SAP HANA on AWS

SAP HANA Guides

SAP HANA on AWS: SAP HANA Guides

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SAP HANA Guides

This section of the SAP on AWS technical documentation provides information for SAP HANA users and partners, including information about planning, migrating, implementing, configuring, and operating your SAP HANA environment on the AWS Cloud. This section includes the following guides:

About this content set

SAP on AWS technical documentation provides detailed information on how to migrate, implement, configure, and operate SAP solutions on AWS.

AWS Backint Agent for SAP HANA

This section of the SAP HANA on AWS documentation contains guidance specific to the installation and configuration of the AWS Backint Agent for SAP HANA, including how to back up and restore your SAP HANA system with AWS Backint agent.

Topics

What is AWS Backint Agent for SAP HANA?

AWS Backint Agent for SAP HANA (AWS Backint agent) is an SAP-certified backup and restore application for SAP HANA workloads running on Amazon EC2 instances in the cloud. AWS Backint agent runs as a standalone application that integrates with your existing workflows to back up your SAP HANA database to Amazon S3 and to restore it using SAP HANA Cockpit, SAP HANA Studio, and SQL commands. AWS Backint agent supports full, incremental, and differential backup of SAP HANA databases. Additionally, you can back up log files and catalogs to Amazon S3. AWS Backint agent runs on an SAP HANA database server, where backups and catalogs are transferred from the SAP HANA database to the AWS Backint Agent. The AWS Backint agent stores your files in the S3 bucket that is specified in the agent configuration file. To restore your SAP HANA database server, SAP HANA reads the catalog files stored in your S3 bucket using the AWS Backint agent. It then initiates a request to restore the required files from S3.

If you want to deploy an SAP HANA database application with AWS Backint agent, you can use AWS Launch Wizard for SAP, a service that guides you through the sizing, configuration, and deployment of SAP applications on AWS, and follows AWS cloud application best practices.

Topics

How AWS Backint Agent for SAP HANA works

You can deploy the AWS Backint agent to your SAP HANA instances from the AWS Systems Manager (SSM) console. From the AWS SSM console, an AWS SSM document is executed on the instances to install the agent. You provide the configuration information in the document as parameters. You can also download and manually install and configure the agent. When the agent is installed, you can back up your SAP HANA database directly to Amazon S3.

AWS Backint agent increases scalability through parallel processing of backup and restore processes, providing maximum throughput and reducing backup Recovery Time Objective (RTO) during recovery.

Billing

AWS Backint agent is a free service. You pay for only the underlying AWS services that you use, for example Amazon S3. For more information about Amazon S3 pricing, see the Amazon S3 pricing page.

Supported operating systems

AWS Backint agent is supported on the following operating systems:

- SUSE Linux Enterprise Server
- SUSE Linux Enterprise Server for SAP
- Red Hat Enterprise Linux for SAP

Supported databases

AWS Backint agent supports the following databases:

- SAP HANA 1.0 SP12 (single node and multi node)
- SAP HANA 2.0 and later (single node and multi node)

Supported Regions

AWS Backint agent is available in all commercial Regions, as well as in China (Beijing), China (Ningxia), and GovCloud.

Get started with AWS Backint Agent for SAP HANA

This topic contains information to help you set up your environment for installation, to install AWS Backint Agent for SAP HANA, and to modify your AWS Backint agent configuration file.

Topics

Prerequisites

After your SAP HANA system is successfully running on an Amazon EC2 instance, verify the following prerequisites to install AWS Backint agent using the Amazon EC2 Systems Manager document or using AWS Backint installer.

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- Amazon S3 bucket (p. 5)

AWS Identity and Access Management

1. To access the AWS resources required to install AWS Backint agent with AWS Systems Manager, you must attach the `AmazonSSMManagedInstanceCore` managed policy to your IAM role.

   Note
   If you choose to install the AWS Backint agent using the AWS Backint installer, you can skip this step.
2. To allow your Amazon EC2 instance to access your target Amazon S3 bucket, you must create or update an inline IAM policy with the following permissions and attach it to your EC2 service role. Replace the resource names, such as the S3 bucket name, to match your resource name. You must provide the AWS Region and Amazon S3 bucket owner account ID along with the Amazon S3 bucket name.

```
{
    "Version": "2012-10-17",
    "Statement": [
        {
            "Sid": "VisualEditor1",
            "Effect": "Allow",
            "Action": [
                "s3:GetBucketPolicyStatus",
                "s3:GetBucketLocation",
                "s3:ListBucket",
                "s3:GetBucketAcl",
                "s3:GetBucketPolicy"
            ],
            "Resource": [
                "arn:aws:s3:::<Bucket Name>/*",
                "arn:aws:s3:::<Bucket Name>"
            ]
        },
        {
            "Sid": "VisualEditor2",
            "Effect": "Allow",
            "Action": [
                "kms:Decrypt",
                "kms:GenerateDataKey"
            ],
            "Resource": "<KMS Arn>"
        },
          {
              "Sid": "VisualEditor0",
              "Effect": "Allow",
              "Action": [
                  "s3:PutObjectTagging",
                  "s3:PutObject",
                  "s3:GetObject",
                  "s3:DeleteObject"
              ],
              "Resource": "arn:aws:s3:::<bucket name>/<folder name>/*"
          }
    ]
}
```

   Note
   If you want to allow cross-account backup and restore, you must add your account details under a principal element in your policy. For more information about principal policies, see AWS JSON Policy Elements: Principal in the *AWS Identity and Access Management*

User Guide. In addition, you must ensure that the S3 bucket policies allow your account to perform the actions specified in the IAM policy example above. For more information, see the example for Bucket owner granting cross-account bucket permissions in the *Amazon S3 Developer Guide*.

For more information about managed and inline policies, see the IAM User Guide.

Amazon EC2 Systems Manager

To install the AWS Backint agent with the Amazon EC2 Systems Manager Agent (SSM) document, you must install the Amazon EC2 Systems Manager Agent (SSM Agent) version 2.3.274.0 or later, and your instance must be a managed instance that is configured for AWS Systems Manager. If you want to install the AWS Backint agent using AWS Backint installer, you can skip this step. For more information about managed instances, see AWS Systems Manager Managed Instances. To update the SSM Agent, see Update SSM Agent by using Run Command.

> **Note**
> The SSM Agent will not work if you do not attach the `AmazonSSMManagedInstanceCore` policy to your EC2 instance role.

Amazon S3 bucket

When you install the AWS Backint agent, you must provide the name of the S3 bucket where you want to store your SAP HANA backups. Only Amazon S3 buckets created after May 2019 are compatible with AWS Backint agent. If you do not own a bucket created after May 2019, create a new S3 bucket in your target Region. Additionally, ensure that the Amazon S3 bucket where you want to store your backups doesn’t have public access enabled. If the S3 bucket has public access enabled, backups will fail.

AWS Backint agent supports backing up to Amazon S3 with VPC endpoints. For more information, see VPC Endpoints.

S3 storage classes —AWS Backint agent supports backing up your SAP HANA database to an Amazon S3 bucket with the S3 Standard, S3 Standard-IA, S3 One Zone-IA, and S3 Intelligent-Tiering storage classes. S3 Reduced Redundancy, Deep Archive, and Glacier storage classes are not supported by AWS Backint agent. By default, the S3 Standard storage class is used to store your backups. You can change the storage class to use for backups by modifying the AWS Backint agent configuration file (p. 13). Alternatively, you can change your backup files to one of the supported storage classes through S3 LifeCycle configuration or directly using APIs. To learn more about Amazon S3 storage classes, see Amazon S3 Storage Classes in the *Amazon S3 Developer Guide*.

> **Note**
> S3 Intelligent-Tiering storage class enables movement of objects between four access tiers. It can also move objects to the archival tiers. However, **AWS Backint agent for SAP HANA does not support backup and recovery from archival tiers.** To recover or delete objects from the archival tiers, you must first restore the archived S3 objects before initiating a recovery or deletion with the AWS Backint agent.

Encryption— AWS Backint agent supports encrypting your SAP HANA backup files while storing them in Amazon S3, using server-side encryption with AWS KMS (KMS). You can encrypt your backups with a `aws-managed-key` called `aws/s3` or you can use your own custom symmetrical AWS KMS key stored in KMS. To encrypt your backup files with keys stored in KMS (AWS-managed or custom), you must provide the KMS ARN during the install, or update the AWS Backint agent configuration file (p. 13) at a later time. To learn more about encrypting your S3 objects using AWS KMS, see How Amazon S3 uses AWS KMS in the *AWS Key Management Service Developer Guide*. Alternatively, you can enable default encryption for your Amazon S3 bucket using keys managed by Amazon S3. To learn more about enabling default encryption for your bucket, see How do I enable default encryption for an Amazon S3 bucket? in the *Amazon S3 Console User Guide*.

Object locking— You can store objects using a *write-once-read-many* (WORM) model with S3 Object Lock. Use S3 Object Lock if you want to prevent your SAP HANA backup files from being accidentally deleted or overwritten for a specific time period or indefinitely. If S3 Object Lock is enabled, you can't delete your SAP HANA backups stored in Amazon S3 using SAP HANA Cockpit, SAP HANA Studio, or SQL commands until the retention period expires. To learn about S3 Object Lock, see Locking objects using S3 Object Lock in the *Amazon S3 Developer Guide*.

Object tagging — By default, AWS Backint agent adds a tag called `AWSBackintAgentVersion` when it stores your SAP HANA backup files in your S3 bucket. This tag helps to identify the AWS Backint version and the SAP HANA version used when backing up your SAP HANA database. You can list the value of the tags from S3 console or using APIs. To disable default tagging, modify the AWS Backint agent configuration file (p. 13).

Install and configure AWS Backint Agent for SAP HANA

This section provides information to help you install the AWS Backint agent using an AWS Systems Manager document or AWS Backint installer. It also provides information to help you configure the agent, view logs, and get the current agent version.

Topics

Install AWS Backint agent using the AWS Systems Manager document

Use the following steps to install the AWS Backint agent using the AWS SSM document.

> **Important**
> Disable any existing backup processes (including scheduled log backups) before continuing with the installation. If you don’t disable existing backup processes before running the SSM document, you can corrupt an in-progress backup, which can impact your ability to recover your database.

1. From the AWS Management Console, choose **Systems Manager** under **Management & Governance**, or enter **`Systems Manager`** in the **Find Services** search bar.
2. From the Systems Manager console, choose **Documents** under **Shared Resources** in the left navigation pane.

3. On the Documents page, select the **Owned by Amazon** tab. You should see a document named **AWSSAP-InstallBackint**.
4. Select the **AWSSAP-InstallBackint** document and choose **Run command**.
5. Under the Command parameters, enter the following

    a. **Bucket Name**. Enter the name of the Amazon S3 bucket where you want to store your SAP HANA backup files.

    b. **Bucket Folder**. Optionally, enter the name of the folder within your Amazon S3 bucket where you want to store your SAP HANA backup files.

    c. **System ID**. Enter your SAP HANA System ID, for example **`HDB`**.

    d. **Bucket Region**. Enter the AWS Region of the Amazon S3 bucket where you want to store your **SAP HANA backup files**. AWS Backint agent supports cross-Region and cross-account backups. You must provide the AWS Region and Amazon S3 bucket owner account ID along with the Amazon S3 bucket name for the agent to perform successfully.

    e. **Bucket Owner Account ID**. Enter the account ID of the Amazon S3 bucket where you want to store your SAP HANA backup files.

    f. **Kms Key**. Enter the ARN of AWS KMS that AWS Backint agent can use to encrypt the backup files stored in your Amazon S3 bucket.

    g. **Installation Directory**. Enter the path of the directory location where you want to install the AWS Backint agent. Avoid using `/tmp` as the install path.

    h. **Agent Version**. Enter the version number of the agent that you want to install. If you do not enter a version number, the latest published version of the agent is installed.

        Note
        1.0 versions are unavailable in the GovCloud Regions.

    i. **Modify Global ini file**. Choose how you want to modify the `global.ini` file. The `global.ini` file of the SAP HANA SYSTEM DB must be updated to complete the setup.

        i. "modify" — SSM will update the `global.ini` file directly.

        ii. "sql" — SSM will create a file called `modify_global_ini.sql` with SQL statements that you can run in your target SAP HANA system to set the required parameters. You can find the `modify_global_ini.sql` file in the `<installation directory>/aws-backint-agent/` folder.

        iii. "none" — No action will be taken by SSM to modify the `global.ini` file. You must manually update it to complete the setup.

    j. **Ignore Bucket Checks**. Select **yes** to ignore sanity checks of the S3 bucket. S3 Bucket sanity checks verify the following:

        - the bucket exists in your account
        - the bucket Region is correct
        - the bucket is public

    k. **Debug Mode**. Select **yes** to activate debug mode.

    l. **Important! Ensure No Backup In Process**. Choose **Yes** to confirm that you have disabled existing backups and are ready to proceed with the installation. **The SSM document will fail if you choose "No"**.
6. Under **Targets**, select the method for your target instance to use to install the AWS Backint agent, and then choose the instance on which to install it. If you are not able to find your instance in the list, verify that you have followed all of the steps in the prerequisites (p. 3).
7. Under **Other parameters**, leave the field empty and choose **Run**.

    Important
    If you do not have the latest version of the SSM Agent installed (2.3.274.0 or later), **Run Command** will fail to execute.

8. When the agent is successfully installed, you will see the **Success** status under the **Command ID**.
9. To verify the installation, log in to your instance and view the `/<install directory>/aws-backint-agent` directory. You should see the following files in the directory: the AWS Backint agent binary, `THIRD_PARTY_LICENSES.txt` file, which contains licenses of libraries used by the agent, the launcher script, the YAML configuration file, and the optional `modify_global_ini.sql` file. In addition, a source file (`aws-backint-agent.tar.gz`) of AWS Backint agent is stored in the package directory. You can verify the signature of this file to ensure that the downloaded source file is original and unmodified. See the Verifying the signature of AWS Backint agent and installer for SAP HANA (p. 28) section in this document for details.

   The SSM document creates symbolic links (symlinks) in the SAP HANA global directory for the Backint configuration. Verify that the symlink for `hdbbackint` exists in the `/usr/sap/<SID>/SYS/global/hdb/opt` directory and the symlink for `aws-backint-agent-config.yaml` exists in the `/usr/sap/<SID>/SYS/global/hdb/opt/hdbconfig` directory.

Install AWS Backint agent using AWS Backint installer — interactive mode

Another way to install the AWS Backint agent is with the AWS Backint installer. You can download the AWS Backint installer from an Amazon S3 bucket. The name of the S3 bucket is `s3://awssap-backint-agent/`.

> **Note**
> For AWS GovCloud (US-East), the name of the S3 bucket is `s3://awssap-backint-agent-us-gov-east-1`.
> For AWS GovCloud (US-West), the name of the S3 bucket is `s3://awssap-backint-agent-us-gov-west-1`.

The latest installer can always be found at `s3://awssap-backint-agent/binary/latest/install-aws-backint-agent` .

> **Note**
> For AWS GovCloud (US-East), the latest installer can always be found at `s3://awssap-backint-agent-us-gov-east-1/binary/latest/install-aws-backint-agent`.
> For AWS GovCloud (US-West), the latest installer can always be found at `s3://awssap-backint-agent-us-gov-west-1/binary/latest/install-aws-backint-agent`.

Follow these steps to install AWS Backint agent using the AWS Backint installer from an SSH session on your SAP HANA instance.

> **Important**
> Disable any existing backup processes (including scheduled log backups) before continuing with the installation. If you don't disable existing backup processes before running the AWS Backint agent installer, you can corrupt an in-progress backup, which can impact your ability to recover your database.

1. Navigate to `/tmp` (or another temporary directory where you downloaded the installer).

   ```
   cd /tmp
   ```

2. Run one of the following commands to download the installer.

   ```
   sudo aws s3 cp s3://awssap-backint-agent/binary/latest/install-aws-backint-agent /tmp/
   ```

   or

```
sudo wget https://s3.amazonaws.com/awssap-backint-agent/binary/latest/install-aws-
backint-agent -O /tmp/install-aws-backint-agent
```

> **Note**
> If you encounter permission issues while downloading the AWS Backint installer using the AWS CLI, check your IAM policy and ensure that your policies allow for downloading objects from the `awssap-backint-agent` bucket. See the Identity and Access Management (p. 4) section of this documentation for details.

3. (Optional) For AWS GovCloud (US-East) and AWS GovCloud (US-West), run one of the following commands to download the installer.

   ```
   sudo aws s3 cp s3://awssap-backint-agent-us-gov-east-1/binary/latest/install-aws-
   backint-agent /tmp/
   ```

   ```
   sudo aws s3 cp s3://awssap-backint-agent-us-gov-west-1/binary/latest/install-aws-
   backint-agent /tmp/
   ```

   or

   ```
   sudo wget https://awssap-backint-agent-us-gov-east-1.s3.us-gov-east-1.amazonaws.com/
   binary/latest/install-aws-backint-agent -O /tmp/install-aws-backint-agent
   ```

   ```
   sudo wget https://awssap-backint-agent-us-gov-west-1.s3.us-gov-west-1.amazonaws.com/
   binary/latest/install-aws-backint-agent -O /tmp/install-aws-backint-agent
   ```

4. Run the installer with the `-h` flag to find all of the available options.

   ```
   sudo python install-aws-backint-agent -h
   ```

5. Run the following command to execute the installer.

   ```
   sudo python install-aws-backint-agent
   ```

   > **Note**
   > Run the installer with the `-l` flag if you want the installer to get the AWS Backint agent binary file from your own file system or Amazon S3 bucket. Specify the location of the `aws-backint-agent.tar.gz` file.
   >
   > ```
   > sudo python install-aws-backint-agent -l /tmp/backint/aws-backint-agent.tar.gz
   > ```
   >
   > ```
   > sudo python install-aws-backint-agent -l s3://AWSDOC-EXAMPLE-BUCKET/aws-backint-
   > agent.tar.gz
   > ```
   >
   > ```
   > sudo python install-aws-backint-agent -l https://AWSDOC-EXAMPLE-
   > BUCKET.s3.amazonaws.com/aws-backint-agent.tar.gz
   > ```

6. Enter information for the following parameters.

   a. **Installation directory** — Enter the path of the directory location where you want to install the AWS Backint agent. The default value for the installation directory is `/hana/shared/`.

   b. **Amazon S3 bucket owner** — Enter the account ID of the Amazon S3 bucket owner of the bucket where you want to store your SAP HANA backup files.

c. **Amazon S3 bucket Region** — Enter the AWS Region of the Amazon S3 bucket where you want to store your SAP HANA backup files.

d. **Amazon S3 bucket name** — Enter the name of the Amazon S3 bucket where you want to store your SAP HANA backup files.

e. **Folder in the S3 bucket** — Enter the name of the folder in the Amazon S3 bucket where you want to store your SAP HANA backup files. This parameter is optional.

f. **Amazon S3 SSE KMS ARN** — Enter the ARN of the AWS KMS that AWS Backint agent can use to encrypt the backup files stored in your Amazon S3 bucket.

   Note
   If you leave this field empty, AWS Backint installer will prompt you to confirm that you don't want to encrypt your backup files with encryption keys stored in AWS KMS. If you do not confirm that you do not want to encrypt with the kms-key, the installer will abort. We strongly recommend that you encrypt your data. See the Encryption (p. 5) section of this documentation for available options.

g. **SAP HANA system ID** — Enter your SAP HANA System ID, for example `HDB`.

h. **HANA opt dir** — Confirm the location of the SAP HANA opt directory.

i. **Modify global.ini [modify/sql/[none]]** — Choose how you want to modify the `global.ini` file. The `global.ini` file of the SAP HANA SYSTEM must be updated to complete the setup.

   i. "modify" — AWS Backint installer will update the `global.ini` file directly.

   ii. "sql" — AWS Backint installer will create a file called `modify_global_ini.sql` with SQL statements that you can run in your target SAP HANA system to set the required parameters. You can find the `modify_global_ini.sql` file in the `<installation directory>/aws-backint-agent/` folder.

   iii. "none" — No action will be taken by AWS Backint installer to modify the `global.ini` file. You must manually update them to complete the setup.

j. **HANA SYSTEM db global.ini file** — Confirm the location of `global.ini` file.

k. **Verify signature of the agent binary `.tar` file** —

   - Choose `y` to verify the signature of the AWS Backint agent source file. If you choose `y`, enter the Amazon S3 bucket location of the signature file of the agent binary `.tar` file, for example, `https://s3.amazonaws.com/awssap-backint-agent/binary/latest/aws-backint-agent.sig`. Or, provide a local file that is stored on the instance. If you proceed without making a selection, the default location listed within brackets ([]) is used.
   - Choose `n` if you do not want to verify the signature of the AWS Backint agent source file.

l. **Save responses for future usage?** — You can save your information for the AWS Backint installer to a file. You can then use it later to run the installer in silent mode, if needed.

m. **Do you want to proceed with the installation?** — Confirm that you have disabled the existing backups and are ready to proceed with the installation.

7. To verify the installation, log in to your instance and view the `/<install directory>/aws-backint-agent` directory. You should see the following files in the directory: the AWS Backint agent binary, the `THIRD_PARTY_LICENSES.txt` file, which contains licenses of libraries used by the agent, the launcher script, the YAML configuration file, and the optional `modify_global_ini.sql` file. In addition, a source file (`aws-backint-agent.tar.gz`) of AWS Backint agent is stored in the package directory. You can verify the signature of this file to ensure that the downloaded source file is original and unmodified. See the Verifying the signature of AWS Backint agent and installer for SAP HANA (p. 28) section in this document for details.

   In addition, the AWS Backint installer creates symbolic links (symlinks) in the SAP HANA global directory for the Backint configuration. Verify that the symlink for `hdbbackint` exists in the `/usr/sap/<SID>/SYS/global/hdb/opt` directory, and that the symlink for `aws-backint-agent-config.yaml` exists in the `/usr/sap/<SID>/SYS/global/hdb/opt/hdbconfig` directory.

Note

If your installation fails due to validation errors and you want to ignore the validation and proceed with the installation, you can execute the installer with the `-n` flag to ignore the validation steps. You can also use the `-d` flag to run the installer in debug mode to generate detailed installation logs for troubleshooting.

Install AWS Backint agent using AWS Backint installer — silent mode

You can install the AWS Backint agent with the AWS Backint installer in a silent mode. Choose this option if you want the installation process to be automated without manual intervention.

To run the AWS Backint installer in silent mode, create a response file with all of the required installation parameters. Follow the steps in the section on installing using the interactive mode (p. 8) to download AWS Backint installer and create a response file. You don't have to confirm to continue with the AWS Backint agent installation in interactive mode. AWS Backint installer will create a response file called `aws-backint-agent-install-YYYYMMDDHHMMSS.rsp`.

When you have a response file, you can modify it with a vim editor and adjust the parameters as needed.

