.1503_1/ORCL	
			Mount Cancel

5. Verify that the mount job completes successfully. Also check on the EC2 instance host to see the that log volume mounted and also the mount point path.

IN NetApp Snap	Center®	k.							• E O- ± niscustares	and territorator	SnapCanter Admin	. Usyno
< III Dathboard		Schedules by name	fveriti Ligs								e 🔔	. •
C Resources	All jobs	í.										
O: Mentor	10	Status	Name					Start date	End date	Owner		
Ci server	1000	- 61	Backup of Resource Group (ord.)	ing theup with policy	Grade log b	eckup		3/25/2022 1 (40:00 PM	3/25/2022 1:40:13 PM. 🗖	etheusture	value of the second	
	4543		Mount Name to 18 8 8 19 19	150672 11 15 10 10	al. 1			UVESIOU FAILOR PK C	01/25/2022 1:00:02 PM 🖽	REALCHING IN	MAL ATTOMAT	
Filesystem devtmpfs tmpfs tmpfs /dev/nvme0n1p 198.19.255.66 /dev/mapper/c /dev/nvme5n1 tmpfs 198.19.255.66 /raorf@ip=10_c	ol :/ora_r :/ora_r bdata01 :/Sceff 0-151	nfs_log nfs_data 1-1vdbda 91c793-5	ta01 5583-480d-9a34-6275da	Si: 7.4 14 7. 9.8 49 49 49 49 1.4 1.4 1.4 1.4 1.4 1.4 1.4 1.4 1.4 1.4	20 Use 36 7.0 36 7.0 36 5.4 36 5.4 36 95 36 3.4 36 471 36 12 36 56 36 91	1 Avail 0 7.6G 5 8.3G X 7.6G 0 7.7G 6 4.3G 4 48G 5 45G 4 39G 5 13G 0 1.6G 0 1.6G 4 48G	Uze% 946% 1556% 56% 8% 29% 49% 9% 9% 1% 1%	Mounted on /dev /dev/hm /run /sys/fs/cgroup /ora_nfs_log /ora_nfs_data /rdsdbdata /rdsdbdta /rdsdbdta /run/user/61001 /run/user/61005 /var/opt/snapcenter/sco/backup_mount	/ip-10-0-0-151_03-25-202	2_11.15.0	1.1503_1/OR	

6. Copy the archive logs from the mounted log volume to the current archive log directory.

```
[ec2-user@ip-10-0-0-151 ~]$ cp /var/opt/snapcenter/sco/backup_mount/ip-
10-0-0-151_03-25-2022_11.15.01.1503_1/ORCL/1/db/ORCL_A/arch/*.arc
/ora_nfs_log/db/ORCL_A/arch/
```

7. Return to the SnapCenter Resource tab > database backup page, highlight the data snapshot copy, and click the Restore button to start the database restore workflow.

Manage Copies									
80 Backups						Summary	Card		
Clones 0.Clones						80 Backups			
Local copies						5 Data Ba	ickups		
						75 Log Bar	kups		
						0 Clones			
Primary Backup(s)									
(search V)						• t	1 10 10 10 10 10 10 10 10 10 10 10 10 10		-
Backup Name	Count	Туре	17	End Date	Verified	Mounted	RMAN Cataloged	5CN	
ip-10-0-0-151_03-25-2022_12.10.01.1097_1	31	Log	03/25/2022 12:	10:09 PM 🛱	Not Applicable	False	Not Cataloged	1782417	
lp-10-0-0-151_03-25-2022_11.55.01.0500_1	3	Log	03/25/2022 11:	55:09 AM 🛱	Not Applicable	False	Not Cataloged	1781160	
ip-10-0-0-151_03-25-2022_11.40.01.0323_1	1	Log	03/25/2022 11:	40:09 AM 🗖	Not Applicable	False	Not Cataloged	1780268	
ip-10-0-6-151_03-25-2022_11.25.01.0430_1	1	Log	03/25/2022 11	25:09 AM 🗖	Not Applicable	False	Not Cataloged	1779368	
lp-10-0-0-151_03-25-2022_11.15.01.1503_1	1	Log	03/25/2022 11	15:17 AM 🛱	Not Applicable	True	Not Cataloged	1778546	
ip 10-0-0-151_03-25-2022_11.15:01.1503_0	3.	Data	03/25/2022 11	15:11 AM 🖽	Unverified	Fable	Not Cataloged	1778504	
ip-10-0-0-151_03-25-2022_11.10.01.1834_1	1	Log	03/25/2022 11:	10:09 AM 🖨	Not	False	Not Cataloged	1778184	