The following is an example response file.

```
[DEFAULT]
s3_bucket_name = awsdoc-example-bucket
s3_bucket_owner_account_id = 111122223333
modify_global_ini = sql
s3_bucket_region = us-east-1
s3_sse_kms_arn = arn:aws:kms:us-east-1:111122223333:key/1abcd9b9-
ab12-1a2a-1abc-12345abc12a3
s3_bucket_folder = myfolder
hana_sid = TST
installation_directory = /hana/shared/
```

If you want to generate the response file programmatically instead of using AWS Backint installer in interactive mode, you can use the `-g` flag to generate a new response file. The following is an example of how to generate a response file using AWS Backint installer.

```
sudo python install-aws-backint-agent -g "s3_bucket_owner_account_id =
 111122223333,s3_bucket_name = awsdoc-example-bucket,s3_bucket_region = us-
east-1,hana_sid = TST,s3_sse_kms_arn = arn:aws:kms:us-east-1:111122223333:key/1abcd9b9-
ab12-1a2a-1abc-12345abc12a3,s3_bucket_folder = myfolder,installation_directory = /hana/
shared/,modify_global_ini = sql" -f myresponse.rsp
```

After the response file is created, use the following steps to run AWS Backint installer in silent mode.

Important

Disable any existing backup processes (including scheduled log backups) before continuing with the installation. If you don't disable existing backup processes before running the AWS Backint agent installer, you can corrupt an in-progress backup, which can impact your ability to recover your database.

Run the following command to execute the installer using the generated response file.

```
sudo python install-aws-backint-agent -m silent -f backint-agent-install-YYYYMMDDHHMMSS.rsp
 -a yes
```

If you want to choose the location from which to install the agent, run the command with the `-l` flag and specify the location.

```
sudo python install-aws-backint-agent -f aws-backint-agent-install-YYYYMMDDHHMMSS.rsp -m
 silent -a yes -d -l /tmp/backint/aws-backint-agent.tar.gz
```

> **Note**
> You must confirm that you have disabled the existing backups and are ready to proceed with the installation in silent mode by passing an acknowledgement flag (`-a yes`). If you don't pass the acknowledgement flag, AWS Backint installer will fail to execute.

Use a proxy address with AWS Backint agent

If you use a proxy address in your SAP HANA environment when you install the agent, you must use the following shell script to install the agent to ensure that the correct proxy settings are used by the AWS Backint agent installer.

```
#!/bin/bash
export https_proxy=<PROXY_ADDRESS>:<PROXY_PORT>
export HTTP_PROXY=<PROXY_ADDRESS>:<PROXY_PORT>
export no_proxy=169.254.169.254
export NO_PROXY=169.254.169.254
sudo python install-aws-backint-agent
```

If you use a proxy address in your SAP HANA environment, you must update the `aws-backint-agent-launcher.sh` file, which is located in the AWS Backint agent installation directory (for example, `/hana/shared/aws-backint-agent/`). You must perform the following update to ensure that the correct proxy settings are used by AWS Backint agent during backup and restore operations.

Add `http_proxy`, `HTTP_PROXY`, `no_proxy`, and `NO_PROXY` variables to the `aws-backint-agent-launcher.sh` script. It is important to exclude the `196.254.169.254` address with the `no_proxy` variable. If you do not exclude this address, instance metadata service calls made by AWS Backint agent will fail and cause errors during backup and restore operations. For more information about instance metadata and user data, see Instance metadata and user data in the *Amazon EC2 User Guide for Linux Instances*.

```
#!/bin/bash
export https_proxy=<PROXY_ADDRESS>:<PROXY_PORT>
export HTTP_PROXY=<PROXY_ADDRESS>:<PROXY_PORT>
export no_proxy=169.254.169.254
export NO_PROXY=169.254.169.254
/hana/shared/aws-backint-agent/aws-backint-agent "$@"
```

Backint-related SAP HANA parameters

To enable SAP HANA backups using AWS Backint agent, you must set the following SAP HANA parameters. If you chose the "modify" option for the `global.ini` file update, the SSM document or AWS Backint installer adds or updates the following backup related SAP HANA parameters in `global.ini` for the system database. If you chose "sql", you can run the SQL statements specified in the `modify_global_ini.sql` file to update these parameters. For more details about these parameters, see Backup Configuration Parameters in the *SAP HANA Administration Guide*.

```
[backup]
catalog_backup_parameter_file = /usr/sap/<SID>/SYS/global/hdb/opt/hdbconfig/aws-backint-
agent-config.yaml
data_backup_parameter_file = /usr/sap/<SID>/SYS/global/hdb/opt/hdbconfig/aws-backint-agent-
config.yaml
log_backup_parameter_file = /usr/sap/<SID>/SYS/global/hdb/opt/hdbconfig/aws-backint-agent-
config.yaml
catalog_backup_using_backint = true
```

```
log_backup_using_backint = true
parallel_data_backup_backint_channels = 8
data_backup_buffer_size = 4096
max_recovery_backint_channels = 1
[communication]
tcp_backlog = 2048
[persistence]
enable_auto_log_backup = yes
verify_signature = yes
input_signature_filepath = https://s3.amazonaws.com/awssap-backint-agent/binary/latest/aws-
backint-agent.sig
```

Note

Changing the `tcp_backlog` parameter requires a restart of SAP HANA to take effect. `max_recovery_backint_channels` determines the number of log files restored/recovered in parallel during the recovery process. When multistreamed backups are recovered, SAP HANA always uses the same number of channels that were used during the backup. For more information, see Multistreaming Data Backups with Third-Party Backup Tools in the SAP documentation.

Modify AWS Backint agent configuration parameters

The AWS Backint agent configuration parameters are maintained in a YAML file in the `/<installation directory>/aws-backint-agent/` directory. The name of the configuration file is `aws-backint-agent-config.yaml`. The following tables summarize the configuration parameters added as part of the AWS Backint agent installation process, and additional parameters that you can add or change.

Parameters added to the `aws-backint-agent-config.yaml` during initial setup

Name of the parameter	Description	Default value
`S3BucketName`	Name of the Amazon S3 bucket where you want to store your SAP HANA backup files. For example, `awsdoc-example-bucket`.	N/A
`S3BucketAwsRegion`	AWS Region of your Amazon S3 bucket. For example, `us-east-1`.	N/A
`S3BucketFolder`	Name of the folder in the Amazon S3 bucket where you want to store your SAP HANA backup files. For example, `my-folder`.	Empty
`S3BucketOwnerAccountID`	12-digit account ID of the Amazon S3 bucket owner. For example, `111122223333`.	N/A
`LogFile`	Location of the AWS Backint agent log file.	`/hana/shared/aws-backint-agent/aws-backint-agent.log`
`S3SseKmsArn`	ARN of the kms-key that AWS Backint agent can use to encrypt the backup files stored in Amazon S3. For example,	Empty

Name of the parameter	Description	Default value
	`arn:aws:kms:us-east-1:111122223333:key/5bfbc9b9-ab12-ab12-a123-11111xxx22xx`.	
`S3SseEnabled`	Specifies whether KMS encryption is enabled.	Set to `false` if the `S3SseKmsArn` parameter is empty. Otherwise, set to `true`.

Parameters that can be added to the `aws-backint-agent-config.yaml` file to update default values

Name of the parameter	Description	Default value	Supported since

`BackupObjectTags`	Enables support for additional S3 object tags.
	`EnableTagging` must be set to `true` in order to use `BackupObjectTags`.
	Allowed values: must be a valid JSON string that uses the following syntax:
	`-BackupObjectTags:`
	` "[{Key=string,Value=string},`
	`{Key=string,Value=string},...]`
	For applicable tag restrictions, see Tag restrictions in the *Amazon EC2 User Guide*.
		N/A	Version 1.03

`EnableTagging`	Enables or disables default object tagging for backups files stored in S3. Tagging helps to identify the AWS Backint version and SAP HANA version used during the backup. Allowed values: `true` or `false`.	`true`	Version 1.03
`LogLevel`	Specifies the logging level for agent logs. Allowed values: `info` or `debug`.	`info`	Version 1.0

Name of the parameter	Description	Default value	Supported since
`LogRotationFrequency`	Specifies the `aws-backint-agent.log` file rotation frequency. Allowed values: `minute`, `hour`, `day`, or `never`.	`never`	Version 1.03
`S3StorageClass`	Specifies the S3 storage class type that AWS Backint agent can use while storing your backup files. Allowed values: `STANDARD`, `STANDARD_IA`, `ONEZONE_IA`, or `INTELLIGENT_TIERING`.	`STANDARD`	Version 1.0 (Intelligent-Tiering since version 1.05)
`UploadConcurrency`	Specifies the number of S3 threads that can work in parallel during backup. Allowed values: `1` to `200`.	`100`	Version 1.0
`UploadChannelSize`	Specifies the number of files that can be uploaded in parallel to the S3 bucket during the backups. Allowed values: `1` to `32`.	`10`	Version 1.0
`MaximumConcurrentFilesForRestore`	Specifies the number of files that can be downloaded in parallel from S3 during the restore. Allowed values: `1` to `32`.	`5`	Version 1.0
`S3ShortenBackupDestinationEnabled`	Specifies whether to use a shorter Amazon S3 path. Allowed values: `true` or `false`.	`false`	Version 1.05

Configure SAP HANA to use a different Amazon S3 bucket and folder for data and log backup

AWS Backint agent uses the same parameters by default for the data and log backups. It stores the data and log backups in the same Amazon S3 bucket and folder.

```
data_backup_parameter_file = /usr/sap/<SID>/SYS/global/hdb/opt/hdbconfig/aws-backint-agent-
config.yaml
log_backup_parameter_file = /usr/sap/<SID>/SYS/global/hdb/opt/hdbconfig/aws-backint-agent-
config.yaml
```

To use a different Amazon S3 bucket and folder for the data and log backups, follow these steps.

1. **Check the SAP HANA backup parameters**

   Locate the `data_backup_parameter_file` and `log_backup_parameter_file` parameters. The default value of these parameters should be `/<installation directory>/aws-backint-agent/aws-backint-agent-config.yaml`. If you do not see this default value, check the configuration file to confirm that it is displaying the same Amazon S3 location.
2. **Retain access to the logs backup stored in the previous Amazon S3 location**

   If this is a new setup or you do not want to retain the previous logs backup, skip this step and continue with Step 3.

   Move the previous logs backup with source type `volume` to the new Amazon S3 location for logs backup only. You can confirm the source type by running the following SQL command.

   ```
   select SOURCE_TYPE_NAME, DESTINATION_PATH from M_BACKUP_CATALOG_FILES
   ```

   The backup catalog is assigned a name in the following format: `log_backup_0_0_0_0.<BackupID>`. This type of backup is managed by a different SAP HANA parameter, has a source type `catalog`, and should remain in the data backup location. This file contains the backup catalog file that stores the history of all backups. Only the log backups with source type `volume` should be moved to the new Amazon S3 location. To change the Amazon S3 location for catalog backup, see the section called “Configure SAP HANA to use a different Amazon S3 bucket and folder for catalog backup” (p. 19).

   The following table provides an example of a SYSTEM DB folder structure:

Backup folder	Descriptions
COMPLETE_DATA_BACKUP_databackup_0_1/	Nameserver data backup with the source type "topology"
COMPLETE_DATA_BACKUP_databackup_1_1/	Nameserver data backup with the source type "volume"
log_backup_0_0_0_0/	Log file with source type "catalog"
log_backup_1_0_<backup ID>_<backup ID>	Log file with source type "volume"

   The following table provides an example of a TENANT DB folder structure:

Backup folder	Descriptions
COMPLETE_DATA_BACKUP_databackup_0_1/	Indexserver data backup with the source type "topology"
COMPLETE_DATA_BACKUP_databackup_2_1/	Indexserver data backup with the source type "volume"
COMPLETE_DATA_BACKUP_databackup_3_1/	Xsengine data backup with the source type "volume"
log_backup_0_0_0_0/	Log file with source type "catalog"
log_backup_2_0_<backup ID>_<backup ID>	Log file with source type "volume"
log_backup_3_0_<backup ID>_<backup ID>	Log file with source type "volume"

Note
Before doing steps a and b, ensure that there is no backup process running.

a. **Change the location of the logs backup for SYSTEM DB**

Run the following commands to move the volume type of SYSTEM DB logs. In the example, we use the same Amazon S3 bucket, but create another folder for the logs backup.

```
# Create the folder structure
aws s3api put-object --bucket <S3 bucket> --key <S3 folder for logs>/<SID>/usr/sap/
<SID>/SYS/global/hdb/backint/SYSTEMDB/

# Execute a Dry Run to check
aws s3 cp s3://<S3 bucket>/<S3 folder>/<SID>/usr/sap/<SID>/SYS/global/hdb/backint/
SYSTEMDB/ s3://<S3 bucket>/<S3 folder for logs>/<SID>/usr/sap/<SID>/SYS/global/hdb/
backint/SYSTEMDB/ --exclude "*" --include "log_backup_1_0*" --recursive --dryrun

# Run the command to move the logs to the new S3 location
aws s3 cp s3://<S3 bucket>/<S3 folder>/<SID>/usr/sap/<SID>/SYS/global/hdb/backint/
SYSTEMDB/ s3://<S3 bucket>/<S3 folder for logs>/<SID>/usr/sap/<SID>/SYS/global/hdb/
backint/SYSTEMDB/ --exclude "*" --include "log_backup_1_0*" --recursive

# Check the output of the S3 location for logs
aws s3 ls s3://<S3 bucket>/<S3 folder for logs>/<SID>/usr/sap/<SID>/SYS/global/hdb/
backint/SYSTEMDB/
```

b. **Change the location of the logs backup for TENANT DB**

Run the following commands to move the volume type TENANT DB logs. In the example, we use the same Amazon S3 bucket, and create another folder for the logs backup. You need to repeat this step for every TENANT DB.

```
#Create the folder structure
aws s3api put-object --bucket <S3 bucket> --key <S3 folder for logs>/<SID>/usr/sap/
<SID>/SYS/global/hdb/backint/DB_<SID>/

#Execute a Dry Run
aws s3 cp s3://<S3 bucket>/<S3 folder>/<SID>/usr/sap/<SID>/SYS/global/hdb/
backint/DB_<SID>/ s3://<S3 bucket>/<S3 bucket for logs>/<SID>/usr/sap/<SID>/SYS/
global/hdb/backint/DB_<SID>/ --exclude "" --include "log_backup_2_0" --include
 "log_backup_3_0" —recursive —dryrun
```

```
#Run the command to move the logs to the new S3 location
aws s3 cp s3://<S3 bucket>/<S3 folder>/<SID>/usr/sap/<SID>/SYS/global/hdb/
backint/DB_<SID>/ s3://<S3 bucket>/<S3 bucket for logs>/<SID>/usr/sap/<SID>/SYS/
global/hdb/backint/DB_<SID>/ --exclude "" --include "log_backup_2_0" --include
 "log_backup_3_0" —recursive

#Check the output of the S3 location for logs
aws s3 ls s3://<S3 bucket>/<S3 bucket for logs>/<SID>/usr/sap/<SID>/SYS/global/hdb/
backint/DB_<SID>/
```

3. **Create the `aws-backint-agent-config-logs.yaml` parameter file**

   a. Make a copy of the existing AWS Backint agent configuration for logs backup.

   ```
   cp /hana/shared/aws-backint-agent/aws-backint-agent-config.yaml  \
   /hana/shared/aws-backint-agent/aws-backint-agent-config-logs.yaml
   ```

   b. Modify the `S3BucketName`, `S3BucketFolder`, and `LogFile` parameters in `aws-backint-agent-config-logs.yaml`, using your preferred editor.

   ```
   S3BucketName: "<Amazon S3 bucket for SAP HANA logs>"
   S3BucketFolder: "<Amazon S3 folder for SAP HANA logs>"
   LogFile: "/hana/shared/aws-backint-agent/aws-backint-agent-logs.log"
   ```

   c. Create a `hdbbackint` soft link from `/usr/sap/<SID>/SYS/global/hdb/opt/hdbconfig/` to `/hana/shared/aws-backint-agent/`.

   ```
   ln -s /hana/shared/aws-backint-agent/aws-backint-agent-config-logs.yaml  \
   /usr/sap/<SID>/SYS/global/hdb/opt/hdbconfig/aws-backint-agent-config-logs.yaml
   ```

4. **Change the parameter to point to the new AWS BACKINT configuration file**

   Change the `log_backup_parameter_file` to `/hana/shared/aws-backint-agent-config-logs.yaml`.

5. **Validate to ensure that all steps have been processed correctly**

   a. Run a point-in-time recovery to a previous state, to ensure that you can access the previous log files in the new Amazon S3 location.

   b. Verify that new logs are uploaded to the new S3 location.

6. **Delete previous backups**

   After a successful validation, we recommend waiting for at least a week before deleting the previous logs.

   When you're ready, delete the previous logs with the following commands.

```
# Delete previous backups in SYSTEMDB
aws s3 rm s3://<S3 bucket>/<S3 folder>/<SID/usr/sap/<SID/SYS/global/hdb/backint/
SYSTEMDB/ --exclude "" --include "log_backup_1_0" —recursive —dryrun
aws s3 rm s3://<S3 bucket>/<S3 folder>/<SID/usr/sap/<SID/SYS/global/hdb/backint/
SYSTEMDB/ --exclude "" --include "log_backup_1_0" —recursive

# Delete previous backups in the TENANT database (Repeat for each tenant)
aws s3 rm s3://<S3 bucket>/<S3 folder>/<SID/usr/sap/<SID/SYS/global/hdb/backint/
DB_<SID/ --exclude "" --include --include "log_backup_2_0" --include "log_backup_3_0" —
recursive —dryrun
aws s3 rm s3://<S3 bucket>/<S3 folder>/<SID/usr/sap/<SID/SYS/global/hdb/backint/
DB_<SID/ --exclude "" --include "log_backup_2_0" --include "log_backup_3_0" —recursive
```

Configure SAP HANA to use a different Amazon S3 bucket and folder for catalog backup

AWS Backint agent uses the same parameters by default for the data, log, and catalog backups. It stores all of the backups in the same Amazon S3 bucket and folder.

```
data_backup_parameter_file = /usr/sap/<SID>/SYS/global/hdb/opt/hdbconfig/aws-backint-agent-config.yaml
log_backup_parameter_file = /usr/sap/<SID>/SYS/global/hdb/opt/hdbconfig/aws-backint-agent-config.yaml
catalog_backup_parameter_file = /usr/sap/<SID>/SYS/global/hdb/opt/hdbconfig/aws-backint-agent-config.yaml
```

To use a different Amazon S3 bucket and folder for catalog backup, follow these steps.

1. **Check the SAP HANA backup parameters**

   Locate the `data_backup_parameter_file`, `log_backup_parameter_file`, and `catalog_backup_parameter_file` parameters. The default value of these parameters should be `/<installation directory>/aws-backint-agent/aws-backint-agent-config.yaml`. If you do not see this default value, check the configuration file to confirm that it is displaying the same Amazon S3 location.
2. **Retain access to the logs backup stored in the previous Amazon S3 location**

   If this is a new setup or you do not want to retain the previous catalog backup, skip this step and continue with Step 3.

   Move the previous catalog backup with source type `catalog` to the new Amazon S3 location for catalog backup only. You can confirm the source type by running the following SQL command.

   ```
   select SOURCE_TYPE_NAME, DESTINATION_PATH from M_BACKUP_CATALOG_FILES
   ```

   The backup catalog is assigned a name in the following format: `log_backup_0_0_0_0.<BackupID>`. This type of backup has a source type `catalog`. This file contains the backup catalog file that stores the history of all backups. Only the catalog backups with source type `catalog` should be moved to the new Amazon S3 location. To change the Amazon S3 location for log backup, see the section called “Configure SAP HANA to use a different Amazon S3 bucket and folder for data and log backup” (p. 16).

   The following table provides an example of a SYSTEM DB folder structure:

Backup folder	Descriptions
COMPLETE_DATA_BACKUP_databackup_0_1/	Nameserver data backup with the source type "topology"
COMPLETE_DATA_BACKUP_databackup_1_1/	Nameserver data backup with the source type "volume"
log_backup_0_0_0_0/	Log file with source type "catalog"
log_backup_1_0_<backup ID>_<backup ID>	Log file with source type "volume"

   The following table is an example of a TENANT DB folder structure:

Backup folder	Descriptions
COMPLETE_DATA_BACKUP_databackup_0_1/	Indexserver data backup with the source type "topology"
COMPLETE_DATA_BACKUP_databackup_2_1/	Indexserver data backup with the source type "volume"
COMPLETE_DATA_BACKUP_databackup_3_1/	Xsengine data backup with the source type "volume"
log_backup_0_0_0_0/	Log file with source type "catalog"
log_backup_2_0_<backup ID>_<backup ID>	Log file with source type "volume"
log_backup_3_0_<backup ID>_<backup ID>	Log file with source type "volume"

Note
Before doing steps a and b, ensure that there is no backup process running.

a. **Change the location of the catalog backup for SYSTEM DB**

Run the following commands to move the `catalog` type of SYSTEM DB logs. In the example, we use the same Amazon S3 bucket, but create another folder for catalog backup.

```
# Create the folder structure
aws s3api put-object --bucket <S3 bucket> --key <S3 folder for catalog>/<SID>/usr/
sap/<SID>/SYS/global/hdb/backint/SYSTEMDB/

# Execute a Dry Run to check
aws s3 cp s3://<S3 bucket>/<S3 folder>/<SID>/usr/sap/<SID>/SYS/global/hdb/backint/
SYSTEMDB/ s3://<S3 bucket>/<S3 folder for catalog>/<SID>/usr/sap/<SID>/SYS/global/
hdb/backint/SYSTEMDB/ --exclude "*" --include "log_backup_0_0_0_0*" --recursive --
dryrun

# Run the command to move the logs to the new S3 location
aws s3 cp s3://<S3 bucket>/<S3 folder>/<SID>/usr/sap/<SID>/SYS/global/hdb/backint/
SYSTEMDB/ s3://<S3 bucket>/<S3 folder for catalog>/<SID>/usr/sap/<SID>/SYS/global/
hdb/backint/SYSTEMDB/ --exclude "*" --include "log_backup_0_0_0_0*" --recursive

# Check the output of the S3 location for logs
aws s3 ls s3://<S3 bucket>/<S3 folder for catalog>/<SID>/usr/sap/<SID>/SYS/global/
hdb/backint/SYSTEMDB/
```

b. **Change the location of the catalog backup for TENANT DB**

Run the following commands to move the `catalog` type tenant database logs. In the example, we use the same Amazon S3 bucket, and create another folder for catalog backup. You need to repeat this step for every TENANT DB.

```
#Create the folder structure
aws s3api put-object --bucket <S3 bucket> --key <S3 folder for catalog>/<SID>/usr/
sap/<SID>/SYS/global/hdb/backint/DB_<SID>/

#Execute a Dry Run
aws s3 cp s3://<S3 bucket>/<S3 folder>/<SID>/usr/sap/<SID>/SYS/global/hdb/backint/
DB_<SID>/ s3://<S3 bucket>/<S3 bucket for catalog>/<SID>/usr/sap/<SID>/SYS/global/
hdb/backint/DB_<SID>/ --exclude "" --include "log_backup_0_0_0_0*" —recursive —
dryrun
```

```
#Run the command to move the catalog to the new S3 location
aws s3 cp s3://<S3 bucket>/<S3 folder>/<SID>/usr/sap/<SID>/SYS/global/hdb/backint/
DB_<SID>/ s3://<S3 bucket>/<S3 bucket for catalog>/<SID>/usr/sap/<SID>/SYS/global/
hdb/backint/DB_<SID>/ --exclude "" --include "log_backup_0_0_0_0*" —recursive

#Check the output of the S3 location for catalog
```

3. **Create the `aws-backint-agent-config-catalog.yaml` parameter file**

   a. Make a copy of the existing AWS Backint agent configuration for catalog backup.

   ```
   cp /hana/shared/aws-backint-agent/aws-backint-agent-config.yaml  \
   /hana/shared/aws-backint-agent/aws-backint-agent-config-catalog.yaml
   ```

   b. Modify the `S3BucketName`, `S3BucketFolder`, and `LogFile` parameters in `aws-backint-agent-config-catalog.yaml`, using your preferred editor.

   ```
   S3BucketName: "<Amazon S3 bucket for SAP HANA catalog>"
   S3BucketFolder: "<Amazon S3 folder for SAP HANA catalog>"
   LogFile: "/hana/shared/aws-backint-agent/aws-backint-agent-catalog.log"
   ```

   c. Create a `hdbbackint` soft link from `/usr/sap/<SID>/SYS/global/hdb/opt/hdbconfig/` to `/hana/shared/aws-backint-agent/`.

   ```
   ln -s /hana/shared/aws-backint-agent/aws-backint-agent-config-catalog.yaml  \
   /usr/sap/<SID>/SYS/global/hdb/opt/hdbconfig/aws-backint-agent-config-catalog.yaml
   ```

4. **Change the parameter to point to the new AWS BACKINT configuration file**

   Change the `catalog_backup_parameter_file` to `/hana/shared/aws-backint-agent-config-catalog.yaml`.

5. **Validate to ensure that all steps have been processed correctly**

   a. Run a point-in-time recovery to a previous state to ensure that you can access the previous log files in the new Amazon S3 location.

   b. Verify that new logs are uploaded to the new S3 location.

6. **Delete previous backups**

   After a successful validation, we recommend waiting for at least a week before deleting the previous catalog.

   When you're ready, delete the previous logs with the following commands.

```
# Delete previous backups in SYSTEMDB
aws s3 rm s3://<S3 bucket>/<S3 folder>/<SID/usr/sap/<SID/SYS/global/hdb/backint/
SYSTEMDB/ --exclude "" --include "log_backup_0_0_0_0" —recursive —dryrun
aws s3 rm s3://<S3 bucket>/<S3 folder>/<SID/usr/sap/<SID/SYS/global/hdb/backint/
SYSTEMDB/ --exclude "" --include "log_backup_0_0_0_0" —recursive

# Delete previous backups in the TENANT database (Repeat for each tenant)
aws s3 rm s3://<S3 bucket>/<S3 folder>/<SID/usr/sap/<SID/SYS/global/hdb/backint/
DB_<SID/ --exclude "" --include --include "log_backup_0_0_0_0" —recursive —dryrun
aws s3 rm s3://<S3 bucket>/<S3 folder>/<SID/usr/sap/<SID/SYS/global/hdb/backint/
DB_<SID/ --exclude "" --include "log_backup_0_0_0_0" —recursive
```

Configure AWS Backint agent to use shorter Amazon S3 paths

AWS Backint agent uses the SAP HANA operating system path as the default location for backups, but you can configure it to use a shorter path.

Default path	s3://<Amazon-s3-bucket>/<Amazon-s3-folder>/<SID>/usr/sap/<SID>/SYS/global/hdb/backint/
New path	s3://<Amazon-s3-bucket>/<Amazon-s3-folder>/<SID>/

To use a shorter path, complete the following steps.

1. **Check the SAP HANA backup parameters**

   Locate the `data_backup_parameter_file`, `log_backup_parameter_file`, and `catalog_backup_parameter_file` parameters. If you are using the same parameter for data, log, and catalog backups, you only need to make this change in the `aws-backint-agent-config.yaml` file. If you are using different files, these changes need to be made in both files.

2. **Retain access to backups that are stored in the previous Amazon S3 location**

   If this is a new setup or you do not want to retain the previous catalog backup, skip this step and continue with Step 3.

   Ensure that there is no backup process running, then run the following command to move all of the previous backups to the new Amazon S3 location. This step assumes that you are using the same configuration parameter for both data and log. The example below uses the same S3 bucket, but you can use a new bucket.

   ```
   # Execute a Dry Run to check
   aws s3 cp s3://<S3 bucket>/<S3 folder>/<SID>/usr/sap/<SID>/SYS/global/hdb/backint/
    s3://<S3 bucket>/<S3 folder>/<SID>/ --recursive --dryrun

   # Run the command to move the backups to new S3 location
   aws s3 cp s3://<S3 bucket>/<S3 folder>/<SID>/usr/sap/<SID>/SYS/global/hdb/backint/
    s3://<S3 bucket>/<S3 folder>/<SID>/ --recursive

   # Check the output of both S3 location
   aws s3 ls s3://<S3 bucket>/<S3 folder>/<SID>/
   ```

3. Modify `aws-backint-agent-config.yaml`.

   ```
   vi /hana/shared/aws-backint-agent/aws-backint-agent-config.yaml
   ```

   Add the `S3ShortenDestinationBackupEnabled` parameter in `aws-backint-agent-config.yaml`, using your preferred editor.

   ```
   S3ShortenBackupDestinationEnabled: "true"
   ```

4. **Validate to ensure that all steps have been processed correctly**

   a. Run a point-in-time recovery to a previous state to ensure that you can access the previous log files in the new Amazon S3 location.

   b. Verify that new logs are uploaded to the new S3 location.

5. **Delete previous backups**

After a successful validation, we recommend waiting for at least a week before deleting the previous catalog.

When you're ready, delete the previous logs with the following commands.

```
# Execute a Dry Run to make sure
aws s3 rm s3://<S3 bucket>/<S3 folder>/<SID>/usr --recursive --dryrun

# Run the command to delete it in the previous S3 location
aws s3 rm s3://<S3 bucket>/<S3 folder>/<SID>/usr --recursive

# Check the output of both S3 location
aws s3 ls s3://<S3 bucket>/<S3 folder>/<SID>/
```

View AWS Backint agent logs

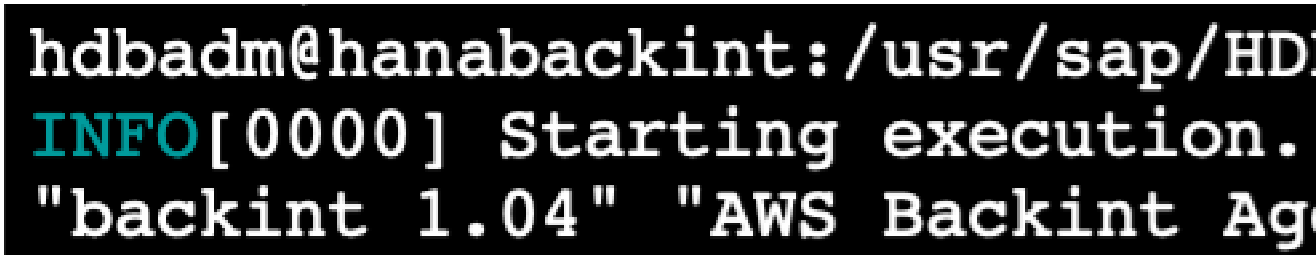
When the AWS Backint agent is called by SAP HANA for backup and restore related operations, the logs are written as `aws-backint-agent.log` to the `<installation directory>/aws-backint-agent/` folder. If you want to change the location of AWS Backint agent logs, you can update the parameter `LogFile` in the `aws-backint-agent-config.yaml` file.

Get the currently installed AWS Backint agent version

To display the backint version and the current AWS Backint agent version that it supports, run the `hdbbackint` command with the `-v` parameter from the install directory as the `<SID>adm` user as shown in the following example.

```
/usr/sap/<SID>/SYS/global/hdb/opt/hdbbackint -v
```

For instance, running the preceding command on a system with `SID` as `HDB` returns the AWS Backint agent version as 1.05 as displayed in the image below.



```
hdbadm@hanabackint:/usr/sap/HD
INFO[0000] Starting execution.
"backint 1.04" "AWS Backint Ag
```

```
/usr/sap/<SID>/SYS/global/hdb/opt/hdbbackint -v
```

Update or install a previous version of AWS Backint agent

The agent and installer are released together and their versions will always match. The latest and previous versions of the installer can be found at the following S3 bucket locations:

- **Latest version** `s3://awssap-backint-agent/binary/latest/install-aws-backint-agent`

  AWS GovCloud (US-East) latest version `s3://awssap-backint-agent-us-gov-east-1/binary/latest/install-aws-backint-agent`

  AWS GovCloud (US-West) latest version `s3://awssap-backint-agent-us-gov-west-1/binary/latest/install-aws-backint-agent`

- **Previous version** `s3://awssap-backint-agent/binary/`**`agent-version`**`/install-aws-backint-agent`

  AWS GovCloud (US-East) previous version`s3://awssap-backint-agent-us-gov-east-1/binary/`**`agent-version`**`/install-aws-backint-agent`

  AWS GovCloud (US-West) previous version`s3://awssap-backint-agent-us-gov-west-1/binary/`**`agent-version`**`/install-aws-backint-agent`

To install a previous version of the installer, download the version you want to install from the S3 folder that contains the previous version.

> **Note**
> The installer will download and install the version of the agent that corresponds to the installer version.

When you install the agent using the SSM document, you can input the version you want to install.

Performance tuning

AWS Backint agent is installed with default values that optimize the performance of backup and restore operations. If you want to further optimize the performance of your backup and restore operations, you can adjust the `UploadChannelSize` and `MaximumConcurrentFilesForRestore` parameters. Ensure that you are using the right instance type and storage configurations to get the best performance. AWS Backint agent is constrained by the resources available in the instance.

The `UploadChannelSize` parameter is used to determine how many files can be uploaded in parallel to the S3 bucket during backups. The default value for this parameter is `10` and it provides optimal performance in most cases.

The `UploadConcurrency` parameter is used to determine how many S3 threads can work in parallel during backups. The default value for this parameter is `100` and it provides optimal performance in most cases.

The `MaximumConcurrentFilesForRestore` parameter is used to determine how many files can be downloaded in parallel from S3 during a restore operation. The default value for this parameter is `5`, which provides the optimal performance for most use cases.

If you want to adjust these parameters, you can add them to the `aws-backint-agent-config.yaml` file and adjust the values (up to the allowed maximum). We strongly recommend that you test both the backup and recovery operations after the change to ensure there is no unintended impact to your backup and restore operations, as well as to other standard operations.

Additionally, to get the best performance during backup and restore operations, ensure that your SAP HANA data and log volumes are configured following the best practices from AWS. See the Storage Configuration for SAP HANA section in the *SAP HANA on AWS* documentation for more details.

Subscribe to AWS Backint agent notifications

Amazon Simple Notification Service (Amazon SNS) can notify you when new versions of AWS Backint agent or AWS Backint installer are released. The following procedure shows how to subscribe to these notifications.

To subscribe to AWS Backint agent notifications

1. Open the Amazon SNS console at https://console.aws.amazon.com/sns/v3/home.
2. From the Region selector in the navigation bar, choose **US East (N. Virginia)**, if it is not selected already. You must select this Region because the SNS notifications for AWS Backint agent that you are subscribing to are generated from this Region only.

3. In the navigation pane, choose **Subscriptions**.
4. Choose **Create subscription**.
5. For **Create subscription**, do the following:

   a. For **Topic ARN**, use the following Amazon Resource Name (ARN):

      ```
      arn:aws:sns:us-east-1:464188257626:AWS-Backint-Agent-Update
      ```

      For AWS GovCloud (US-East) and AWS GovCloud (US-West), use `arn:aws-us-gov:sns:us-gov-east-1:516607370456:AWS-Backint-Agent-Update`
   b. For **Protocol**, choose **Email** or **SMS**.
   c. For **Endpoint**, enter an email address that you can use to receive the notifications. If you choose **SMS**, enter an area code and number.
   d. Choose **Create subscription**.
6. If you chose **Email**, you'll receive an email asking you to confirm your subscription. Open the email and follow the directions to complete your subscription.

   Whenever a new version of AWS Backint agent or AWS Backint installer is released, we send notifications to subscribers. If you no longer want to receive these notifications, use the following procedure to unsubscribe.

To unsubscribe from AWS Backint agent notifications

1. Open the Amazon SNS console.
2. In the navigation pane, choose **Subscriptions**.
3. Select the subscription and then choose **Actions**, **Delete subscriptions**. When prompted for confirmation, choose **Delete**.

Back up and restore your SAP HANA system with the AWS Backint Agent for SAP HANA

When the AWS Backint agent is installed and configured on your Amazon EC2 instance, you can initiate backup and recovery using SQL statements, SAP HANA Cockpit, or SAP HANA Studio.

Topics

Backup and recovery using SQL statements

The following are a limited number of examples of SQL statements that you can use to perform backup and recovery. We recommend that you always refer to the SAP, SAP HANA Administration, or SQL Reference guides to find the syntax of all of the other options for your specific SAP HANA version. For more details, see Backup and Recovery Statements in the *SAP HANA SQL Reference Guide*.

The following example shows the syntax to initiate a full data backup of the system database.

```
BACKUP DATA USING BACKINT ('/usr/sap/<SID>/SYS/global/hdb/backint/SYSTEMDB/<MY_PREFIX>')
```

The following example shows the syntax to initiate a full data backup of the tenant database.

```
BACKUP DATA FOR <TENANT DB ID> USING BACKINT ('/usr/sap/<SID>/SYS/global/hdb/backint/
DB_<TENANT DB ID>/<MY_PREFIX >')
```

The following example shows the syntax to initiate a differential data backup of the tenant database.

```
BACKUP DATA DIFFERENTIAL FOR <TENANT DB ID> USING BACKINT ('/usr/sap/<SID>/SYS/global/hdb/
backint/DB_<TENANT DB ID>/<MY_PREFIX >')
```

The following example shows the syntax to initiate an incremental data backup of the tenant database.

```
BACKUP DATA INCREMENTAL FOR <TENANT DB ID> USING BACKINT ('/usr/sap/<SID>/SYS/global/hdb/
backint/DB_<TENANT DB ID>/<MY_PREFIX >')
```

The following example shows the syntax to recover your tenant database to a particular point in time.

```
RECOVER DATABASE FOR <TENANT DB ID> UNTIL TIMESTAMP 'YYYY-MM-DD HH:MM:SS' USING DATA PATH
 ('/usr/sap/<SID>/SYS/global/hdb/backint/DB_<TENANT DB ID>/') USING LOG PATH ('/usr/sap/
<SID>/SYS/global/hdb/backint/DB_<TENANT DB ID>') USING BACKUP_ID 1234567890123 CHECK ACCESS
 USING BACKINT
```

The following example shows the syntax to recover your tenant database with a specific data backup using catalogs stored in S3.

```
RECOVER DATA FOR <TENANT DB ID> USING BACKUP_ID 1234567890123 USING CATALOG BACKINT USING
 DATA PATH ('/usr/sap/<SID>/SYS/global/hdb/backint/DB_<TENANT DB ID>/') CLEAR LOG
```

The following example shows the syntax to recover your tenant database with a specific data backup without using a catalog.

```
RECOVER DATA FOR <TENANT DB ID>  USING BACKINT ('/usr/sap/<SID>/SYS/global/hdb/backint/
DB_<TENANT DB ID>/<MY_PREFIX >') CLEAR LOG
```

With AWS Backint agent, you can perform system copies by restoring a backup of the source database into the target database. To perform system copies using AWS Backint agent, verify the following requirements.

1. You must have AWS Backint agent configured in both the source and target systems.
2. Check the compatibility of the SAP HANA software version of the source and target systems.
3. The AWS Backint agent in your target system should be able to access the Amazon S3 bucket where the backups of the source system are stored. If you use a different Amazon S3 bucket for backups in the source and target systems, you have to adjust the configuration parameters of the AWS Backint agent in the target system to temporarily point to the Amazon S3 bucket where the backups are stored in the source system.
4. If you are performing a system copy across two different AWS accounts, ensure that you have the appropriate IAM permissions and Amazon S3 bucket policies in place. See the Identity and Access Management (p. 4) section in this document for details.

The following is the syntax to restore a specific backup of the source tenant database into your target tenant database.

```
RECOVER DATA FOR <TARGET TENANT DB ID>  USING SOURCE '<SOURCE TENANT DB ID>@<SOURCE SYSTEM
 ID>' USING BACKUP_ID 1234567890123 USING CATALOG BACKINT USING DATA PATH ('/usr/sap/
<SOURCE SYSTEM ID>/SYS/global/hdb/backint/DB_<SOURCE TENANT DB ID>/') CLEAR LOG
```

The following is an example of a SQL statement to restore a specific backup of the source tenant database, called `SRC`, in the source system `QAS` into a target tenant database called `TGT`.

```
RECOVER DATA FOR TGT USING SOURCE 'SRC@QAS' USING BACKUP_ID 1234567890123 USING CATALOG
 BACKINT USING DATA PATH ('/usr/sap/QAS/SYS/global/hdb/backint/DB_SRC/')  CLEAR LOG
```

The following is an example of a SQL statement to perform a point-in-time recovery of a source tenant database, called `SRC`, in a source system `QAS` into a target tenant database called `TGT`.

```
RECOVER DATABASE FOR TGT UNTIL TIMESTAMP '2020-01-31 01:00:00' CLEAR LOG USING SOURCE
 'SRC@QAS' USING CATALOG BACKINT USING LOG PATH ('/usr/sap/QAS/SYS/global/hdb/backint/
DB_SRC') USING DATA PATH ('/usr/sap/QAS/SYS/global/hdb/backint/DB_SRC/') USING BACKUP_ID
 1234567890123 CHECK ACCESS USING BACKINT
```

Backup and recovery using SAP HANA Cockpit or SAP HANA Studio

In addition to using SQL statements, you can initiate the backup and recovery process from SAP HANA Cockpit or SAP HANA Studio. For more information, see Backup and Recovery and Reference: Backup Console (SAP HANA Studio) in the SAP documentation. Ensure that you are using the latest version of SAP HANA Cockpit or SAP HANA studio to get all of the latest features from SAP.

Get backup and recovery status

Use your current backup and restore methods to confirm the status of a backup and restore request, and to verify whether the AWS Backint agent is working correctly. For example, if you are using SAP HANA Studio to monitor the progress of a running backup, you can do the same for any backup requests triggered by the AWS Backint agent. For failure scenarios, you can review the AWS Backint agent logs or the SAP HANA backup logs for errors, and take action or reach out to AWS Support for assistance.

Find your backup in an Amazon S3 bucket

You can verify the backup files in your Amazon S3 bucket from the Amazon S3 console or by using APIs. AWS Backint agent stores your backup files using a designated folder structure within your Amazon S3 bucket. During backup and restore, SAP HANA uses this folder structure to stream data into a pipe that Backint agents can read and write. AWS Backint agent maintains this same folder structure in the Amazon S3 bucket. We recommend that you do not change this structure after you back up your files. Changing the folder structure can cause issues during the restore operation and impact your recoverability.

For system and tenant databases, you can find your data, log, and catalog backups in the following locations. Your data backups will include an additional prefix that you used during the backup.

```
<awsdoc-example-bucket>/<optional-my-folder>/<SID>/usr/sap/<SID>/SYS/global/hdb/backint/
SYSTEMDB/
```

```
<awsdoc-example-bucket>/<optional-my-folder>/<SID>/usr/sap/<SID>/SYS/global/hdb/backint/
DB_<Tenant ID>/
```

Schedule and manage backups

You can use SAP HANA Cockpit to schedule periodic backups of your target SAP HANA database, including log backups. Ensure that you choose Backint as the backup type when scheduling your backup. For more details, see Schedule Backups in the *SAP HANA Administration with SAP HANA Cockpit Guide*.

Backup retention

Beginning with SAP HANA 2 SPS 03, you can use SAP HANA Cockpit to set the retention policies for your SAP HANA database backups. Based on your retention policies, SAP HANA Cockpit can automatically trigger jobs to delete old backups from catalogs, as well as the physical backups. This process also automatically deletes backup files stored in your Amazon S3 buckets. For more information, see “Retention Policy” under Backup Configuration Settings in the *SAP HANA Administration with SAP HANA Cockpit Guide*.

Verify the signature of the AWS Backint agent and installer for SAP HANA

The source file of AWS Backint agent (`aws-backint-agent.tar.gz`) and AWS Backint installer (`install-aws-backint-agent`) supports signature verification. You can use a public key to verify that the downloaded source file and AWS Backint installer are original and unmodified. You can find the AWS Backint installer in your `/tmp` directory or any other location where you have downloaded the installer. You can find the source file (`aws-backint-agent.tar.gz`) of AWS Backint agent under `<installation directory>/aws-backint-agent/package/`.

Automatic signature verification

To enable automatic signature verification during agent installation, see the parameter descriptions at Install AWS Backint agent using AWS Backint installer — interactive mode (p. 8) (Step 6k).

To verify the AWS Backint agent package on a Linux server

1. Download the public key.

```
shell$ wget https://s3.amazonaws.com/awssap-backint-agent/binary/public-key/aws-
backint-agent.gpg
```

2. (Optional) For AWS GovCloud (US-East) or AWS GovCloud (US-West), download one of the following keys.

```
shell$ wget https://awssap-backint-agent-us-gov-east-1.s3.us-gov-east-1.amazonaws.com/
binary/public-key/aws-backint-agent.gpg
```

```
shell$ wget https://awssap-backint-agent-us-gov-west-1.s3.us-gov-west-1.amazonaws.com/
binary/public-key/aws-backint-agent.gpg
```

3. Import the public key into your keyring.

```
shell$ gpg --import aws-backint-agent.gpg
gpg: key 1E65925B: public key "AWS Backint Agent" imported
gpg: Total number processed: 1
gpg: imported: 1 (RSA: 1)
```

Make a note of the key value, as you will need it in the next step. In the preceding example, the key value is `1E65925B`.

4. Verify the fingerprint by running the following command.

```
shell$ gpg --fingerprint 1E65925B
pub 2048R/1E65925B 2020-03-18
Key fingerprint = BD35 7A5F 1AE9 38A0 213A 82A8 80D8 5C5E 1E65 925B
uid [ unknown] AWS Backint Agent
```

The fingerprint should be equal to the following:

```
BD35 7A5F 1AE9 38A0 213A 82A8 80D8 5C5E 1E65 925B
```

If the fingerprint string doesn't match, don't install the agent. Contact Amazon Web Services.

After you have verified the fingerprint, you can use it to verify the signature of the AWS Backint agent binary.