8. Check "All Datafiles" and "Change database state if needed for restore and recovery", and click Next.

Restore ORCL		×
1 Restore Scope	Restore Scope 🚯	
2 Recovery Scope	All Datafiles	
3 PreOps	O Tablespaces	
4 PostOps	Control files	
5 Notification	Database State     Change database state if needed for restore and recovery	
6 Summary	Restore Mode 1	
	Force in place restore If this check box is not selected and if any of the in place restore criteria is not met, restore will be performed using the connect and copy method. The connect and copy restore method might take time based on the files being restored.	
	Previous	t

9. Choose a desired recovery scope using either SCN or time. Rather than copying the mounted archive logs

to the current log directory as demonstrated in step 6, the mounted archive log path can be listed in "Specify external archive log files locations" for recovery.

Restore ORCL			×
1 Restore Scope	Choose Recovery Scope		
2 Recovery Scope	O All Logs		
3 PreOps	SCN 1778546	0	
4 PostOps	O Date and Time		
5 Notification	O No recovery		
6 Summary	Specify external archive log files locations		-
		Previous Next	

10. Specify an optional prescript to run if necessary.

Restore ORCL			×
1 Restore Scope	Specify optional so	ripts to run before performing a restore job 🚯	
2 Recovery Scope	Prescript full path	/var/opt/snapcenter/spl/scripts/ Enter Prescript path	]
3 PreOps	Arguments		
4 PostOps	Script timeout	60 secs	
5 Notification			
6 Summary			
-			
		Previous	lext

11. Specify an optional afterscript to run if necessary. Check the open database after recovery.

Restore ORCL				×
Restore Scope	Specify optional scripts to run after performing a	restore job 🚯		
2 Recovery Scope	Postscript full path /var/opt/snapcenter/spl/scripts/	Enter Postscript path		
3 PreOps	Arguments			
4 PostOps	Open the database or container database in READ-Will	lTE mode after recovery		
5 Notification				
6 Summary				
				_
			Previous Next	

12. Provide an SMTP server and email address if a job notification is needed.

Restore ORCL			×
Restore Scope	Provide email set	tings ()	
2 Recovery Scope	Emall preference	Never -	
3 PreOps	From	From email	1
A PostOps	То	Email to	1
	Subject	Notification	
5 Notification	<ul> <li>Attach job report</li> </ul>		
6 Summary			
		Previous	Next

13. Restore the job summary. Click finish to launch the restore job.

Restore ORCL		3	×
1 Restore Scope	Summary		
2 Recovery Scope	Backup name	lp-10-0-0-151_03-25-2022_11.15.01.1503_0	
<b>O</b> 200	Backup date	03/25/2022 11:15:11 AM	
Preops	Restore scope	All DataFiles	
O PostOps	Recovery scope	Until SCN 1778546	
A	Auxiliary destination		
Notification	Options	Change database state if necessary , Open the database or container database in READ-WRITE mode after recovery	
6 Summary	Prescript full path	None	
	Prescript arguments		
	Postscript full path	None	
	Postscript arguments		
	Send email	No	
		Previous Finish	

14. Validate the restore from SnapCenter.

Job	etails	×
Rest	re 'ip-10-0-0-151.ec2.internal\ORCL'	*
~	Restore 'lp-10-0-0-151.ec2.internal\ORCL'	
~	ip-10-0-0-151.ec2.internal	
~	Prescripts	
~	Pre Restore	
~	Restore	
~	Post Restore	
~	Postscripts	
~	Post Restore Cleanup	
~	Data Collection	
~	Send EMS Messages	
1 Tas	Name: ip-10-0-0-151.ec2.internal Start Time: 03/25/2022 3:33:53 PM End Time: 03/25/2022 3:35:10 PM	
		-
	View Logs Cancel job Close	-

15. Validate the restore from the EC2 instance host.



16. To unmount the restore log volume, reverse the steps in step 4.

### Creating a database clone

The following section demonstrates how to use the SnapCenter clone workflow to create a database clone from a primary database to a standby EC2 instance.