5. Download the signature files for the source file and the installer.

```
shell$ wget https://s3.amazonaws.com/awssap-backint-agent/binary/latest/aws-backint-
agent.sig

shell$ wget https://s3.amazonaws.com/awssap-backint-agent/binary/latest/install-aws-
backint-agent.sig
```

6. (Optional) For AWS GovCloud (US-East) and AWS GovCloud (US-West), download the signature files from one of the following locations.

```
shell$ wget https://awssap-backint-agent-us-gov-east-1.s3.us-gov-east-1.amazonaws.com/
binary/latest/aws-backint-agent.sig

shell$ wget https://awssap-backint-agent-us-gov-east-1.s3-us-gov-east-1.amazonaws.com/
binary/latest/install-aws-backint-agent.sig
```

```
shell$ wget https://awssap-backint-agent-us-gov-west-1.s3.us-gov-west-1.amazonaws.com/
binary/latest/aws-backint-agent.sig

shell$ wget https://awssap-backint-agent-us-gov-west-1.s3-us-gov-west-1.amazonaws.com/
binary/latest/install-aws-backint-agent.sig
```

7. To verify the signature, run `gpg --verify` against the `aws-backint-agent.tar.gz` source file and `install-aws-backint-agent` installer.

```
shell$ gpg --verify aws-backint-agent.sig aws-backint-agent.tar.gz
gpg: Signature made Fri 08 May 2020 12:24:48 AM UTC using RSA key ID 1E65925B
gpg: Good signature from "AWS Backint Agent" [unknown]
gpg: WARNING: This key is not certified with a trusted signature!
gpg: There is no indication that the signature belongs to the owner.
Primary key fingerprint: BD35 7A5F 1AE9 38A0 213A  82A8 80D8 5C5E 1E65 925B

shell$ gpg --verify install-aws-backint-agent.sig install-aws-backint-agent
```

```
gpg: Signature made Fri 08 May 2020 12:15:40 AM UTC using RSA key ID 1E65925B
 gpg: Good signature from "AWS Backint Agent" [unknown]
 gpg: WARNING: This key is not certified with a trusted signature!
 gpg: There is no indication that the signature belongs to the owner.
 Primary key fingerprint: BD35 7A5F 1AE9 38A0 213A  82A8 80D8 5C5E 1E65 925B
```

If the output includes the phrase `BAD signature`, check whether you performed the procedure correctly. If you continue to get this response, contact Amazon Web Services and avoid using the downloaded files.

> **Note**
> A key is trusted only if you or someone you trust has signed it. If you receive a warning about trust, this doesn't mean that the signature is invalid. Instead, it means that you have not verified the public key.

Troubleshoot AWS Backint Agent for SAP HANA

The following documentation can help you troubleshoot problems that you might have with your AWS Backint Agent for SAP HANA installation or backups.

Topics

Agent logs

To find logs to help you troubleshoot errors and failures, check the following locations.

Agent logs

```
{INSTALLATION DIRECTORY}/aws-backint-agent/aws-backint-agent.log
```

System db backup/recovery logs

```
/usr/sap/<SID>/HDB<Instance No>/<hostname>/trace/backup.log
/usr/sap/<SID>/HDB<Instance No>/<hostname>/trace/backint.log
```

Tenant db backup/recovery logs

```
/usr/sap/<SID>/HDB<Instance No>/<hostname>/trace/DB_<TENANT>/backup.log
/usr/sap/<SID>/HDB<Instance No>/<hostname>/trace/DB_<TENANT>/backint.log
```

Installation

Problem: Error returned when installing AWS Backint agent.

Error returned:

```
SyntaxError: Non-UTF-8 code starting with '\xf3' in file install-aws-backint-agent on line
 1, but no encoding declared; see http://python.org/dev/peps/pep-0263/ for details
```

- **Root Cause**: Only Python version 3 is installed on the user environment.
- **Resolution**: Run the following commands to install Python version 2 and create a symbolic link to `usr/bin/python`.

```
yum install -y python2
```

```
ln -s /usr/bin/python2.7 /usr/bin/python
```

Problem: Unable to view the instance listed for installation with the SSM document.

- **Root Causes**:
  1. The SSM Agent is not installed on the instance.
  2. If the SSM Agent is installed, either the instance is not running or the SSM Agent on the instance is not running.
  3. The SSM Agent installed on the instance is a version older than 2.3.274.0.
- **Resolution**: Follow the steps listed at Practice Installing or Updating SSM Agent on an Instance. You can verify whether the SSM Agent is running with the following command.

```
sudo systemctl status amazon-ssm-agent
```

Problem: The following error is returned when you use the SSM installation document.

```
failed to download manifest - failed to retrieve package document description:
InvalidDocument: Document with name AWSBackintAgent with version x does not
exist.
```

- **Root Cause**: An unsupported version of AWS Backint agent was entered.
- **Resolution**: To view supported versions of AWS Backint agent, see the versions listed at the following location.

  `s3://awssap-backint-agent/binary/`**`agent-version`**

  For AWS GovCloud (US-East), see `s3://awssap-backint-agent-us-gov-east-1/binary/`**`agent-version`**

  For AWS GovCloud (US-West), see `s3://awssap-backint-agent-us-gov-west-1/binary/`**`agent-version`**

Backup and recovery

Problem: `AccessDenied` appears in agent logs.

- **Root Causes**:
  1. The IAM role for the EC2 instance does not have the correct permissions to access the S3 bucket.
  2. The agent configuration file does not have the `S3BucketOwnerAccountID` in double quotes. The `S3BucketOwnerAccountID` is the 12-digit AWS Account ID.
  3. The S3 bucket is not owned by the provided account for `S3BucketOwnerAccountID`.

4. The S3 bucket provided for the `S3BucketOwnerAccountID` was created before May 2019.

- **Resolution**: Verify the prerequisite steps (p. 3) for installing the AWS Backint agent.

Problem: Backup or recovery failed due to S3 connectivity

- **Root Cause**: The IAM role attached to the instance does not have the correct permissions to access the S3 bucket.
- **Resolution**: Verify the prerequisite steps (p. 3) for installing the AWS Backint agent.

Problem: Agent logs display `Backint cannot execute hdbbackint` or `No such file or directory`.

- **Root Causes**:
  1. If you are installing the agent manually, the creation of a symlink for the agent executable did not succeed.
  2. If you are using the SSM agent, step 2 of the agent failed while creating symlinks. You can verify this by viewing the RunCommand implementation details.
- **Resolution**: Verify that you have correctly followed the installation steps (p. 6) in this document.

Problem: The following error is displayed when initiating a backup from the SAP HANA console:

```
Could not start backup for system <SID> DBC: [447]: backup could not be
completed: [110091] Invalid path selection for data backup using backint: /usr/
sap/<SID>/SYS/global/hdb/backint/COMPLETE_DATA_BACKUP must start with /usr/sap/
<SID>/SYS/global/hdb/backint/DB_<TENANT>
```

- **Root Cause**: When adding your SAP HANA system to SAP HANA Studio, you chose the single container mode instead of the multiple container mode.
- **Resolution**: Add the SAP HANA system to SAP HANA Studio and select multiple container mode, and then try to initiate your backup again. For more details, see Invalid path selection for data backup using backint.

Problem: Your backup fails and the following error appears in `aws-backint-agent.log`:

```
Error creating uploadId: AuthorizationHeaderMalformed: The authorization header
is malformed; the region '<region id>' is wrong; expecting '<region id>'
```

- **Root Cause**: You specified an incorrect Region ID for the `AwsRegion` parameter in the `aws-backint-agent-config.yaml` configuration file.
- **Resolution**: Specify the AWS Region of your Amazon S3 bucket and initiate the backup again. You can find the Region in which your Amazon S3 bucket is created from the Amazon S3 console.

Problem: Any AWS Backint agent operation fails with one of the following errors, which appear in the `aws-backint-agent.log`:

```
“Error creating upload id for bucket:<mys3bucket>"
```

or

```
"NoCredentialProviders: no valid providers in chain.
```

- **Potential Root Cause**: No IAM role is attached to your Amazon EC2 instance.

- **Resolution**: AWS Backint agent requires an attached IAM role to your EC2 instance to access AWS resources for backup and restore operations. Attach an IAM role to your EC2 instance and attempt the operation again. For more information, see the prerequisites (p. 3) for installing AWS Backint agent.
- **Potential Root Cause**: Use of proxy for HANA instance on which agent is run causes agent failure.
- **Resolution**: When using a proxy for the HANA instance on which the agent is run, do not use a proxy for the instance metadata call, otherwise the call hangs. Instance metadata information can not be obtained via proxy, so it must be excluded. Update the launcher script at `{INSTALLATION DIRECTORY}/aws-backint-agent-launcher.sh` to designate `169.254.169.254` as a `no_proxy` host.

```
# cat aws-backint-agent-launcher.sh
#!/bin/bash
export https_proxy=<PROXY_ADDRESS>:<PROXY_PORT>
export HTTP_PROXY=<PROXY_ADDRESS>:<PROXY_PORT>
export no_proxy=169.254.169.254
export NO_PROXY=169.254.169.254
/hana/shared/aws-backint-agent/aws-backint-agent "$@"
```

  For more information about using a proxy address in your SAP HANA environment, see Use a proxy address with AWS Backint agent (p. 12).

Problem: When you initiate a backup or restore, you get the following error in SAP HANA Studio or SAP HANA Cockpit:

```
backup could not be completed, Backint cannot execute /usr/sap/<SID>/SYS/
global/hdb/opt/hdbbackint, Permission denied (13)
```

- **Root Cause**: The AWS Backint agent binary or launcher script doesn't have the execute permission at the operating system level.
- **Resolution**: Set the execute permission for AWS Backint agent binary `aws-backint-agent` and for the launcher script `aws-backint-agent-launcher.sh` in the installation directory (for example, `/hana/shared/aws-backint-agent/`).

Problem: My backup is running too slowly and is taking a longer time to complete.

- **Root Cause**: The performance of backup and restore depends on many factors, such as the type of EC2 instance used, the EBS volumes, and the number of SAP HANA channels. If your database size is less than 128 GB, SAP HANA defaults to a single channel, or your SAP HANA parameter `parallel_data_backup_backint_channels` is set to 1.
- **Resolution**: The speed of your database backup depends on how much storage throughput is available to your SAP HANA data volumes (/hana/data). Total storage throughput available for SAP HANA data volumes depends on your Amazon EBS storage type and the number of volumes used for striping. For best performance, follow the storage configuration best practices. You can switch your Amazon EBS volumes associated with SAP HANA data filesystem to `io1`, `io2` or `gp3` volume type. Additionally, if your database size is greater than 128 GB, you can improve your backup performance by adjusting the number of parallel backup channels. Increase the value of `parallel_data_backup_backint_channels` and try to initiate your backup again. We recommend that you take the resource contention with normal system operation performance into consideration when you try to tune the performance of your backup.

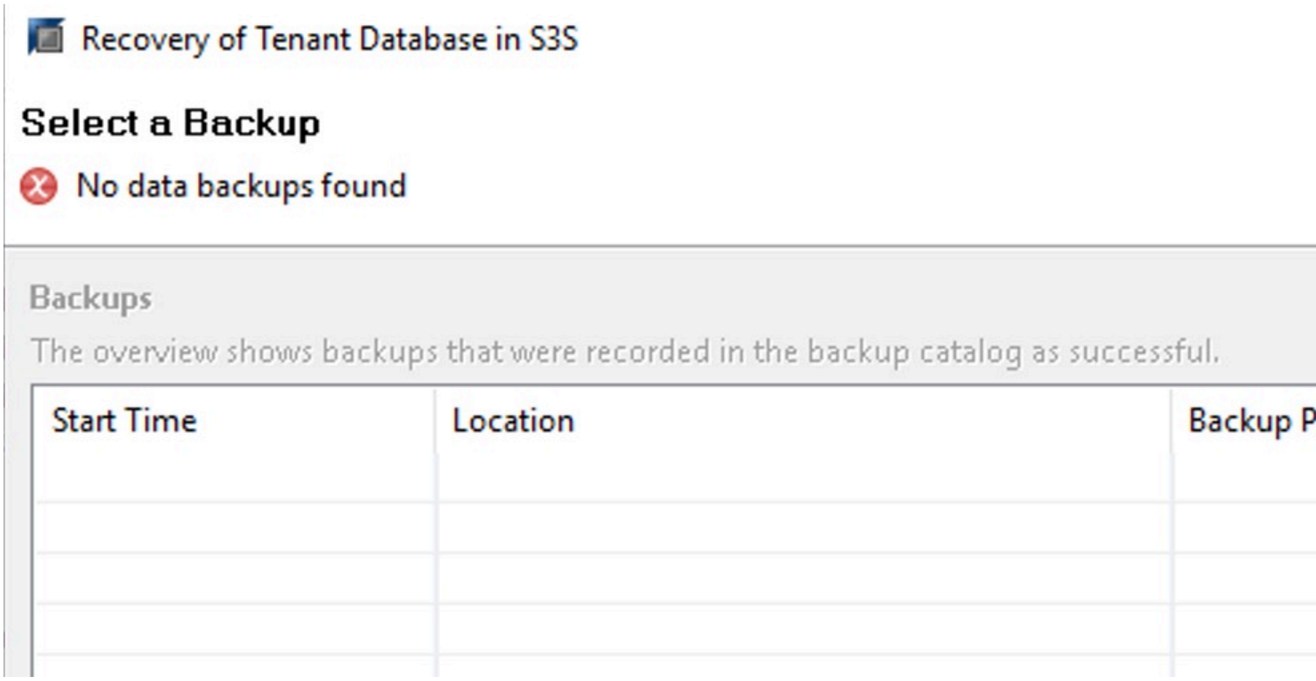
Problem: My backup fails with one of the following errors in `aws-backint-agent.log`.

1. `write tcp 10.0.2.83:56192->52.216.88.123:443: use of closed network connection`

2. `caused by: read tcp 10.0.2.83:54890->52.216.130.243:443: read: connection reset by peer`

- **Root Cause**: The connection between the AWS Backint agent and S3 fails due to high throughput.
- **Resolution**: Update AWS Backint agent to version 1.02 or later.

Problem: When you set the S3ShortenBackupDestinationEnabled = ‘true’ parameter in the `aws-backint-agent-config.yaml`, a ‘No data backups found’ error is displayed when processing a database recovery.



Recovery of Tenant Database in S3S

Select a Backup

No data backups found

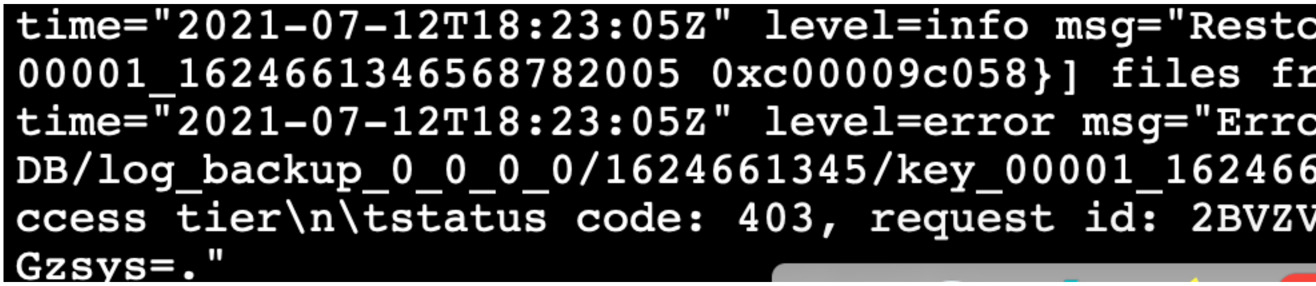
Backups

The overview shows backups that were recorded in the backup catalog as successful.

Start Time	Location	Backup P

- **Root Cause**: AWS Backint agent searches for the logs and data backups only in the Amazon S3 path that's provided in the configuration file. Because the `S3ShortenBackupDestinationEnabled` parameter changes the Amazon S3 folder, it cannot find the backup.
- **Resolution**: You can either change the `S3ShortenBackupDestinationEnabled` parameter to **`false`** and run the restore, or you can move the previous backups and the SAP HANA backup catalog to the new S3 location. For more details, see the section called “Configure AWS Backint agent to use shorter Amazon S3 paths” (p. 22).

Problem: When processing a database recovery, a 'No data backups found' error is displayed and the agent log shows, 'The operation is not valid for the objects' access tier'.



```
time="2021-07-12T18:23:05Z" level=info msg="Resto
00001_1624661346568782005 0xc00009c058}] files fr
time="2021-07-12T18:23:05Z" level=error msg="Erro
DB/log_backup_0_0_0_0/1624661345/key_00001_162466
ccess tier\n\tstatus code: 403, request id: 2BVZV
Gzsys=."
```

- **Root Cause**: With the **S3StorageClass = 'INTELLIGENT_TIERING'** parameter set in the `aws-backint-agent-config.yaml`, the objects have moved to archival storage tiers. AWS Backint agent does not support recovery from archival tiers.
- **Resolution**: You must first restore the archived S3 objects to move them in the access tier. This can take from a few minutes to 12 hours, depending on the archival tier and restore option that is selected. After the S3 restore is complete, you can initiate recovery for the HANA database.

Backup deletion

Problem: You deleted your SAP HANA backup from the SAP HANA backup console (SAP HANA Studio or SAP HANA Cockpit) but the deleted backup files still appear in the Amazon S3 folder.

- **Root Cause**: AWS Backint agent couldn't delete the associated backup files from the Amazon S3 bucket due to a permission issue.
- **Resolution**: AWS Backint agent requires `s3:DeleteObject` permission to delete the backup files from your target Amazon S3 bucket when you delete the backup from the SAP HANA backup console. Ensure that the IAM profile attached to your EC2 instance has `s3:DeleteObject` permission. For backups that are already deleted from SAP HANA, you can manually delete the associated files from the Amazon S3 bucket. We recommend that you take additional precaution before manually deleting any backup files. Manually deleting the wrong backup file could impact your ability to recover your SAP HANA system in the future.

Version history

The following table summarizes the changes for each release of AWS Backint agent.

Version	Details	Release date
1.05	**Agent** • Support for Intelligent-Tiering S3 storage class. • Support for shortening S3 paths. • Support for separate log, data, and catalog backup S3 paths. **SSM & manual installer** • Support for `python3` non-compiled version of the installer. • Support for installation through Ansible configurations. • Bug fix: Removal of ASCII characters. **Manual installer** • Bug fix: Agent binary signature verification in silent mode.	August 30, 2021
1.04	**Agent** • Support for bucket owner full control access to backup objects for cross-account backups.	May 28, 2021

Version	Details	Release date
	- Bug fix: Parallel restore configuration issue. **Manual installer** - Support for Amazon EC2 Instance Metadata Service (IMDS) v2.	
1.03	**Agent** - Support for `ap-northeast-3` (Osaka-Local) Region. - Support for rotating agent log files. - Support for additional S3 object tags. - Improvements to parallel restore using efficient parallelism. **SSM installer** - Bug Fix: SSM document to locate `python2` library for installation. **Manual installer** - Bug Fix: Support for isolated instances to make Regional S3 calls. - Support for automatic agent signature verification.	March 31, 2021
1.02.1	**Agent** - Bug Fix: kms-key formatting issue.	December 4, 2020
1.02	**Agent** - Bug Fix: Backup failure at high throughput due to failed connection with S3.	November 19, 2020

Version	Details	Release date
1.01	**Agent** • Support for GovCloud Regions. • Support for specifying number of S3 threads that can run in parallel using UploadConcurrency parameter in configuration file. **Manual installer** • Removed -o flag. • Added -l flag, which allows you to specify the location of the agent .tar file. **SSM installer** • Added support for specifying agent installation version. • Added feature to ignore S3 bucket validations. • Bug Fix: Occasional installation failure when AWS CLI installation is selected.	July 17, 2020
1.0	Initial release.	May 18, 2020

Migrating SAP HANA to AWS: Patterns for AWS Migrations

SAP specialists, Amazon Web Services

Last updated (p. 63): May 11, 2021

This guide describes the most common scenarios, use cases, and options for migrating SAP HANA systems from on-premises or other cloud platforms to the Amazon Web Services Cloud.

This guide is intended for SAP architects, SAP engineers, IT architects, and IT administrators who want to learn about the methodologies for migrating SAP HANA systems to AWS, or who want to have a better understanding of migration approaches to AWS in general.

This guide does not replace AWS and SAP documentation and is not intended to be a step-by-step, detailed migration guide. For a list of helpful resources, see the Additional Reading (p. 62) section. Information and recommendations regarding integrator and partner tools are also beyond the scope of this guide. Also, some of the migration scenarios may involve additional technology, expertise, and process changes, as discussed later in this guide (p. 49).

Note

To access the SAP notes and Knowledge Base articles (KBA) referenced in this guide, you must have an SAP ONE Support Launchpad user account. For more information, see the SAP Support website.

About this Guide

This guide is part of a content series that provides detailed information about hosting, configuring, and using SAP technologies in the AWS Cloud. For the other guides in the series, ranging from overviews to advanced topics, see https://aws.amazon.com/sap/docs/.

Migration Frameworks

Although this guide focuses on SAP HANA migrations to AWS, it is important to understand AWS migrations in a broader context. To help our customers conceptualize and understand AWS migrations in general, we have developed two major guidelines: 6 Rs and CAF.

6 Rs Framework

The 6 Rs migration strategy helps you understand and prioritize portfolio and application discovery, planning, change management, and the technical processes involved in migrating your applications to AWS. The 6 Rs represent six strategies listed in the following table that help you plan for your application migrations.

"R" migration strategy	Methodology
Rehosting	The application is migrated as is to AWS. This is also called a “lift-and-shift” approach.
Replatforming	The application is changed or transformed in some aspect as part of its migration to AWS.

"R" migration strategy	Methodology
Repurchasing	You move to a different application or solution on the cloud.
Refactoring / Re-architecting	The application is redesigned (for example, it's converted from a monolithic architecture to microservices) as part of the migration to AWS.
Retiring	The application is retired during migration to AWS.
Retaining	The application isn't migrated.

The decision tree diagram in Figure 1 will help you visualize the end-to-end process, starting from application discovery and moving through each 6 R strategy.

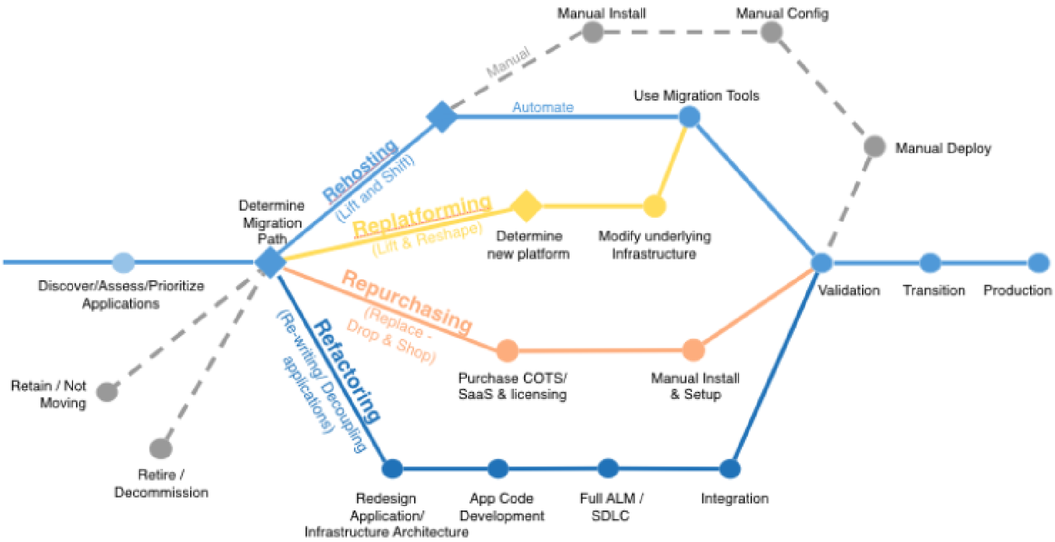


Figure 1: 6 Rs framework

The two strategies that are specifically applicable for SAP HANA migrations to AWS are rehosting and replatforming. Rehosting is applicable when you want to move your SAP HANA system as is to AWS. This type of migration involves minimal change and can be seen as a natural fit for customers who are already running some sort of SAP HANA system. Replatforming is applicable when you want to migrate from an *anyDB* source database (such as IBM DB2, Oracle Database, or SQL Server) to an SAP HANA database.

AWS CAF Framework

The second guideline is the AWS Cloud Adoption Framework (CAF). The AWS CAF breaks down the complex process of planning a move to the cloud into manageable pieces called *perspectives*. Perspectives represent essential areas of focus that span people, processes, and technology. Capabilities within each perspective identify the areas of your organization that require attention. From this information, you can build an action plan organized into prescriptive work streams that support a successful cloud journey. Both the CAF and 6 Rs frameworks help you understand and plan the broader context of an AWS migration and what it means to you and your company.

Planning

Before you start migrating your SAP environment to AWS, there are some prerequisites that we recommend you go over, to ensure minimal interruptions or delays. For details, see the SAP on AWS overview. The following sections discuss additional considerations for planning your migration.

Understanding On-Premises Resource Utilization

If you are planning to rehost your on-premises SAP HANA environment on AWS, AWS Application Discovery Service can help you understand the utilization of resources as well as hardware configuration, performance data, and network connections in your on-premises SAP HANA environment. You can use this information to ensure that appropriate communication ports are enabled between SAP HANA and other systems in the security groups or virtual private clouds (VPCs) on AWS.

Application Discovery Service can be deployed in an agentless mode (for VMware environments) or with an agent-based mode (all VMs and physical servers). We recommend that you run Application Discovery Service for a few weeks to get a complete, initial assessment of how your on-premises environment is utilized, before you migrate to AWS.

Reviewing AWS Automation Tools for SAP

It is a good idea to review AWS automation tools and services that can help you migrate your SAP environment to AWS. For example, AWS Quick Starts are automated reference deployments for workloads such as SAP HANA and SAP NetWeaver application servers. For details, see the Migration Tools and Methodologies (p. 44) section later in this guide.

Data Tiering

If you are planning on replatforming your SAP HANA environment on AWS, you can also consider different services and options available to you for distributing your data into warm and cold SAP-certified storage solutions like SAP HANA dynamic tiering or Hadoop on AWS. Currently, SAP supports Cloudera, HortonWorks, and MapR as possible Hadoop distributions for SAP HANA. See the SAP HANA administration guide for details on how to connect SAP HANA systems with Hadoop distribution using smart data access.

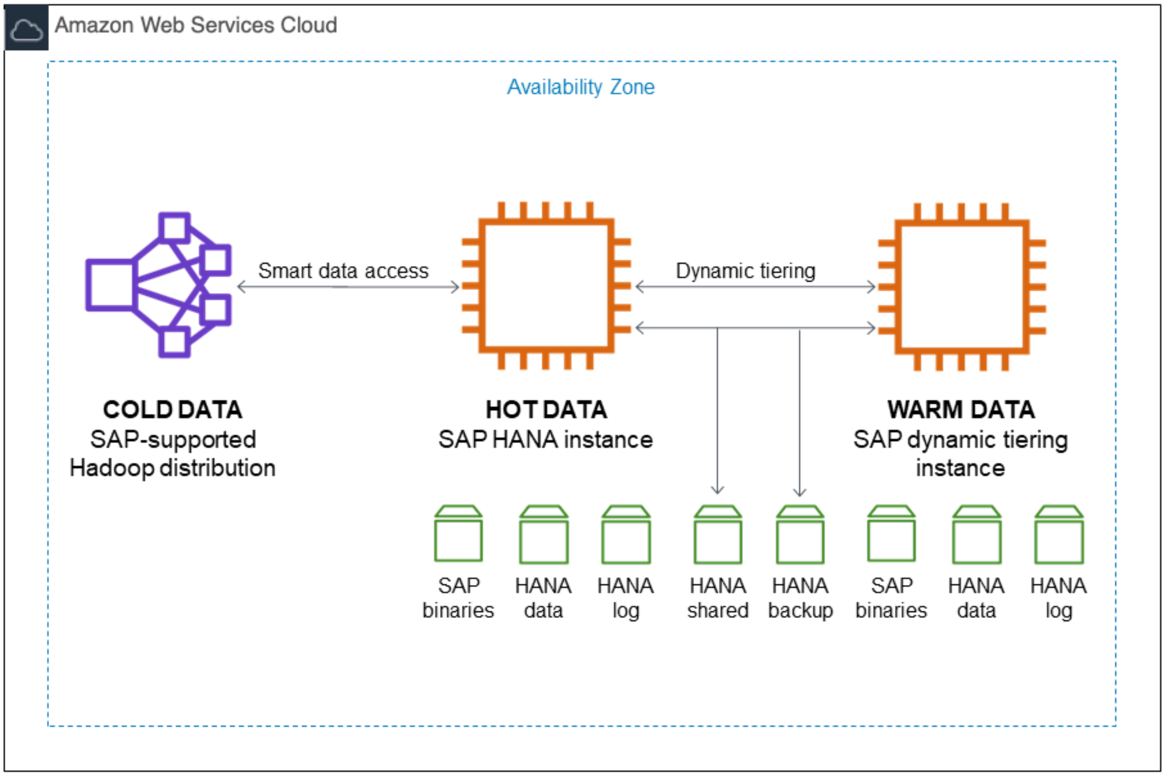


Figure 2: Data tiering

Migrating warm or cold data can further simplify your SAP environment and help reduce your total cost of ownership (TCO). For more information, see our web post for SAP dynamic tiering sizes and recommendations.

Prerequisites

SAP HANA system migration requires a moderate to high-level knowledge of the source and target IT technologies and environments. We recommend that you familiarize yourself with the following information:

AWS Cloud architecture and migration:

- AWS Well-Architected Framework
- An Overview of the AWS Cloud Adoption Framework
- Architecting for the Cloud: Best Practices
- Migrating Your Existing Applications to the AWS Cloud

AWS services:

- Amazon Virtual Private Cloud (Amazon VPC)
- Amazon Elastic Compute Cloud (Amazon EC2)
- Amazon Elastic Block Store (Amazon EBS)
- Amazon Simple Storage Service (Amazon S3)

SAP on AWS:

- SAP on AWS Implementation and Operations Guide
- SAP HANA Quick Start Reference Deployment
- SAP HANA Environment Setup on AWS
- SAP on Amazon Web Services High Availability Guide

SAP HANA Sizing

The size of the SAP HANA system required on the AWS Cloud depends on the migration scenario. As mentioned earlier, migrating SAP HANA to AWS involves two possible scenarios: rehosting or replatforming.

Memory Requirements for Rehosting

Because rehosting implies that you are already running SAP HANA, you can determine the size of the SAP HANA system you need on the AWS Cloud from the peak memory utilization of your existing SAP HANA system. You may have oversized your on-premises SAP HANA environment (for example, to support future growth), so measuring peak memory utilization is a better approach than measuring allocated memory. When you have determined the base memory requirement, you should choose the smallest SAP-certified EC2 instance that provides more memory than your base requirement.

There are three ways to determine peak memory utilization of your existing SAP HANA system:

- SAP HANA Studio: The overview tab of the SAP HANA Studio administration view provides a memory utilization summary.
- SAP EarlyWatch alerts: This is a free, automated service from SAP that helps you monitor major administrative areas of your SAP system. See the SAP portal for details.
- SQL statements: SAP provides SQL statements that you can use to determine peak memory utilization. For details, see SAP KBA 1999997 – FAQ: SAP HANA Memory and SAP Note 1969700 – SQL statement collection for SAP HANA.

Tip
We recommend determining peak memory utilization for a timeframe during which your system utilization is likely to be high (for example, during year-end processing or a major sales event).

Memory Requirements for Replatforming

The replatforming scenario involves two possibilities:

- You are already running SAP HANA but you want to change your operating system—for example, from Red Hat Enterprise Linux (RHEL) to SUSE Linux Enterprise Server (SLES) or the other way around—when you migrate to the AWS Cloud, or you are migrating from an IBM POWER system to the x86 platform. In this case, you should size SAP HANA as described for the rehosting scenario.
- You are migrating from *anyDB* to SAP HANA. There are multiple ways you can estimate your memory requirements:
  - SAP standard reports for estimation: This is the best possible approach and is based on standard sizing reports provided by SAP. For examples, see the following SAP Notes:
    - 1736976 – Sizing Report for BW on HANA
    - 1637145 – SAP BW on HANA: Sizing SAP In-Memory Database

  - 1872170 - Business Suite on HANA and S/4HANA sizing report
  - 1736976 – Sizing Report for BW on HANA
- SQL statements: SAP provides scripts that you can run in your existing environment to get high-level SAP HANA sizing estimates. These scripts run SQL statements against your existing database to estimate SAP HANA memory requirements. For more information, see SAP Note 1514966 - SAP HANA 1.0: Sizing SAP In-Memory Database.
- Rule of thumb: See the PDF attached to SAP Note 1514966 - SAP HANA 1.0: Sizing SAP In-Memory Database for instructions on estimating SAP HANA memory requirements manually. Note that this will be a very rough and generic estimate.

You should also consider the following SAP notes and Knowledge Base articles for SAP HANA sizing considerations:

- 706478 – Preventing Basis tables from increasing considerably
- 1855041 – Sizing Recommendation for Master Node in BW-on-HANA
- 1702409 – HANA DB: Optimal number of scale out nodes for BW on HANA

Instance Sizing for SAP HANA

AWS offers SAP-certified systems that are configured to meet the specific SAP HANA performance requirements (see SAP Note 1943937 – Hardware Configuration Check Tool - Central Note and the SAP Certified SAP HANA Hardware Directory). After you have determined your SAP HANA sizing, you can map your requirements to the EC2 instance family sizes. That is, you map the maximum amount of memory required for each of your SAP HANA instances to the maximum amount of memory available for your desired EC2 instance type. You should also consider appropriate storage volume types and sizes to ensure optimal performance of the SAP HANA database. For best practices and recommendations for volume types and file system layout, see the Planning the Deployment section of the SAP HANA Quick Start deployment guide.

> **Note**
> Only production SAP HANA systems need to run on certified configurations that meet SAP HANA key performance indicators (KPIs). SAP provides more flexibility when running SAP HANA non-production systems. For more information, see SAP HANA TDI – FAQ and OSS Note 2271345 on the SAP website.

Network Planning and Sizing

You will need to consider network planning and sizing for the amount of data you will be transferring to AWS. Data transfer time depends on network bandwidth available to AWS and influences total downtime. Higher bandwidth helps with faster data transfer and helps reduce overall migration time. For non-production systems where downtime isn't critical, you can use a smaller network pipe to reduce costs. Alternatively, to transfer extremely large data, you can use services like AWS Snowball for a physical (non-network) transport of data to AWS. We'll discuss AWS Snowball more extensively later in this guide.

As a guideline, you can use this formula to help estimate how long your network data transfer might take:

(Total bytes to be transferred / Transfer rate per second) = Total transfer time in seconds

For example, for a 1 TB SAP HANA appliance, the total bytes to be transferred is usually 50% of the memory, which would be 512 GB. The transfer rate per second is your network transfer rate—if you had a 1 Gb AWS Direct Connect connection to AWS, you could transfer up to 125 MB per second, and your total data transfer time would be:

512 GB / 125 MB per second = 4,096 seconds (or 1.1 hours)

After you determine the amount of data you need to transfer and how much time you have available to transfer the files, you can determine the AWS connectivity options that best fit your cost, speed, and connectivity requirements. Presenting all available network connectivity options is beyond the scope of this document; see the Additional Reading (p. 62) section of this document for more detailed references.

SAP HANA Scale-up and Scale-out

AWS provides several types of EC2 instances for SAP HANA workloads. This gives you options for your SAP HANA scale-up and scale-out deployments. In a scale-up scenario, you utilize the compute, memory, network, and I/O capacity of a single EC2 instance. If you require more capacity, you can resize your instances to a different EC2 instance type. For example, if you're using an R4 instance type and it becomes too small for your workload, you can change it to an R5, X1, or X1e instance type. The limitation is the maximum capacity of a single EC2 instance. In AWS, scale-up enables you to start with the smallest EC2 instance type that meets your requirements and grow as needed. If your requirements change or new requirements surface, you can easily scale up to meet the changing requirements.

In a scale-out scenario, you add capacity to your SAP HANA system by adding new EC2 instances to the SAP HANA cluster. For example, once you reach the maximum memory capacity of a single EC2 instance, you can scale out your SAP HANA cluster and add more instances. AWS has certified SAP HANA scale-out clusters that support up to 100 TiB of memory. Please note that the minimum number of recommended nodes in an SAP HANA scale-out cluster can be as low as two nodes; for more information, see SAP Note 1702409 - HANA DB: Optimal number of scale out nodes for BW on HANA. It's likely that your sizing estimates will reveal the need to plan for a scale-out configuration before you start your SAP HANA migration. AWS gives you the ability to easily deploy SAP HANA scale-out configurations when you use the SAP HANA Quick Start.

The following table illustrates example scale-up and scale-out sizing.

Scenario	Source configuration	Target configuration
Scale-up	r4.8xlarge	r4.16xlarge
Scale-up	r4.16xlarge	x1.16xlarge
Scale-up	x1.32xlarge	x1e.32xlarge
Scale-out	3 nodes of x1.16xlarge	4 nodes of x1.16xlarge
Scale-out	x1.32xlarge	3 nodes of x1.16xlarge

When you finalize your SAP sizing and SAP HANA deployment models, you can plan your migration strategy.

In addition to SAP HANA sizing, you may also need to size your SAP application tier. To find the SAP Application Performance Standard (SAPS) ratings of SAP-certified EC2 instances, see SAP Standard Application Benchmarks and the SAP on AWS support note on the SAP website (SAP login required).

Migration Tools and Methodologies

This section provides an introduction to the tools and methodologies available to you for your SAP system migration.

AWS Quick Starts

AWS Quick Starts are automated reference deployments designed by AWS solutions architects and AWS partners. These reference deployments implement key technologies automatically on the AWS Cloud, often with a single click and in less than an hour. You can build your test or production environment in a few steps, and start using it immediately. For SAP HANA migrations, you can use either the SAP HANA or the SAP NetWeaver Quick Starts to automatically provision, deploy, configure, and install your SAP HANA and SAP NetWeaver system in the AWS Cloud. Using AWS Quick Starts saves you time and ensures repeatability, because you don't have to develop custom deployment scripts or manually deploy, configure, and install your SAP HANA systems. As a result, you can often migrate your SAP systems faster.

Migration Using DMO with System Move

SAP has enhanced the database migration option (DMO) of their Software Update Manager (SUM) tool to accelerate the testing of SAP application migrations (see SAP Note 2377305). DMO with System Move enables you to migrate your SAP system from your on-premises environment to AWS by using a DMO tool and a special export and import process. You can use AWS services such as Amazon S3, Amazon EFS (over AWS Direct Connect), Storage Gateway file interface, and AWS Snowball to transfer your SAP export files to AWS.

You can then use the AWS Quick Start for SAP HANA to rapidly provision SAP HANA instances and build your SAP application servers on AWS, when you are ready to trigger the import process of the DMO tool.

The SUM DMO tool can convert data from *anyDB* to SAP HANA or SAP ASE, with OS migrations, release/enhancement pack upgrades, and Unicode conversions occurring at the same time. Results are written to flat files, which are transferred to the target SAP HANA system on AWS. The second phase of DMO with System Move imports the flat files and builds the migrated SAP application with the extracted data, code, and configuration. Here's a conceptual flow of the major steps involved:

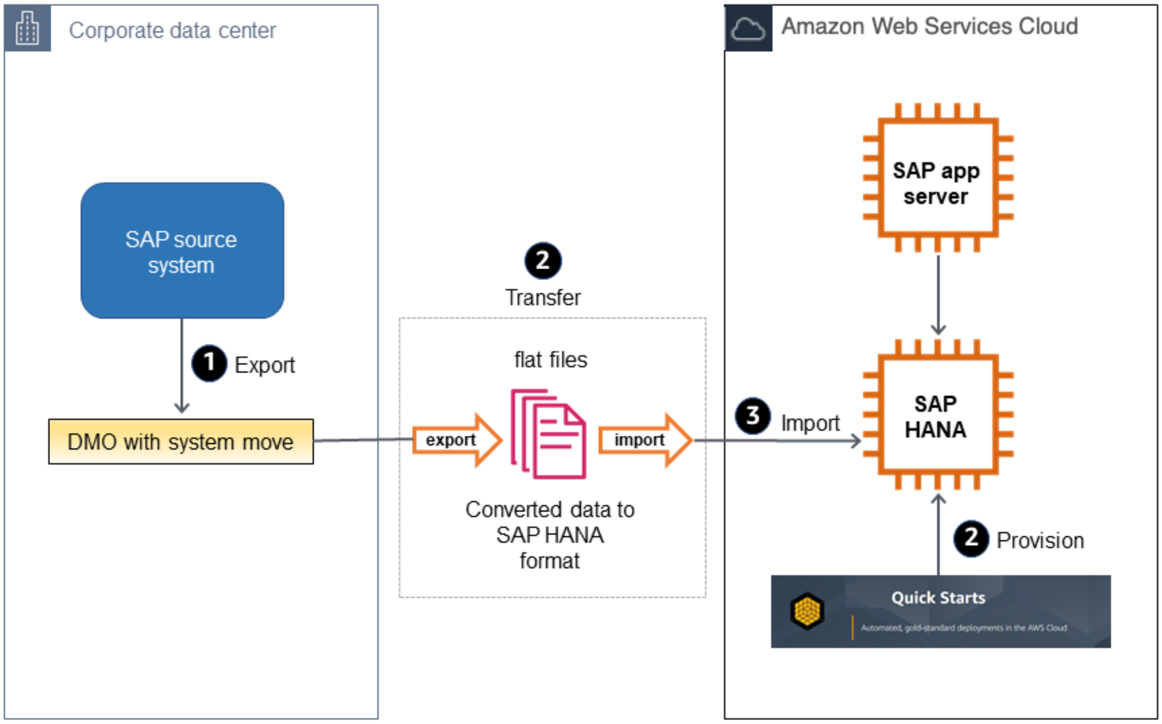


Figure 3: DMO with System Move

SAP HANA Classical Migration

SAP offers the SAP HANA classical migration option for migrating from other database systems to SAP HANA. This option uses the SAP heterogeneous system copy process and tools. To copy the exported files, you can use the options described in the Backup/Restore Tools (p. 46) section later in this guide. For details on the classical migration approach, see the classical migration overview on the SAP website.

SAP Software SUM DMO

SAP offers the standard SUM DMO approach as a one-step migration option from other database systems to HANA. This option uses the SAP DMO process and tool to automate multiple required migration steps. This is a preferred option if you are already running SAP on *anyDB* on AWS, as it will improve your migration times to SAP HANA, since there is no need for data export/import at a file system level. For details, see the DMO of SUM overview on the SAP website.

SAP HANA HSR

SAP HANA System Replication (HSR) is a tool for replicating the SAP HANA database to a secondary database or location. The secondary database is an exact copy of the primary database and can be used as the new primary database in the event of a takeover. The advantage of HSR is that it replicates the data directly from source to target. For details, see SAP HANA Disaster Recovery Support in the *SAP HANA Administration Guide* and the High Availability and Disaster Recovery Options for SAP HANA on AWS whitepaper.

SAP HANA HSR with Initialization via Backup and Restore

SAP supports the option of initializing the HSR target system with a backup and restore process. Using backup and restore can be useful if the network connection between your source SAP HANA system and the target system does not have enough bandwidth to replicate the data in a timely manner. Additionally, you may not want the data replication to consume part of your network traffic bandwith. For details, see SAP Note 1999880 – FAQ: SAP HANA System Replication.

Backup/Restore Tools

Backup and restore options are tried-and-true mechanisms for saving data on a source system and restoring it to another destination. AWS has various storage options available to help facilitate data transfer to AWS. Some of those are explained in this section. We recommend that you discuss which option would work best for your specific workload with your systems integrator (SI) partner or with an AWS solutions architect.

- Storage Gateway: This is a virtual appliance installed in your on-premises data center that helps you replicate files, block storage, or tape libraries by integrating with AWS storage services such as Amazon S3 and by using standard protocols like Network File system (NFS) or Internet Small Computer System Interface (iSCSI). Storage Gateway offers file-based, volume-based, and tape-based storage solutions. For SAP systems, we will focus on file replication using a file gateway and block storage replication using a volume gateway. For scenarios where multiple backups or logs need to be continuously copied to AWS, you can copy these files to the locally mounted storage and they will be replicated to AWS.

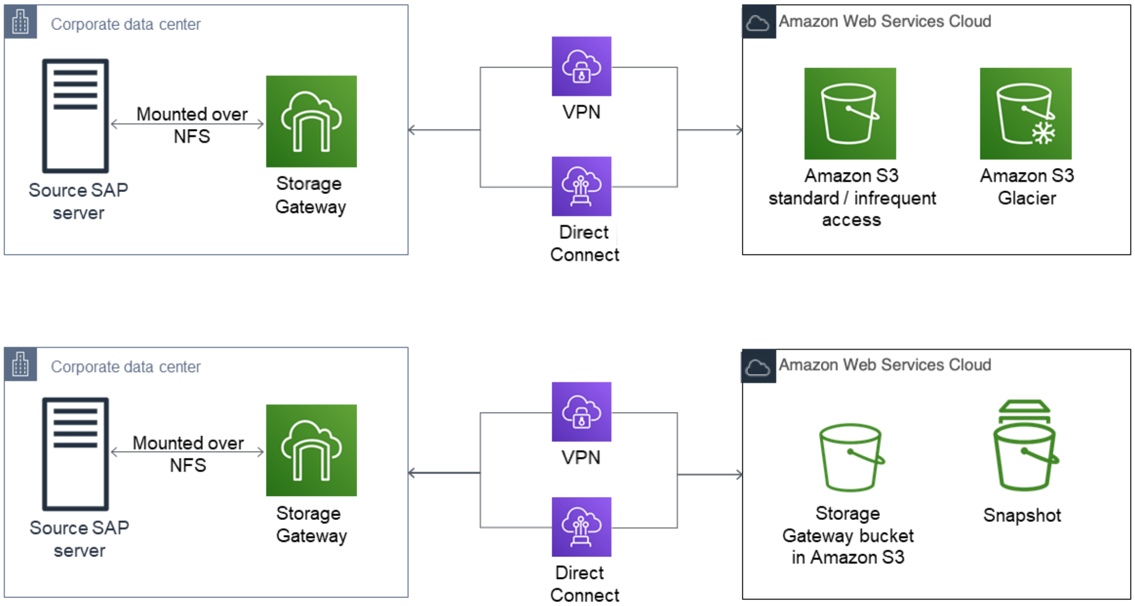


Figure 4: SAP file replication with Storage Gateway

See the SAP ASE Cloud Backup to Amazon S3 using AWS File Gateway whitepaper on the SAP website to learn how to use a file gateway to manage backup files of SAP ASE on AWS with Amazon S3, with the STANDARD-IA (infrequent access) and Amazon S3 Glacier storage classes. For more information about these storage classes, see the Amazon S3 documentation.