1. Take a full snapshot backup of the primary database from SnapCenter using the full backup resource group.

II Ne	etApp SnapCenter®				•	0-	L rdscustomval\administrat	or SnapCei	nterAdmin	🛿 Sign Ou
>	Oracle Database 👻	orcl_full_bkup Details								
	Search resource groups	search					Modify Resource Group	U Rock up Now	Maintenance	Delete
U	Name	Resource Name	Туре	Host						
٠	orel_full_bkup	ORCL	Oracle Database	ip-10-0-0-151.ec2.internal						
â	orcl_log_bkup									
A.										
h.										
**										
A										

2. From the SnapCenter Resource tab > Database view, open the Database Backup Management page for the primary database that the replica is to be created from.

II N	etApp SnapCenter®						Linkcelumvallastine	nitatur SnapConterA	anan 🗃 Sagn Ca
5	Oracle Database	Dirth Topology							
	Search databases								2 =
U	17 PM Name	Manage Copies							
0 2 ~	ORC.	91 Buckups D Clores Local opper					Summar B Backups 6 Data 8 87 Log Ba 0 Dones	y Card Ierkups exups	
		( seen. V							·
		Backup Name	Court	Type	Lif Fred Date	Verhed	Mounted	RMAN Cataloged	SCN
		@ 10-0-0-151_03-25-2022,17:55.01.0197_1	1	Ling	03/25/2012 5:35/09 PM	Not: Applicable	fathe	Next Cataloged	1183059
		gr 10.0-0-151_03-25.2022_17.56.56.0853_1	1	Log	63/25/2022 5:51:12 PM	Not Applicable	False	Not Cataloged	1785879
		gr 10 0 0 151,03.25.2022,17.50.55.0853,0	35	Dete	03/25/2022 5:51:05 PM	Unvertified	Site -	NOI Catalogett	1198032
		q-10-0-151,03-25-2022,17-45.00.9794,1	7.	Log	03/25/2122 5:40/08 PM	Not Applicable	Ealter	Next Canalogers	1768110
		sp-10-0-9-151,03-25-2022,17,25:01.0529,1	1	ing	03/25/2022 5/25/06 PM	Not.	Eator	Not Cataloged	1787180

3. Mount the log volume snapshot taken in step 4 to the standby EC2 instance host.

Summary Card         Spinologie         Social copies         Social copies             Immary Backupic             Impary Backupic             Impary Backupic             Impary Backupic             Impary Backupic             Impary Backupic	95 Backups 0 Clones Local copies					Summar 95 Backups	y Card	
Build rooms         By Backupt           Social coopes         Coopes         Social coopes         Social coopes         Social coopes         Social coopes         Social coopes         Social coopes	Local copies					95 Backops		
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Mount backups × Choose the host to mount the backup	10.0-0-151_03-25-2022_17.40.00.9758_1	1	Log	03/25/2022 5:40:08 PM 🛱	Not	False	Not Cataloged	1788110
Mount path : //var/opt/snapcenter/sco/backup_mount/ip-10-0-0-151_03-25-2022_17.50.55.0853_1/ORCL	Choose the host to mount the backup // Ip-10-0-0-47.ec2.internal	o mount/lo-10-0-0-15	51 03-2	5-2022 17.50.55.0853 1/0	DRCL			

4. Highlight the snapshot copy to be cloned for the replica, and click the Clone button to start the clone procedure.

ORCL Topology								
							E California Sectory	2 5
Manage Copies								
93 Backups						Summary	Card	
0 Clones						93 Backups		
Local copies						6 Data Ba	ckups	
						B7 Log Bac	Rups	
						0-Clones		
Primary Backup(s)								
(search V)						e it		
Backup Name	Count	Type	17	End Date	Verified	Mounted	RMAN Cataloged	SCN
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ip-10-0-0-151_03-25-2022_17.25.01.0539_1	.1	Log		03/25/2022 5:25:08 PM 🖨	Not	False	Not Cataloged	1787180