- Amazon EFS file transfer: AWS provides options to copy data from an on-premises environment to AWS by using Amazon Elastic File System (Amazon EFS). Amazon EFS is a fully managed service, and you pay only for the storage that you use. You can mount an Amazon EFS file share on your on-premises server, as long as you have AWS Direct Connect set up between your corporate data center and AWS. This is illustrated in Figure 5.

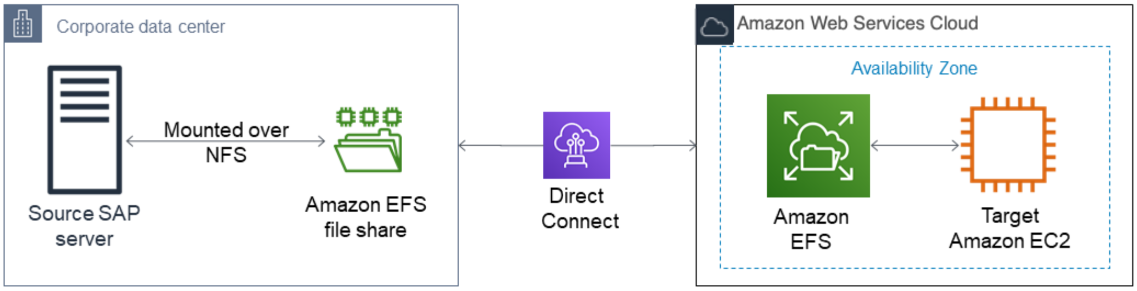


Figure 5: Transferring SAP files with Amazon EFS

AWS Snowball

With AWS Snowball, you can copy large amounts of data from your on-premises environment to AWS, when it’s not practical or possible to copy the data over the network. AWS Snowball is a storage appliance that is shipped to your data center. You plug it into your local network to copy large volumes of data at high speed. When your data has been copied to the appliance, you can ship it back to AWS, and your data will be copied to Amazon S3 based on the desired target storage destination that you specify. AWS Snowball is very useful when you’re planning very large, multi-TB SAP system migrations. For more information, see *When should I consider using Snowball instead of the Internet* in the AWS Snowball FAQ.

Amazon S3 Transfer Acceleration

Amazon S3 Transfer Acceleration provides a faster way to copy data from your on-premises environment to AWS by copying data first to Amazon CloudFront edge locations that are closest to the source, and then using an optimized network path to copy data to Amazon S3. There is a network charge associated with this type of transfer. You can run an AWS-provided test tool to compare the speed of Amazon S3 Transfer Acceleration to standard Amazon S3 data transfer. For SAP workloads, you can copy backups or DB logs at regular intervals over Amazon S3 Transfer Acceleration to reduce the transfer time, if your regular network connection is slow—for example, if your SAP environment is hosted in a location that doesn’t have very strong internet connectivity. For more information, see the Amazon S3 documentation.

Amazon EC2 Instance Resize

Amazon EC2 provides you with the ability to easily change your instance type in minutes, from the Amazon EC2 console, the AWS Command Line Interface (AWS CLI), or the Amazon EC2 API. You can start with an instance type that meets your current needs and size your instance up or down, when your requirements change. When you change your EC2 instance type, all instance metadata, including the IP address, instance ID, and hostname, remains the same. This enables you to migrate your SAP HANA to a new instance type seamlessly, without incurring a longer downtime. For details, see the Changing the Instance Type in the Amazon EC2 documentation.

AMIs

You can use an Amazon Machine Image (AMI) to launch any EC2 instance. You can create an AMI of an EC2 instance that hosts SAP HANA, including the attached EBS volumes, through the Amazon EC2 console, the AWS CLI, or the Amazon EC2 API. You can then use the AMI to launch a new EC2 instance with SAP HANA in any Availability Zone within the AWS Region where the AMI was created. You can also copy your AMI to another AWS Region and use it to launch a new instance. You can use this feature to move your SAP HANA instance to another Availability Zone or AWS Region, or to change the tenancy type of your EC2 instance. For example, you can create an AMI of your EC2 instance with default tenancy and use it to launch a new EC2 instance with host or dedicated tenancy and vice versa. For details, see the Amazon Machine Images (AMIs) in the Amazon EC2 documentation.

Migration Scenarios

The following table lists the migration scenarios that we will cover in detail in this guide. The tools and methodologies listed in the table were discussed in the previous section.

Migration scenario	Source database	Target database	Migration tool or methodology
Migration of *anyDB* from other platforms to AWS*	*anyDB* (any non-SAP HANA database such as IBM DB2, Oracle Database, or SQL Server)	SAP HANA	[✔] SAP HANA classical migration [✔] SAP DMO with System Move
Migration of SAP HANA from other platforms to AWS*	SAP HANA (scale-up and scale-out	SAP HANA	[✔] SAP HANA backup and restore

Migration scenario	Source database	Target database	Migration tool or methodology
	considerations apply here as well)		[✓] SAP HANA classical migration (considered a homogeneous system copy in this scenario)** [✓] SAP HANA HSR [✓] SAP HANA HSR with initialization via backup and restore
Migration of SAP HANA from an existing EC2 instance to an EC2 High Memory instance	SAP HANA	SAP HANA	[✓] Instance resize [✓] Amazon Machine Image (AMI) [✓] SAP HANA backup and restore [✓] SAP HANA HSR

* Other platforms include on-premises infrastructures and other cloud infrastructures outside of AWS.

** See SAP Note 1844468 – Homogeneous system copy on SAP HANA.

Migrating *AnyDB* to SAP HANA on AWS

Migrating from *anyDB* to HANA typically involves changes to the database platform and sometimes includes operating system changes. However, migration might also involve additional technical changes and impacts, such as the following:

- SAP ABAP code changes. For example, you might have custom code that has database or operating system dependencies, such as database hints coded for the *anyDB* platform. You might also need to change custom ABAP code so it performs optimally on SAP HANA. See SAP's recommendations and guidance for these SAP HANA-specific optimizations. For details and guidance, see Considerations for Custom ABAP Code During a Migration to SAP HANA and SAP Notes 1885926 – ABAP SQL monitor and 1912445 – ABAP custom code migration for SAP HANA on the SAP website.
- Operating system-specific dependencies such as custom file shares and scripts that would need to be re-created or moved to a different solution.
- Operating system tunings (for example, kernel parameters) that would need to be accounted for. Note that the AWS Quick Start for SAP HANA incorporates best practices from operating system partners like SUSE and Red Hat for SAP HANA.
- Technology expertise such as Linux administration and support, if your organization doesn't already have experience with Linux.

SAP provides tools and methodologies such as classical migration and SUM DMO to help its customers with the migration process for this scenario. (For more information, see the section Migration Tools and Methodologies (p. 44).) AWS customers can use the SAP SUM DMO tool (p. 46) to migrate their database to SAP HANA on AWS. Some considerations for the SAP SUM DMO method are network bandwidth, amount of data to be transferred, and the amount of time available for the data to be transferred.

Implementing SAP HANA on AWS enables quick provisioning of scale-up and scale-out SAP HANA configurations and enables you to have your SAP HANA system available in minutes. In addition to fast provisioning, AWS lets you quickly scale up by changing your EC2 instance type, as discussed earlier in the SAP HANA Sizing (p. 42) section. With this capability, you can react to changing requirements promptly and focus less on getting your sizing absolutely perfect. This means that you can spend less time sizing (that is, you can move through your project's planning and sizing phase faster) knowing that you can scale up later, if needed.

Migrating SAP HANA from Other Platforms to AWS

This scenario is more straightforward than migrating from *anyDB*, because you're already using SAP HANA. For this migration, you need to map your existing SAP HANA systems and sizing that are on a different platform to SAP HANA solutions on AWS.

EC2 instance memory capabilities give you the option to consolidate multiple SAP HANA databases on a single EC2 instance (scale-up) or multiple EC2 instances (scale-out). SAP calls these options HANA and ABAP One Server, Multiple Components in One Database (MCOD), Multiple Components in One System (MCOS), and Multitenant Database Containers (MDC). It is beyond the scope of this guide to recommend specific consolidation combinations; for possible combinations, see SAP Note 1661202 – Support for multiple applications on SAP HANA.

This migration scenario involves provisioning your SAP HANA system on AWS, backing up your source database, transferring your data to AWS, and installing your SAP application servers. If you are resizing your HANA environment from scale-up to scale-out, please follow the process highlighted in SAP Note 2130603. If you are resizing your HANA environment from scale-out to scale-up, refer to SAP Note 2093572. Depending on your specific scenario, you can use standard backup and restore, SAP HANA classical migration, SAP HANA HSR, AWS Server Migration Service (AWS SMS), or third-party continuous data protection (CDP) tools; see the following sections for details on each option.

Option 1: SAP HANA Backup and Restore

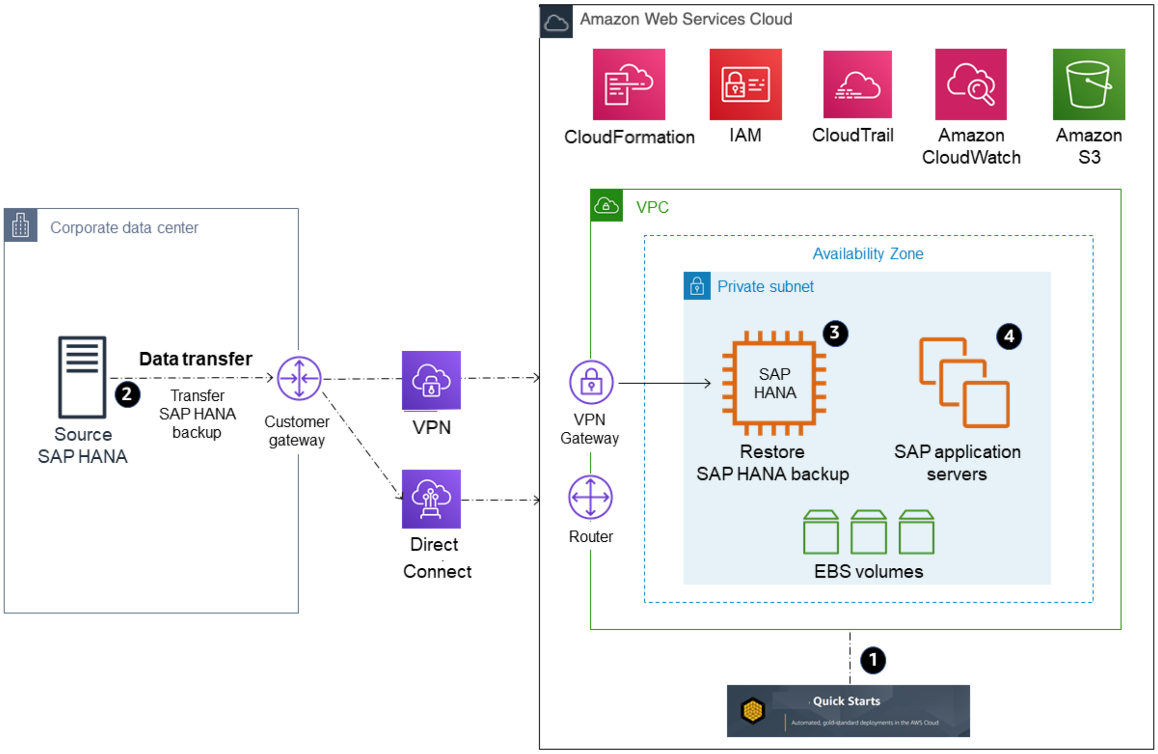


Figure 6: Backup and restore

1. Provision your SAP HANA system and landscape on AWS. (The AWS Quick Start for SAP NetWeaver can help expedite and automate this process for you.)
2. Transfer (**sftp** or **rsync**) a full SAP HANA backup, making sure to transfer any necessary SAP HANA logs for point-in-time recovery, from your source system to your target EC2 instance on AWS. A general tip here is to compress your files and split your files into smaller chunks to parallelize the transfer. If your transfer destination is Amazon S3, using the **aws s3 cp** command will automatically parallelize the file upload for you. For other options for transferring your data to AWS, see the AWS services listed previously in the Backup/Restore Tools (p. 46) section.
3. Recover your SAP HANA database.
4. Install your SAP application servers. (Skip this step if you used the AWS Quick Start for SAP NetWeaver in step 1.)
5. Depending on your application architecture, you might need to reconnect your applications to the newly migrated SAP HANA system.

Option 2: SAP HANA Classical Migration

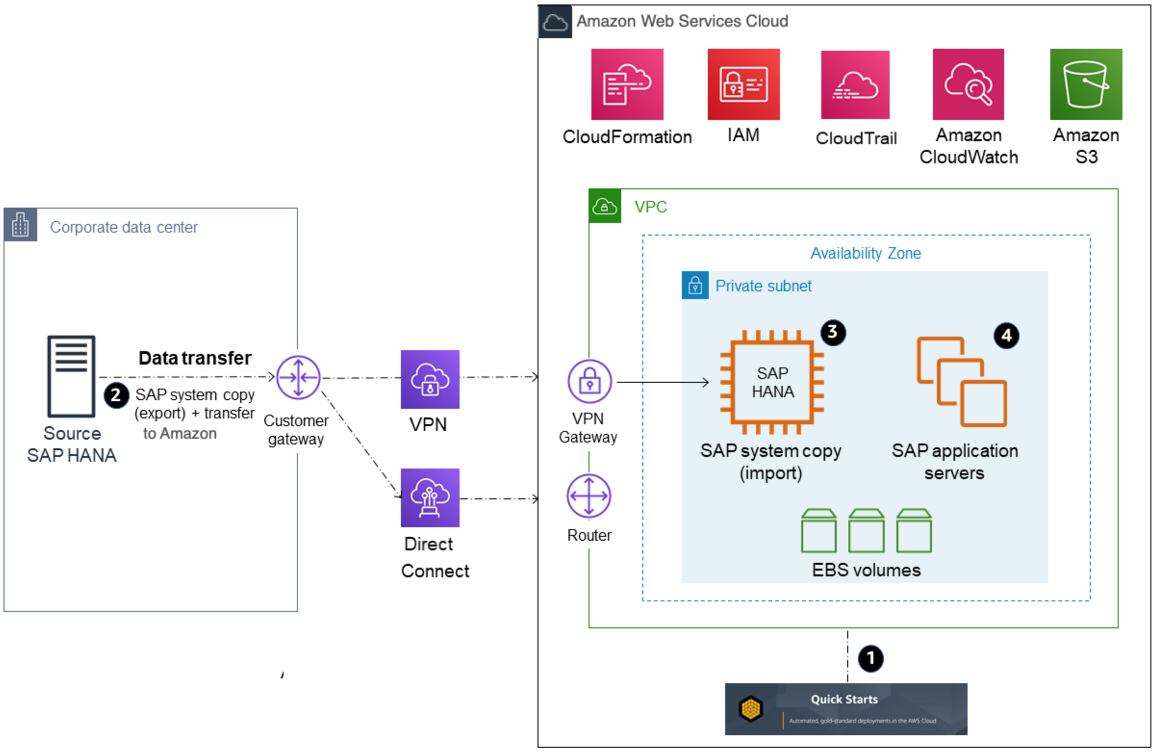


Figure 7: SAP HANA classical migration

1. Provision your SAP HANA system and landscape on AWS. (The AWS Quick Start for SAP NetWeaver can help expedite and automate this process for you.)
2. Perform an SAP homogeneous system copy to export your source SAP HANA database. You may also choose to use a database backup as the export; see SAP Note 1844468 – Homogeneous system copy on SAP HANA. When export is complete, transfer your data into AWS.
3. Continue the SAP system copy process on your SAP HANA system on AWS to import the data you exported in step 2.
4. Install your SAP application servers. (Skip this step if you used the AWS Quick Start for SAP NetWeaver in step 1.)
5. Depending on your application architecture, you might need to reconnect your applications to the newly migrated SAP HANA system.

Option 3: SAP HANA HSR

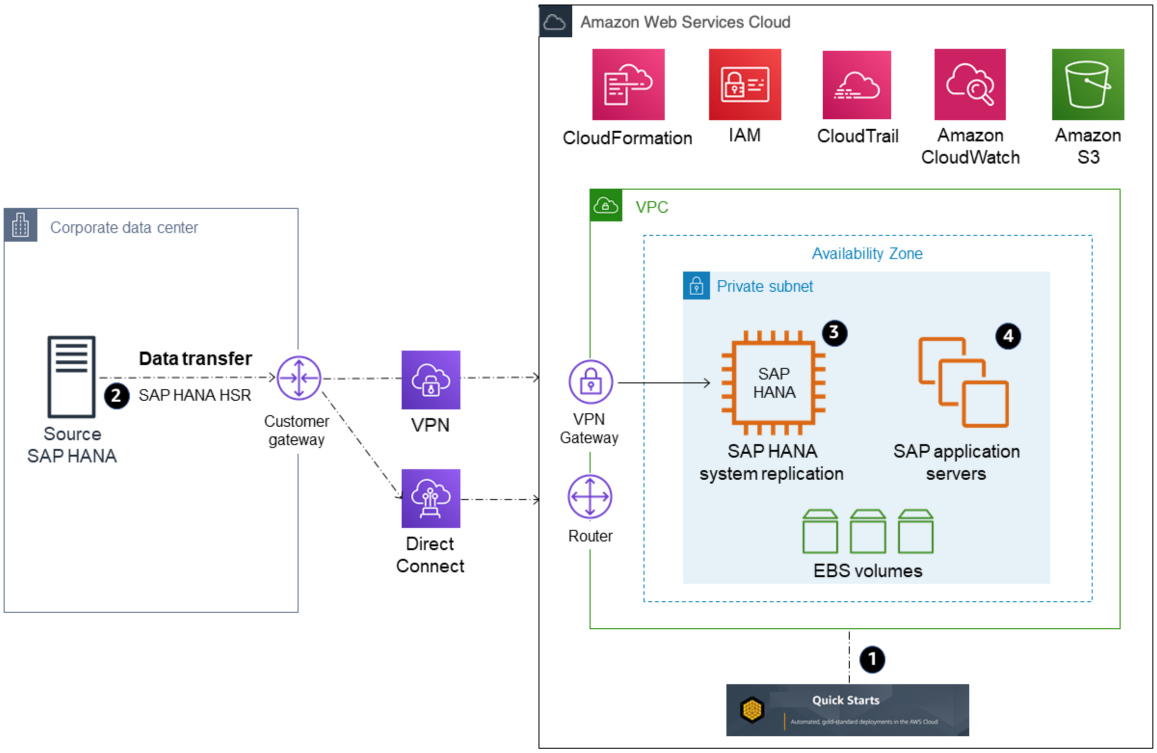


Figure 8: SAP HANA system replication

1. Provision your SAP HANA system and landscape on AWS. (The AWS Quick Start for SAP NetWeaver can help expedite and automate this process for you.) To save costs, you might choose to stand up a smaller EC2 instance type.
2. Establish asynchronous SAP HANA system replication from your source database to your standby SAP HANA database on AWS.
3. Perform an SAP HANA takeover on your standby database.
4. Install your SAP application servers. (Skip this step if you used the AWS Quick Start for SAP NetWeaver in step 1.)
5. Depending on your application architecture, you might need to reconnect your applications to the newly migrated SAP HANA system.

Option 4: SAP HANA HSR (with Initialization via Backup and Restore)

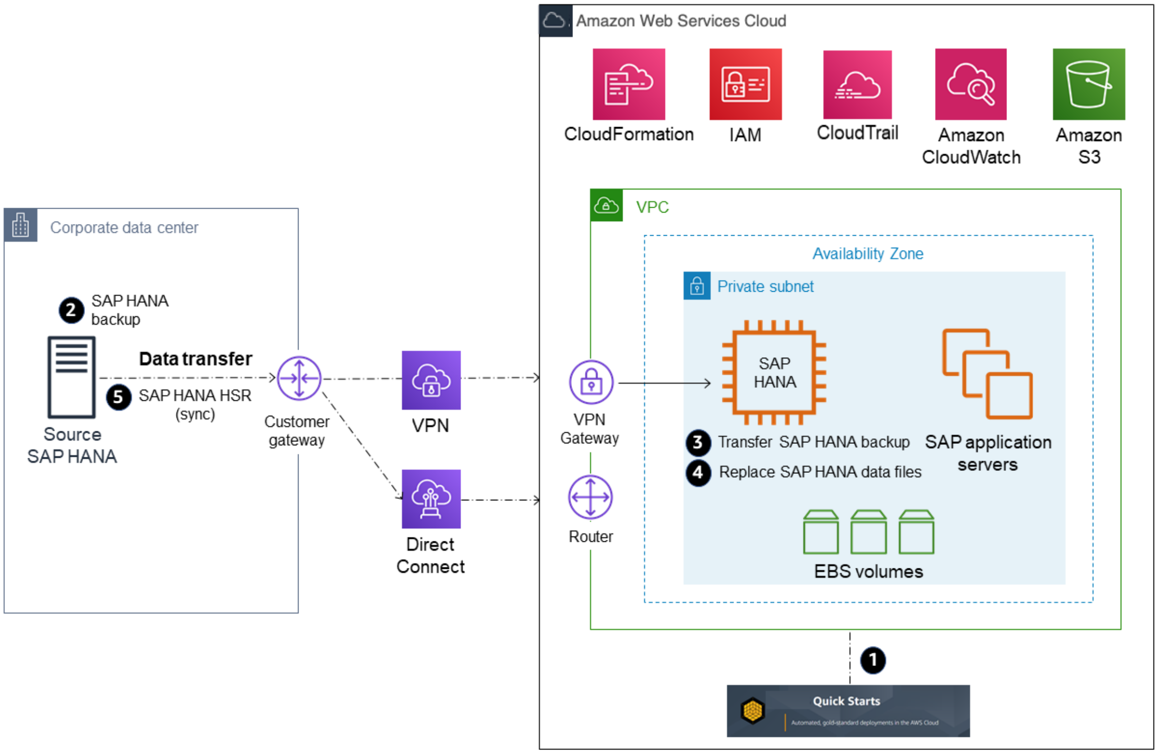


Figure 9: SAP HANA system replication (with initialization via backup and restore)

1. Provision your SAP HANA system and landscape on AWS. (The AWS Quick Start for SAP NetWeaver can help expedite and automate this process for you.) To save costs, you might choose to stand up a smaller EC2 instance type.
2. Stop the source SAP HANA database and obtain a copy of the data files (this is essentially a cold backup). After the files have been saved, you may start up your SAP HANA database again.
3. Transfer the SAP HANA data files to AWS, to the SAP HANA server you provisioned in step 1. (For example, you can store the data files in the /backup directory or in Amazon S3 during the transfer process.)
4. Stop the SAP HANA database on the target system in AWS. Replace the SAP HANA data files (on the target server) with the SAP HANA data files you transferred in step 3.
5. Start the SAP HANA system on the target system and establish asynchronous SAP HANA system replication from your source system to your target SAP HANA system in AWS.
6. Perform an SAP HANA takeover on your standby database.
7. Install your SAP application servers. (Skip this step if you used the AWS Quick Start for SAP NetWeaver in step 1.)
8. Depending on your application architecture, you might need to reconnect your applications to the newly migrated SAP HANA system.

Migrating SAP HANA on AWS to an EC2 High Memory Instance

EC2 High Memory instances are built on AWS Nitro System with up to 24TB of memory in a single instance to deliver scalable and elastic infrastructure capabilities for large in-memory databases, such as SAP HANA.

For SAP HANA workloads, EC2 High Memory instances support SUSE Linux Enterprise Server for SAP Applications (SLES for SAP) and Red Hat Enterprise Linux for SAP Solutions (RHEL for SAP) operating systems. The following table provides the minimum supported operating system version for SAP HANA workloads.

Instance Type	Supported operating system version
u-6tb1.metal, u-9tb1.metal, u-12tb1.metal and u-6tb1.56xlarge	SLES for SAP 12 SP3 and above; RHEL for SAP 7.4 and above
u-18tb1.metal and u-24tb1.metal	SLES for SAP 12 SP4 and above; RHEL for SAP 8.1 and above
u-6tb1.112xlarge, u-9tb1.112xlarge and u-12tb1.112xlarge	SLES for SAP 12 SP4 and above; RHEL for SAP 8.1 and above

See the SAP HANA hardware directory for a list of supported operating systems for your instance type.

Important
If you are using `u-*tb1.112xlarge` instance types with one of the following operating system version, verify that your system has the minimum required kernel version in order to use all available vCPUs.

- SLES for SAP 12 SP4 – 4.12.14-95.68
- SLES for SAP 12 SP5 – 4.12.14-122.60
- SLES for SAP 15 – 4.12.14-150.66
- SLES for SAP 15 SP1 – 4.12.14-197.83
- SLES for SAP 15 SP2 – 5.3.18-24.52
- RHEL for SAP 8.1 - 4.18.0-147.44.1.el8_1
- RHEL for SAP 8.2 - 4.18.0-193.47.1.el8_2

Note
`u-*tb1.metal` instances can be launched only as Amazon EC2 Dedicated Hosts with host tenancy. `u-6tb1.56xlarge` and `u-*tb1.112xlarge` instances can be launched with default, dedicated or host tenancy.
Before you start your migration, if you plan to use `u-*tb1.metal` instances, make sure that an `u-*tb1.metal` instance is allocated to your target account, Availability Zone, and AWS Region. If you plan to use `u-6tb1.56xlarge` or `u-*tb1.112xlarge`, ensure your account limit for resource “On-Demand High Memory instances” or “U*TB1 Dedicated Hosts” (required only if you intend to use it as dedicated host) is set appropriately. If needed, submit a request from AWS console to increase your account limit. For more information, see Amazon EC2 service quotas and On-Demand Instance limits in the AWS documentation.

You have several options for migrating your existing SAP HANA workload on AWS to an EC2 High Memory instance, as discussed in the following sections.

> **Note**
> In the following sections, we show X1 instance as the source instance type for migration. These procedures are applicable for any other source instance types as well.

Option 1: Resizing an Existing EC2 Instance with Host or Dedicated Tenancy

If your existing EC2 instance is running with host or dedicated tenancy, you can follow the steps in this section to migrate it to `u-*tb1.metal` EC2 High Memory instance. With this option, all your instance properties, including IP addresses, hostnames, and EBS volumes, remain the same after migration.

Figure 10 provides a high-level illustration of this method.

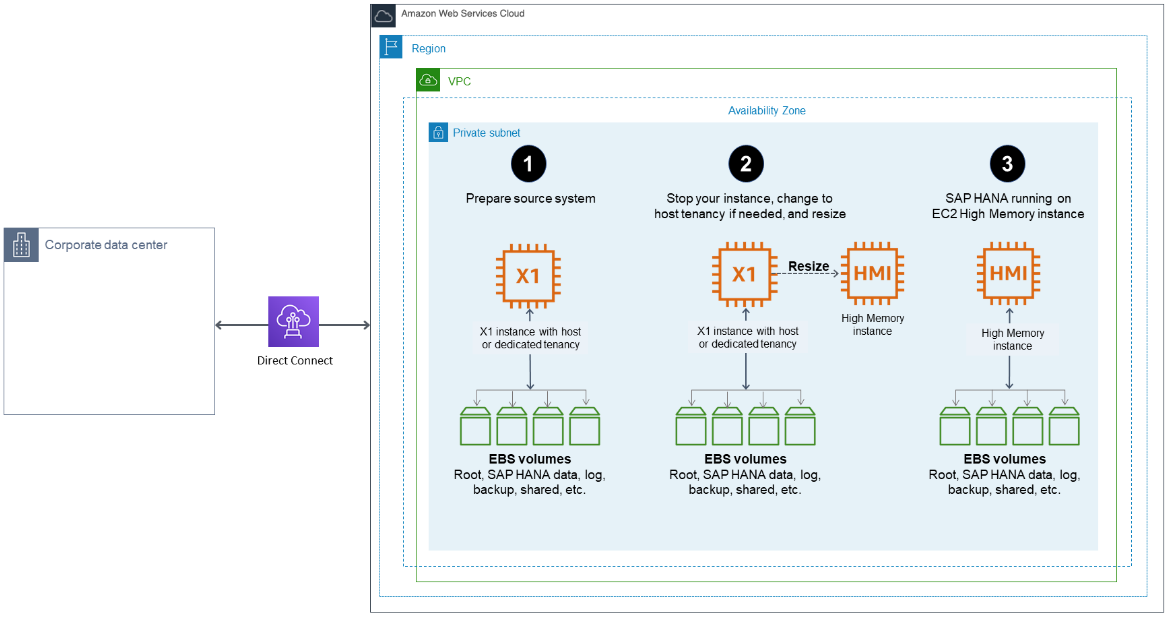

Amazon Web Services Cloud
Region
VPC
Availability Zone
Private subnet
1
Prepare source system
2
Stop your instance, change to host tenancy if needed, and resize
3
SAP HANA running on EC2 High Memory instance
Corporate data center
Direct Connect
X1
X1 instance with host or dedicated tenancy
X1
Resize
HMI
X1 instance with host or dedicated tenancy
High Memory instance
HMI
High Memory instance
EBS volumes
Root, SAP HANA data, log, backup, shared, etc.
EBS volumes
Root, SAP HANA data, log, backup, shared, etc.
EBS volumes
Root, SAP HANA data, log, backup, shared, etc.

Figure 10: Migrating to an EC2 High Memory instance with resize option

1. Verify that your source system is running on a supported operating system version. If not, you might have to upgrade your operating system before resizing to an EC2 High Memory instance.
2. EC2 High Memory instances are based on the Nitro system. On Nitro-based instances, EBS volumes are presented as NVMe block devices. If your source system has any mount point entries in `/etc/fstab` with reference to block devices such as `/dev/xvd<x>`, you need to create a label for these devices and mount them by label before migrating to EC2 High Memory instances. Otherwise, you will face issues when you start SAP HANA on an EC2 High Memory instance.
3. Verify that you don’t exceed the maximum supported EBS volumes to your instance. An `-*tb1.metalu` EC2 High Memory instance currently supports up to 19 EBS volumes. `u-6tb1.56xlarge` and `u-*tb1.112xlarge` instances supports up to 27 EBS volumes. For details, see Instance Type Limits in the AWS documentation.
4. When you are ready to migrate, make sure that you have a good backup of your source system. You can use AWS Backint Agent for SAP HANA to easily backup your SAP HANA database to Amazon S3. For details, see AWS Backint Agent for SAP HANA in the AWS documentation.
5. Stop the source instance in the Amazon EC2 console or by using the AWS CLI.
6. If your source EC2 instance is running with dedicated tenancy, modify the instance placement to host tenancy. For instructions, see Modifying instance Tenancy and Affinity in the AWS documentation. Skip this step if your instance is running with host tenancy.

7. Modify the instance placement of your existing instance to your target EC2 High Memory Dedicated Host through the Amazon EC2 console or the AWS CLI. For details, see modify-instance-placement in the AWS documentation.
8. Change your instance type to the desired EC2 High Memory instance type (for example, `u-12tb1.metal` or `u-12tb1.112xlarge`) through the AWS CLI or AWS Console.

   Note
   You can change the instance type to `u-*tb1.metal` only through the AWS CLI or Amazon EC2 API.
9. Start your instance in the Amazon EC2 console or by using the AWS CLI.
10. When you increase the memory of your SAP HANA system, you might need to adjust the storage size of SAP HANA data, log, shared, and backup volumes as well to accommodate data growth and to get improved performance. For details, see SAP HANA on AWS Operations Guide.
11. Start your SAP HANA database and perform your validation.
12. Complete any SAP HANA-specific post-migration activities.
13. Complete any AWS-specific post-migration activities, such as setting up Amazon CloudWatch, AWS Config, and AWS CloudTrail.
14. Configure your SAP HANA system for high availability on the EC2 High Memory instance with SAP HANA HSR and clustering software, and test it.

Option 2: Migrating from an Existing EC2 Instance with Default Tenancy

If your existing EC2 instance is running with default tenancy, you have multiple options to migrate it to an EC2 High Memory instance: If you plan to use `u-6tb1.56xlarge` or `u-*tb1.112xlarge` instance types, you can simply stop your instance and resize it to desired target instance size. Additionally, if you plan to use `u-*tb1.metal` instances, you can use an Amazon Machine Image (AMI) to launch your `u-*tb1.metal` EC2 High Memory instance with host tenancy, or you can set up a new SAP HANA on EC2 High Memory instance and then copy the data over from your source system.

Option 2(a): Resizing an existing EC2 instance

In this option, if you are using `u-6tb1.56xlarge` or `u-*tb1.112xlarge` instance types, you can simply resize your instance through AWS Management Console or AWS CLI.

Figure 11 provides a high-level illustration of this option.

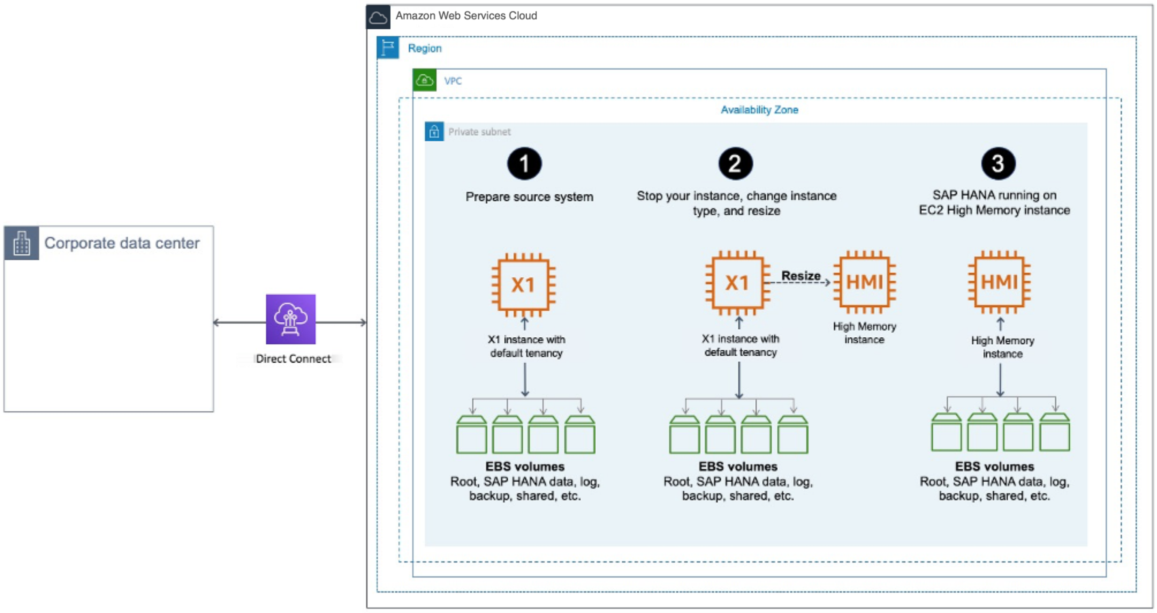

Amazon Web Services Cloud
Region
VPC
Availability Zone
Private subnet
Corporate data center
Direct Connect
1
Prepare source system
2
Stop your instance, change instance type, and resize
3
SAP HANA running on EC2 High Memory instance
X1
X1 instance with default tenancy
X1
Resize
HMI
X1 instance with default tenancy
High Memory instance
HMI
High Memory instance
EBS volumes
Root, SAP HANA data, log, backup, shared, etc.
EBS volumes
Root, SAP HANA data, log, backup, shared, etc.
EBS volumes
Root, SAP HANA data, log, backup, shared, etc.

Figure 11: Resizing an existing EC2 instance

1. Verify that your source system is running on a supported operating system version. If it isn't, you might have to upgrade your operating system before resizing to an EC2 High Memory instance.
2. EC2 High Memory instances are based on the Nitro system. On Nitro-based instances, EBS volumes are presented as NVMe block devices. If your source system has any mount point entries in `/etc/fstab` with reference to block devices such as `/dev/xvd<x>`, you need to create a label for these devices and mount them by label before migrating to EC2 High Memory instances. Otherwise, you will face issues during instance launch.
3. EC2 High Memory instances are based on the Nitro system. On Nitro-based instances, EBS volumes are presented as NVMe block devices. If your source system has any mount point entries in `/etc/fstab` with reference to block devices such as `/dev/xvd<x>`, you need to create a label for these devices and mount them by label before migrating to EC2 High Memory instances. Otherwise, you will face issues when you start SAP HANA on an EC2 High Memory instance.
4. When you are ready to migrate, verify that you have a good backup of your source system.
5. Stop the source instance in the Amazon EC2 console or by using the AWS CLI.
6. Change the instance type to target EC2 High Memory instance size such as `u-6tb1.56xlarge` or `u-*tb1.112xlarge`
7. When you increase the memory of your SAP HANA system, you might need to adjust the storage size of SAP HANA data, log, shared, and backup volumes as well to accommodate data growth and to get improved performance. For details, see the SAP HANA on AWS Operations Guide.
8. Start your SAP HANA database and perform your validation.
9. When you increase the memory of your SAP HANA system, you might need to adjust the storage size of SAP HANA data, log, shared, and backup volumes as well to accommodate data growth and to get improved performance. For details, see SAP HANA on AWS Operations Guide.
10. Start your SAP HANA database and perform your validation.

    Note

    If necessary, complete any SAP HANA-specific post-migration activities.
11. Check the connectivity between your SAP application servers and the new SAP HANA instance.
12. If necessary, complete any AWS-specific post-migration activities, such as setting up Amazon CloudWatch, AWS Config, and AWS CloudTrail.

13. Configure your SAP HANA system for high availability on the EC2 High Memory instance with SAP HANA HSR and clustering software, and test it.

Option 2(b): Migrating Using an AMI

In this option, you launch a new EC2 High Memory instance based on the AMI that you created from your source system for the migration.

Figure 12 provides a high-level illustration of this option.

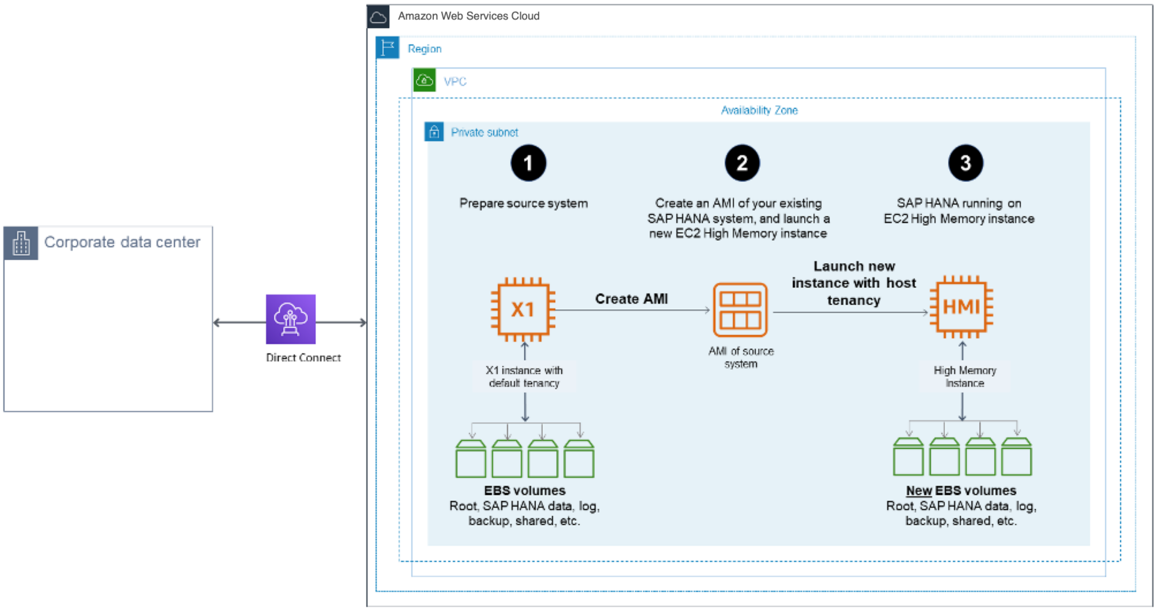

Amazon Web Services Cloud
Region
VPC
Availability Zone
Private subnet
Corporate data center
Direct Connect
1
Prepare source system
2
Create an AMI of your existing SAP HANA system, and launch a new EC2 High Memory instance
3
SAP HANA running on EC2 High Memory instance
X1
Create AMI
AMI of source system
Launch new instance with host tenancy
HMI
X1 instance with default tenancy
High Memory Instance
EBS volumes
Root, SAP HANA data, log, backup, shared, etc.
New EBS volumes
Root, SAP HANA data, log, backup, shared, etc.

Figure 12: Migrating to an EC2 High Memory instance using an AMI

1. Verify that your source system is running on a supported operating system version. If it isn’t, you might have to upgrade your operating system before resizing to an EC2 High Memory instance.
2. EC2 High Memory instances are based on the Nitro system. On Nitro-based instances, EBS volumes are presented as NVMe block devices. If your source system has any mount point entries in `/etc/fstab` with reference to block devices such as `/dev/xvd<x>`, you need to create a label for these devices and mount them by label before migrating to EC2 High Memory instances. Otherwise, you will face issues when you start SAP HANA on an EC2 High Memory instance.
3. When you are ready to migrate, verify that you have a good backup of your source system.
4. Stop the source instance in the Amazon EC2 console or by using the AWS CLI.
5. Create an AMI of your source instance. For details, see Creating an Amazon EBS-Backed Linux AMI in the AWS documentation.

   Tip
   Creating an AMI for the first time with the attached EBS volumes could take a long time, depending on your data size. To expedite this process, we recommend that you take snapshots of EBS volumes attached to the instance ahead of time.
6. Launch a new EC2 High Memory instance with host tenancy for `u-*tb1.metal` instances. For `u-6tb1.56xlarge` and `u-*tb1.112xlarge`, you can launch a new EC2 High Memory instance with default, dedicated or host tenancy.
7. The new instance will have a new IP address. Update all references to the IP address of the source system, including the /etc/hosts file for the operating system and DNS entries, to reflect the new IP address. The hostname and storage layout will remain the same as on the source system.

8. When you increase the memory of your SAP HANA system, you might need to adjust the storage size of SAP HANA data, log, shared, and backup volumes as well to accommodate data growth and to get improved performance. For details, see the SAP HANA on AWS Operations Guide.
9. Start your SAP HANA database and perform your validation.

   Note
   You might notice that SAP HANA is slow when loading data into memory for the first time after you create your instance with an AMI. This is expected behavior when EBS volumes associated with SAP HANA data are created from a snapshot. You will not experience the slowness after the initial hydration.
10. Complete any SAP HANA-specific post-migration activities.
11. Check the connectivity between your SAP application servers and the new SAP HANA instance.
12. Complete any AWS-specific post-migration activities, such as setting up Amazon CloudWatch, AWS Config, and AWS CloudTrail.
13. Configure your SAP HANA system for high availability on the EC2 High Memory instance with SAP HANA HSR and clustering software, and test it.

Option 2(c): Migrating Using SAP HANA HSR or SAP HANA backup and restore

In this option, you launch a new EC2 High Memory instance, install and configure SAP HANA on the instance, and then copy the data over from your source system to complete the migration.

1. Launch a new SAP HANA EC2 High Memory instance with host tenancy for `u-*tb1.metal` instances. For `u-6tb1.56xlarge` and `u-*tb1.112xlarge`, you can launch your instance with default, dedicated or host tenancy. You can use the SAP HANA Quick Start or the AWS Launch Wizard for SAP to set up your instance automatically, or follow the SAP HANA Environment Setup on AWS guide to set up your instance manually. Make sure that you are using an operating system that supports EC2 High Memory instances.
2. Complete any AWS-specific post-migration activities, such as setting up Amazon CloudWatch, AWS Config, and AWS CloudTrail, ahead of time.
3. Migrate the data from your existing SAP HANA instance by using SAP HANA HSR or SAP HANA backup and restore tools.

   - If you plan to use SAP HANA HSR for data migration, configure HSR to move data from your source system to your target system. This is illustrated in Figure 13. For details, see the SAP HANA Administration Guide from SAP.

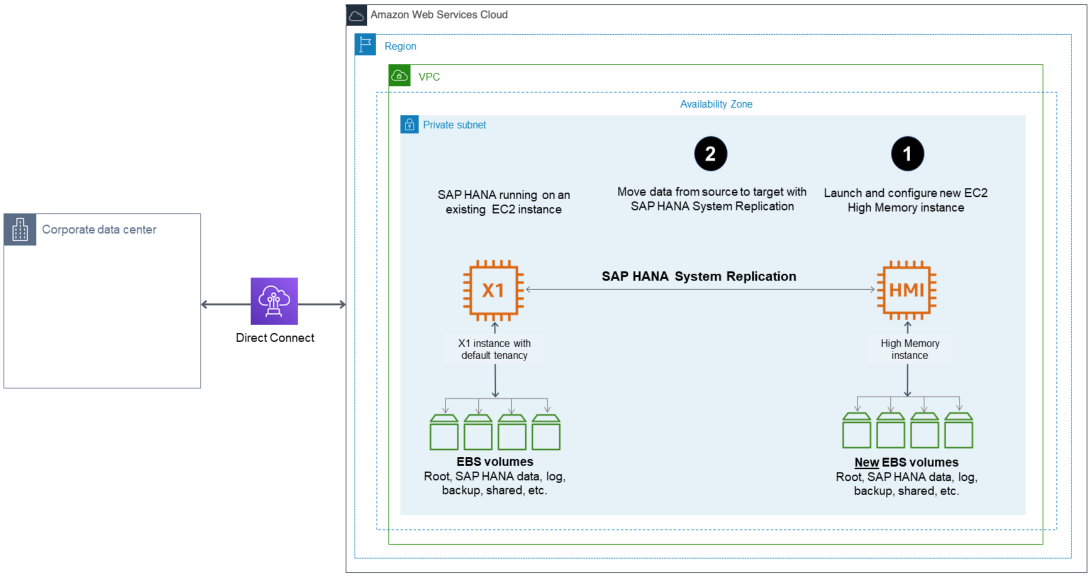

Amazon Web Services Cloud
Region
VPC
Availability Zone
Private subnet
2
1
SAP HANA running on an existing EC2 instance
Move data from source to target with SAP HANA System Replication
Launch and configure new EC2 High Memory instance
Corporate data center
Direct Connect
X1
SAP HANA System Replication
HMI
X1 instance with default tenancy
High Memory instance
EBS volumes
Root, SAP HANA data, log, backup, shared, etc.
New EBS volumes
Root, SAP HANA data, log, backup, shared, etc.