5. Change the replica copy name so that it is different from the primary database name. Click Next.

Clone from OR	CL				×
1 Name Provide clone database SID					
2 Locations	Clone SID	ORCLREAD			
3 Credentials					
4 PreOps					
5 PostOps					
6 Notification					
7 Summary					
				Previous	Next

6. Change the clone host to the standby EC2 host, accept the default naming, and click Next.

Clone from OF	RCL						×
1 Name	Select the host to	create a clone					
2 Locations	Clone host	ip-10-0-0-47.ec2.int	ternal		•		
3 Credentials	⊙ Datafile locations <b>()</b>						
4 PreOps	/ora_nfs_data_ORCLREAD					* *	Reset
5 PostOps							
6 Notification	🕤 Control files 🚯						
7 Summary	/ora_nfs_data_ORCLREAD/ORCLREAD/control/control01.ctl						+ Reset
	⊙ Redo logs 🚯					I	
	Group		Size	Unit	Number of files		
	<ul> <li>RedoGroup 1</li> </ul>	×	128	MB	1	+	*
	/ora_nfs_data	a_ORCLREAD/ORCLRE/	AD/redolog	/redo04.log		×	Reset
	RedoGroup 2	×	128	MB	1	+	•
_							
							Previous Next

7. Change your Oracle home settings to match those configured for the target Oracle server host, and click Next.

Clone from OR		×	
1 Name	the clone		
2 Locations	Credential name for sys user	None - + O	
3 Credentials	Database port	1521	
4 PreOps	Oracla Homa Sattings		
5 PostOps	Oracle Home	/rdsdbbin/oracle	
6 Notification	Oracle OS User	rdsdb	
7 Summary	Oracle OS Group	database	
_			
		Previous Next	

8. Specify a recovery point using either time or the SCN and mounted archive log path.

Clone from OF	RCL	×
1 Name	Z Recover Database	
<ul> <li>2 Locations</li> <li>3 Credentials</li> <li>4 PreOps</li> <li>5 PostOps</li> <li>6 Notification</li> <li>7 Summary</li> </ul>	<ul> <li>Until Cancel</li> <li>Date and Time</li> <li>Date-time format: MM/DD/YYYY hh:mm:ss</li> <li>Until SCN (System Change Number) 1788879</li> <li>Specify external archive log locations </li> <li></li></ul>	
	<ul> <li>Create new DBID ()</li> <li>Create tempfile for temporary tablespace ()</li> <li>Enter SQL queries to apply when clone is created</li> <li>Enter scripts to run after clone operation ()</li> </ul>	
	Previous	Next

9. Send the SMTP email settings if needed.

Clone from ORCL						
1 Name	Name Provide email settings ()					
2 Locations	Email preference	Never 👻				
3 Credentials	From	From email	1			
PreOns	То	Email to				
C ricops	Subject	Notification				
5 PostOps	Attach job report					
6 Notification						
7 Summary						
		Previous	Next			

10. Clone the job summary, and click Finish to launch the clone job.

Clone from O	RCL					
1 Name	Summary					
2 Locations	Clone from backup	lp-10-0-0-151_03-25-2022_17.50.55.0853_0				
0	Clone SID	ORCLREAD				
Credentials	Clone server	ip-10-0-0-47.ec2.internal				
A PreOps	Oracle home	/rdsdbbin/oracle				
•	Oracle OS user	rdsdb				
5 PostOps	Oracle OS group	database				
6 Notification	Datafile mountpaths	/ora_nfs_data_ORCLREAD				
A	Control files	/ora_nfs_data_ORCLREAD/ORCLREAD/control/control01.ctl				
	Redo groups	RedoGroup =1 TotalSize =128 Path =/ora_nfs_data_ORCLREAD/ORCLREAD/redolog/redo03.log RedoGroup =2 TotalSize =128 Path =/ora_nfs_data_ORCLREAD/ORCLREAD/redolog/redo03.log RedoGroup =3 TotalSize =128 Path =/ora_nfs_data_ORCLREAD/ORCLREAD/redolog/redo02.log RedoGroup =4 TotalSize =128 Path =/ora_nfs_data_ORCLREAD/ORCLREAD/redolog/redo01.log				
	Recovery scope	Until SCN 1788879				
	Prescript full path	none				
	Prescript arguments					
	Postscript full path	none				
	Postscript arguments					
	Send email	No				
		Previous				

11. Validate the replica clone by reviewing the clone job log.

Job Details	×							
Clone from backup 'ip-10-0-0-151_03-25-2022_17.50.55.0853_0'								
Clone from backup 'ip-10-0-0-151_03-25-2022_17.50.55.0853_0'	- 1							
✓ /p-10-0-0-47.ec2.internal								
<ul> <li>Prescripts</li> </ul>								
<ul> <li>Query Host Information</li> </ul>								
<ul> <li>Prepare for Cloning</li> </ul>								
<ul> <li>Cloning Resources</li> </ul>								
<ul> <li>FileSystem Clone</li> </ul>								
<ul> <li>Application Clone</li> </ul>								
<ul> <li>Postscripts</li> </ul>								
Register Clone								
V Unmount Clone								
<ul> <li>Data Collection</li> </ul>								
<ul> <li>Send EMS Messages</li> </ul>								
Task Name: ip-10-0-0-47.ec2.internal Start Time: 03/25/2022 9:08:32 PM End Time: 03/25/2022 9:12:03 PM	*							
View Logs Cancel Job	Close							

The cloned database is registered in SnapCenter immediately.

	NetApp Sna	pCenter®					• = • •	t nbcustomud administrator SnapCer	en Adem 🛛 Syn O
4		Dracke Dat	Atome 💽						
	Deshboard	View 0	atabese	Search databases	7				* *
	Resources	37 14	Nome	Oracle Database Type	Host/Cluster	Resource Group	Polces	Last Backup	Overall Status
۲	Maritor		ORCL	targle instance	10.10-0-151.ec2.mternal	ont Aut play ont Jog blup	Oracle full backup Onarte log backup	03/35/2003 9:10:09 PM 🛱	Backup surneyded
-	Reports		ORCLADAD	tingle instates	ip-10-0-0-47.ec2.internal				Not protected
۸	HIRDS								
ł	Storage System	•							
=	Sector .								
•	Alarts								

12. Turn off Oracle archive log mode. Log into the EC2 instance as oracle user and execute following command:

sqlplus / as sysdba

shutdown immediate;

startup mount;

alter database noarchivelog;

alter database open;



Instead primary Oracle backup copies, a clone can also be created from replicated secondary backup copies on target FSx cluster with same procedures.

## HA failover to standby and resync

The standby Oracle HA cluster provides high availability in the event of failure in the primary site, either in the compute layer or in the storage layer. One significant benefit of the solution is that a user can test and validate the infrastructure at any time or with any frequency. Failover can be user simulated or triggered by real failure. The failover processes are identical and can be automated for fast application recovery.

See the following list of failover procedures:

- 1. For a simulated failover, run a log snapshot backup to flush the latest transactions to the standby site, as demonstrated in the section Taking an archive log snapshot. For a failover triggered by an actual failure, the last recoverable data is replicated to the standby site with the last successful scheduled log volume backup.
- 2. Break the SnapMirror between primary and standby FSx cluster.
- 3. Mount the replicated standby database volumes at the standby EC2 instance host.
- 4. Relink the Oracle binary if the replicated Oracle binary is used for Oracle recovery.
- 5. Recover the standby Oracle database to the last available archive log.
- 6. Open the standby Oracle database for application and user access.
- 7. For an actual primary site failure, the standby Oracle database now takes the role of the new primary site and database volumes can be used to rebuild the failed primary site as a new standby site with the reverse SnapMirror method.
- 8. For a simulated primary site failure for testing or validation, shut down the standby Oracle database after the completion of testing exercises. Then unmount the standby database volumes from the standby EC2 instance host and resync replication from the primary site to the standby site.

These procedures can be performed with the NetApp Automation Toolkit available for download at the public NetApp GitHub site.

```
git clone https://github.com/NetApp-
Automation/na_ora_hadr_failover_resync.git
```

Read the README instruction carefully before attempting setup and failover testing.

# Database migration from on-prem to public cloud

Database migration is a challenging endeavor by any means. Migrating an Oracle database from on-premises to the cloud is no exception.

The following sections provide key factors to consider when migrating Oracle databases to the AWS public cloud with the AWS EC2 compute and FSx storage platform.

## **ONTAP** storage is available on-premises

If the on-premises Oracle database is sitting on an ONTAP storage array, then it is easier to set up replication for database migration using the NetApp SnapMirror technology that is built into AWS FSx ONTAP storage. The migration process can be orchestrated using NetApp BlueXP console.

- 1. Build a target compute EC2 instance that matches the on-premises instance.
- 2. Provision matching, equally sized database volumes from FSx console.
- 3. Mount the FSx database volumes to the EC2 instance.
- 4. Set up SnapMirror replication between the on-premises database volumes to the target FSx database volumes. The initial sync might take some time to move the primary source data, but any following incremental updates are much quicker.
- 5. At the time of switchover, shut down the primary application to stop all transactions. From the Oracle sqlplus CLI interface, execute an Oracle online log switch and allow SnapMirror sync to push the last archived log to the target volume.
- 6. Break up the mirrored volumes, run Oracle recovery at the target, and bring up the database for service.
- 7. Point applications to the Oracle database in the cloud.

The following video demonstrates how to migrate an Oracle database from on-premises to AWS FSx/EC2 using the NetApp BlueXP console and SnapMirror replication.

#### Migrate on-prem Oracle DB to AWS

### ONTAP storage is not available on premises

If the on-premises Oracle database is hosted on third-party storage other than ONTAP, database migration is based on the restore of a Oracle database backup copy. You must play the archive log to make it current before switching over.

AWS S3 can be used as a staging storage area for database move and migration. See the following high level steps for this method:

- 1. Provision a new, matching EC2 instance that is comparable with the on-premises instance.
- 2. Provision equal database volumes from FSx storage and mount the volumes to the EC2 instance.
- 3. Create a disk-level Oracle backup copy.
- 4. Move the backup copy to AWS S3 storage.
- 5. Recreate the Oracle control file and restore and recover the database by pulling data and the archive log from S3 storage.
- 6. Sync the target Oracle database with the on-premises source database.
- 7. At switchover, shut down the application and source Oracle database. Copy the last few archive logs and apply them to the target Oracle database to bring it up to date.
- 8. Start up the target database for user access.
- 9. Redirect application to the target database to complete the switchover.

# Migrate on-premises Oracle databases to AWS FSx/EC2 using PDB relocation with maximum availability

This migration approach is best suited to Oracle databases that are already deployed in PDB/CDB multitenant model, and ONTAP storage is not available on-premises. The PDB relocation method utilizes Oracle PDB hot clone technology to move PDBs between a source CDB and a target CDB while minimizing service interruption.

First, create CDB in the AWS FSx/EC2 with sufficient storage to host PDBs to be migrated from on-premises. Multiple on-premises PDBs can be relocated one at a time.

- 1. If the on-premises database is deployed in a single instance rather than in the multitenant PDB/CDB model, follow the instructions in Converting a single instance non-CDB to a PDB in a multitenant CDB to convert the single instance to multitenant PDB/CDB. Then follow the next step to migrate the converted PDB to CDB in AWS FSx/EC2.
- 2. If the on-premises database is already deployed in the multitenant PDB/CDB model, follow the instructions in Migrate on-premises Oracle databases to cloud with PDB relocation to perform the migration.

The following video demonstrates how an Oracle database (PDB) can be migrated to FSx/EC2 using PDB relocation with maximum availability.

### Migrate on-prem Oracle PDB to AWS CDB with max availability



Although the instructions in step 1 and 2 are illustrated in the context of Azure public cloud, the procedures are applicable to AWS cloud without any changes.

The NetApp Solutions Automation team provides a migration toolkit that can facilitate Oracle database migration from on-premises to the AWS cloud. Use following command to download the Oracle database migration toolkit for PDB relocation.

```
git clone https://github.com/NetApp-Automation/na_ora_aws_migration.git
```

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