Figure 13: Migrating to an EC2 High Memory instance with HSR

- If you plan to use the SAP HANA backup and restore feature to migrate your data, back up your source SAP HANA system. When backup is complete, move the backup data to your target system and perform a restore in your target system. If you back up your source SAP HANA system directly to Amazon S3 using AWS Backint Agent for SAP HANA, you can directly restore it in the target system from Amazon S3. For details, see the AWS Backint Agent for SAP HANA in the AWS documentation. This is illustrated in Figure 14.

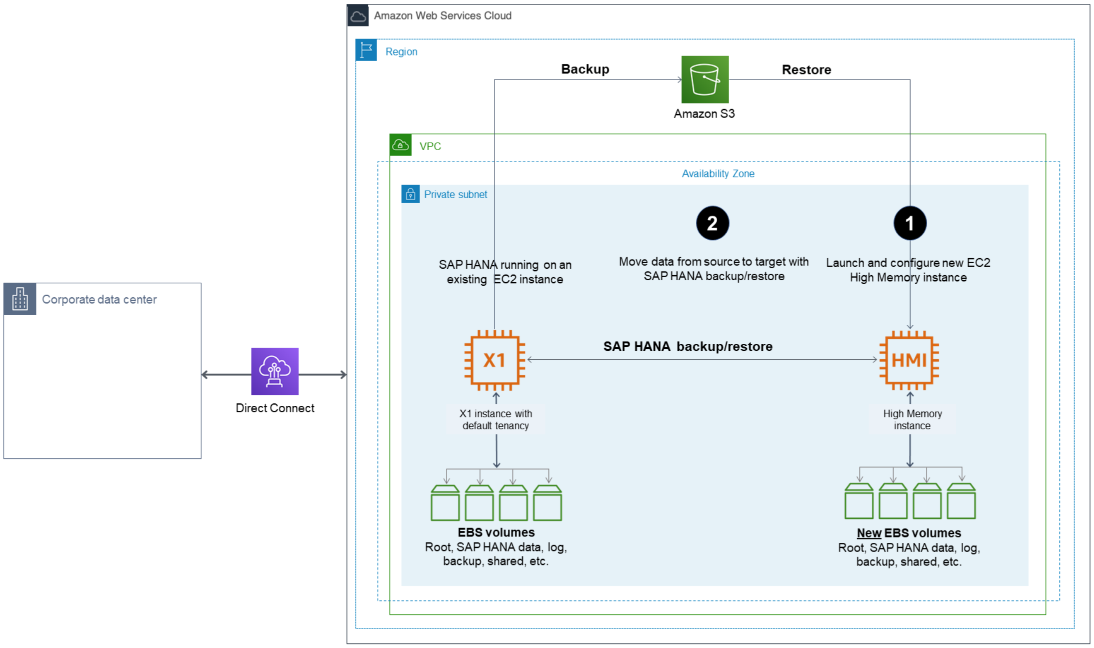

Amazon Web Services Cloud
Region
Backup
Restore
Amazon S3
VPC
Availability Zone
Private subnet
2
1
SAP HANA running on an existing EC2 instance
Move data from source to target with SAP HANA backup/restore
Launch and configure new EC2 High Memory instance
Corporate data center
Direct Connect
X1
SAP HANA backup/restore
HMI
X1 instance with default tenancy
High Memory instance
EBS volumes
Root, SAP HANA data, log, backup, shared, etc.
New EBS volumes
Root, SAP HANA data, log, backup, shared, etc.

Figure 14: Migrating to an EC2 High Memory instance with SAP backup and restore

4. Stop your source system, complete any additional post-migration steps, like updating DNS and checking the connectivity between your SAP application servers and the new SAP HANA instance.
5. Configure your SAP HANA system for high availability on the EC2 High Memory instance with SAP HANA HSR and clustering software, and test it.

Third-Party Migration Tools

If you are interested in using the rehosting option (see the 6 Rs Framework (p. 38) section) for your on-premises SAP HANA environment, you can also leverage third-party continuous data protection (CDP) tools such as CloudEndure, Delphix, ATADATA, and Double-Take, which replicate the on-premises virtual machine, physical servers, and database on AWS. These tools provide an automated way to build your AWS environment, and migrate your source environment as is to AWS, including retaining host names and operating system configuration. These tools are application-agnostic and operate at the operating system and storage level, so they do not need to be SAP-certified for SAP migrations. There may be additional configuration steps needed to ensure that your SAP systems are running in the most optimized manner. For storage and instance requirements, see the Planning the Deployment section of the SAP HANA Quick Start deployment guide.

Security

In the AWS Cloud Adoption Framework (CAF), security is a perspective that focuses on subjects such as account governance, account ownership, control frameworks, change and access management, and other security best practices. We recommend that you become familiar with these security processes when planning any type of migration. In some cases, you might need to get sign-off from your internal IT audit and security teams before you start your migration project or during migration. See the CAF security whitepaper for a deeper dive into each of these topic areas.

Additionally, there are AWS services that help you secure your systems in AWS. For example, AWS CloudTrail, Amazon CloudWatch, and AWS Config can help you secure your AWS environment.

See the following AWS blog posts for help analyzing and evaluating architectures and design patterns for the VPC setup and configuration of your SAP landscape.

- VPC Subnet Zoning Patterns for SAP on AWS, Part 1: Internal-Only Access
- VPC Subnet Zoning Patterns for SAP on AWS, Part 2: Network Zoning
- VPC Subnet Zoning Patterns for SAP on AWS, Part 3: Internal and External Access

Beyond VPC and network security, SAP HANA systems require routine maintenance to remain secure, reliable, and available; see the SAP HANA operations overview for specific recommendations in this topic area.

Additional Reading

- SAP FAST
- SAP HANA on the AWS Cloud: Quick Start Reference Deployment
- X1 Overview
- SAP and Amazon Web Services website
- SAP on AWS whitepapers

- AWS documentation

Document Revisions

Date	Change	
May 11, 2021	Added new migration scenario for EC2 High Memory instances	
June 2019	Added new migration scenario for EC2 High Memory instances, and updated to reflect latest information	
August 2018	Initial publication	

SAP HANA Environment Setup on AWS

SAP specialists, Amazon Web Services

Last updated: February 2019

This guide is part of a content series that provides detailed information about hosting, configuring, and using SAP technologies in the AWS Cloud. For the other guides in the series, ranging from overviews to advanced topics, see the SAP on AWS Technical Documentation home page.

This document provides guidance on how to set up AWS resources and configure SUSE Linux Enterprise Server (SLES) and Red Hat Enterprise Linux (RHEL) operating systems to deploy SAP HANA on Amazon Elastic Compute Cloud (Amazon EC2) instances in an existing virtual private cloud (VPC). It includes instructions for configuring storage for scale-up and scale-out workloads with Amazon Elastic Block Store (Amazon EBS) and Amazon Elastic File System (Amazon EFS).

This document follows AWS best practices to ensure that your system meets all key performance indicators (KPIs) that are required for Tailored Data Center Integration (TDI)–based SAP HANA implementations on AWS. In addition, this document also follows recommendations provided by SAP, SUSE, and Red Hat for SAP HANA in SAP OSS Notes 2205917, 1944799, 2292690 and 2009879. SAP regularly updates these OSS notes. Review the latest version of the OSS notes for up-to-date information before proceeding.

This guide is intended for users with a good understanding of AWS services, network concepts, the Linux operating system and SAP HANA administration to successfully launch and configure the resources that are required for SAP HANA.

AWS provides a Quick Start reference deployment for SAP HANA to fast-track your SAP HANA deployment on the AWS cloud. The Quick Start leverages AWS CloudFormation and scripts to quickly provision resources needed to deploy SAP HANA, and usually takes less than an hour to complete with minimal manual intervention. Refer to the SAP HANA on AWS Quick Start deployment guide if you want to use the automated deployment.

If your organization can’t use the Quick Start reference deployment and you require additional customization to meet internal policies, you can follow the steps in this document to manually set up AWS resources such as Amazon EC2, Amazon EBS, Amazon EFS, by using the AWS Command Line Interface (AWS CLI) or the AWS Management Console.

Unlike the SAP HANA on AWS Quick Start, this document doesn’t provide guidance on how to set up network and security constructs such as Amazon VPC, subnets, route tables, access control lists (ACLs), NAT Gateway, AWS Identity and Access Management (IAM) roles, security groups, etc. Instead, this document focuses on configuring compute, storage, and operating system resources for SAP HANA deployment on AWS.

Prerequisites

Specialized Knowledge

If you are new to AWS, see Getting Started with AWS.

Technical Requirements

1. If necessary, request a service limit increase for the instance type that you're planning to use for your SAP HANA system. If you already have an existing deployment that uses this instance type, and you think you might exceed the default limit with this deployment, you will need to request an increase. For details, see Amazon EC2 Service Limits in the AWS documentation.
2. Ensure that you have a key pair that you can use to launch your Amazon EC2 instance. If you need to create or import a key pair, refer to Amazon EC2 Key Pairs in the AWS documentation.
3. Ensure that you have the network details of the VPC, such as VPC ID and subnet ID, where you plan to launch the Amazon EC2 instance that will host SAP HANA.
4. Ensure that you have a security group to attach to the Amazon EC2 instance that will host SAP HANA and that the required ports are open. If needed, create a new security group that allows the traffic for SAP HANA ports. For a detailed list of ports, see Appendix C in the SAP HANA on AWS Quick Start guide.
5. If you intend to use AWS CLI to launch your instances, ensure that you have installed and configured AWS CLI with the necessary credentials. For details, see Installing the AWS Command Line Interface in the AWS documentation.
6. If you intend to use the console to launch your instances, ensure that you have credentials and permissions to launch and configure Amazon EC2, Amazon EBS, and other services. For details, see Access Management in the AWS documentation.

Architecture

This guide contains instructions for the following two environment setups:

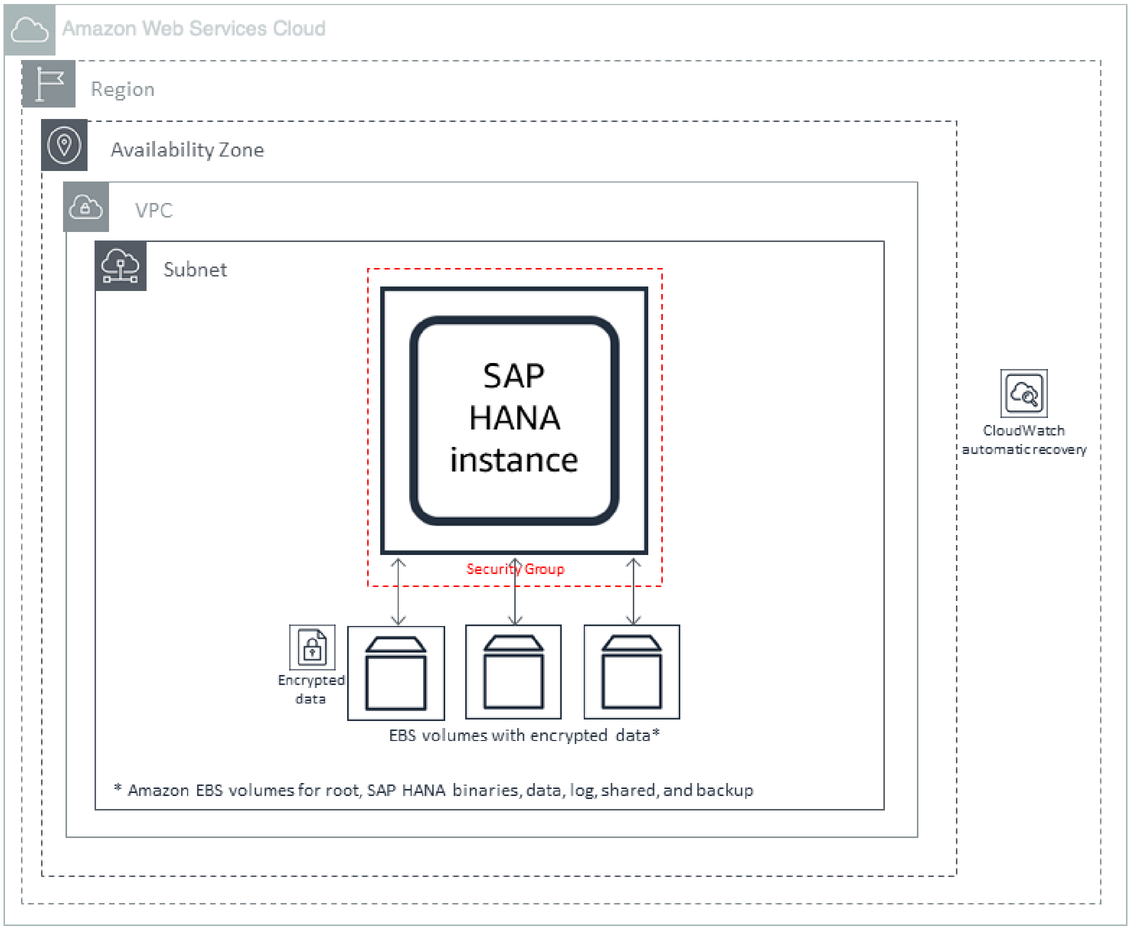

Amazon Web Services Cloud
Region
Availability Zone
VPC
Subnet
SAP HANA instance
Security Group
Encrypted data
EBS volumes with encrypted data*
* Amazon EBS volumes for root, SAP HANA binaries, data, log, shared, and backup
CloudWatch automatic recovery

Figure 1: AWS configured for scale-up SAP HANA workloads

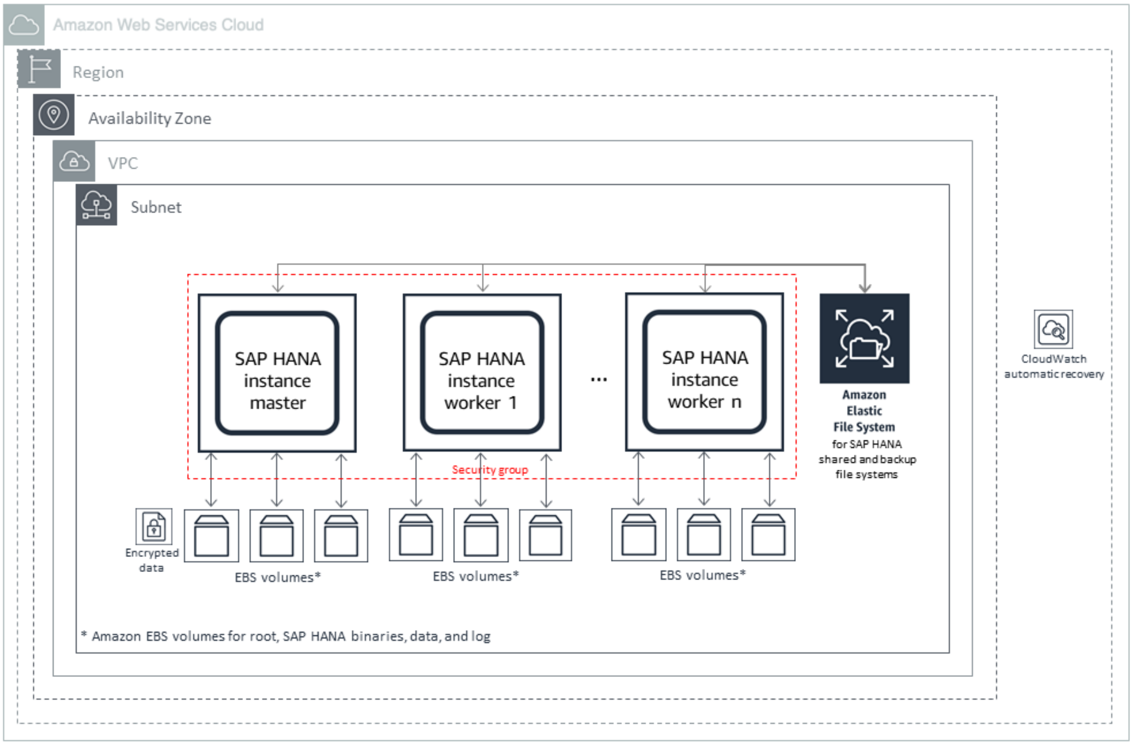

Amazon Web Services Cloud
Region
Availability Zone
VPC
Subnet
SAP HANA instance master
SAP HANA instance worker 1
...
SAP HANA instance worker n
Amazon Elastic File System
for SAP HANA shared and backup file systems
CloudWatch automatic recovery
Security group
Encrypted data
EBS volumes*
EBS volumes*
EBS volumes*
* Amazon EBS volumes for root, SAP HANA binaries, data, and log

Figure 2: AWS configured for scale-out SAP HANA workloads

Planning the Deployment

Compute

AWS provides multiple instance families with different sizes to run SAP HANA workloads. See the SAP Certified and Supported SAP HANA Hardware Directory and the Amazon EC2 Instance Types for SAP page to find list of certified Amazon EC2 instances. For your production workloads, ensure that you choose an instance type that has been certified by SAP. You can run your non-production workloads on any size of a particular certified instance family to save costs.

Operating System

You can deploy your SAP HANA workload on SLES, SLES for SAP, RHEL for SAP with High Availability and Update Services (RHEL for SAP with HA and US), or RHEL for SAP Solutions.

SLES for SAP and RHEL for SAP with HA and US products are available in AWS Marketplace under an hourly or an annual subscription model.

SLES for SAP

SLES for SAP provides additional benefits, including Extended Service Pack Overlap Support (ESPOS), configuration and tuning packages for SAP applications, and High Availability Extenstions (HAE). For details, see the SUSE SLES for SAP product page to learn more about the benefits of using SLES for SAP. We strongly recommend using SLES for SAP instead of SLES for all your SAP workloads.

If you plan to use Bring Your Own Subscription (BYOS) images provided by SUSE, ensure that you have the registration code required to register your instance with SUSE to access repositories for software updates.

RHEL for SAP

RHEL for SAP with HA and US provides access to Red Hat Pacemaker cluster software for High Availability, extended update support, and the libraries that are required to run SAP HANA. For details, see the RHEL for SAP Offerings on AWS FAQ in the Red Hat Knowledgebase.

If you plan to use the BYOS model with RHEL, either through the Red Hat Cloud Access program or another means, ensure that you have access to a RHEL for SAP Solutions subscription. For details, see Overview of Red Hat Enterprise Linux for SAP Solutions subscription in the Red Hat Knowledgebase.

Amazon Machine Image (AMI)

A base AMI is required to launch an Amazon EC2 instance. Depending on your choice of operating system, ensure that you have access to the appropriate AMI in your target region for the deployment.

If you plan to use the SLES for SAP or RHEL for SAP Amazon Machine Images (AMIs) offered in AWS Marketplace, ensure that you have completed the subscription process. For details on how to subscribe to one of these AMIs, see the Appendix sections of the SAP HANA on AWS Quick Start deployment guide.

If you are using AWS CLI, you will need to provide the AMI ID when you launch the instance.

Storage

Deploying SAP HANA on AWS requires specific storage size and performance to ensure that SAP HANA data and log volumes both meet the SAP KPIs and sizing recommendations. Refer the SAP HANA on AWS Operations Guide to undertsnad the storage configuration details for different instance types. You need to configure your storage based on these recommendations during instance launch.

Network

Ensure that your network constructs are set up to deploy resources related to SAP HANA. If you haven’t already set up network components such as Amazon VPC, subnets, route table, etc., you can use the AWS Modular and Scalable VPC Quick Start to easily deploy a scalable VPC architecture in minutes. For details, see the deployment guide.

Deployment steps using AWS CLI

Step 1. Prepare Storage Configuration for SAP HANA

Use the editor of your choice to create a .json file that contains block device mapping details similar to the following example, and save your file in a temporary directory. The example shows the block device mapping details for the x1.32xlarge instance type with io1 volumes for HANA data and log. Change the details depending on instance and storage type that you intend to use for your deployment. For more information about the storage details for different instance types, see the Planning the deployment section of the SAP HANA on AWS Quick Start guide.

```
  [
  {"DeviceName":"/dev/sda1","Ebs":
{"VolumeSize":50,"VolumeType":"gp2","DeleteOnTermination":false}},
  {"DeviceName":"/dev/sdb","Ebs":
{"VolumeSize":800,"VolumeType":"io1","Iops":3000,"Encrypted":true,"DeleteOnTermination":false}},
  {"DeviceName":"/dev/sdc","Ebs":
{"VolumeSize":800,"VolumeType":"io1","Iops":3000,"Encrypted":true,"DeleteOnTermination":false}},
  {"DeviceName":"/dev/sdd","Ebs":
{"VolumeSize":800,"VolumeType":"io1","Iops":3000,"Encrypted":true,"DeleteOnTermination":false}},
  {"DeviceName":"/dev/sde","Ebs":
{"VolumeSize":1024,"VolumeType":"gp2","Encrypted":true,"DeleteOnTermination":false}},
  {"DeviceName":"/dev/sdf","Ebs":
{"VolumeSize":4096,"VolumeType":"st1","Encrypted":true,"DeleteOnTermination":false}},
  {"DeviceName":"/dev/sdh","Ebs":
{"VolumeSize":525,"VolumeType":"io1","Iops":2000,"Encrypted":true,"DeleteOnTermination":false}},
  {"DeviceName":"/dev/sdr","Ebs":
{"VolumeSize":50,"VolumeType":"gp2","Encrypted":true,"DeleteOnTermination":false}}
  ]
```

Important

If the `DeleteOnTermination` flag is set to false, Amazon EBS volumes are not deleted when you terminate your Amazon EC2 instance. This helps preserve your data from accidental termination of your Amazon EC2 instance. When you terminate the instance, you need to manually delete the Amazon EBS volumes that are associated with the terminated instance to stop incurring storage cost.

See Appendix A (p. 81) for more examples of block device mappings for other Amazon EC2 instance types and Amazon EBS volume types.

Note

If you plan to deploy scale-out workloads, you don't have to include Amazon EBS volumes for SAP HANA shared and backup volumes. You can use Amazon EFS and Network File System (NFS) to mount the SAP HANA shared and backup volumes to your master and worker nodes.

Step 2. Launch the Amazon EC2 instance

Use AWS CLI to launch the Amazon EC2 instance for SAP HANA, including Amazon EBS storage, in the VPC in your target AWS Region by using the information you gathered during the preparation steps; for example:

Important

Be sure to enter the command on a single line.

```
  $ aws ec2 run-instances
  --image-id ami-xxxxxxxx
  --count 1
  --instance-type x1.32xlarge
  --region us-west-2
  --key-name=my_key
  --security-group-ids sg-xxxxxxxx
  --subnet-id subnet-xxxxxxxx
  --placement GroupName=My-PlacementGroup,Tenancy=default,HostId=My-DedicatedHostId
  --block-device-mappings file:///tmp/ebs_hana.json
  --tag-specifications 'ResourceType=instance,Tags=[{Key=Name,Value=MyHANA}]'
 'ResourceType=volume,Tags=[{Key=Name,Value=MyHANAVolumes}]'
```

Notes

- The `--placement` parameter is optional and needed only when you use a dedicated host with host tenancy or you want to place all your Amazon EC2 instances in close proximity. You may also pass additional parameters like `private-ip-address`, `disable-api-termination`, etc., as needed for your environment. For additional details, see run-instances in the AWS CLI Command Reference.

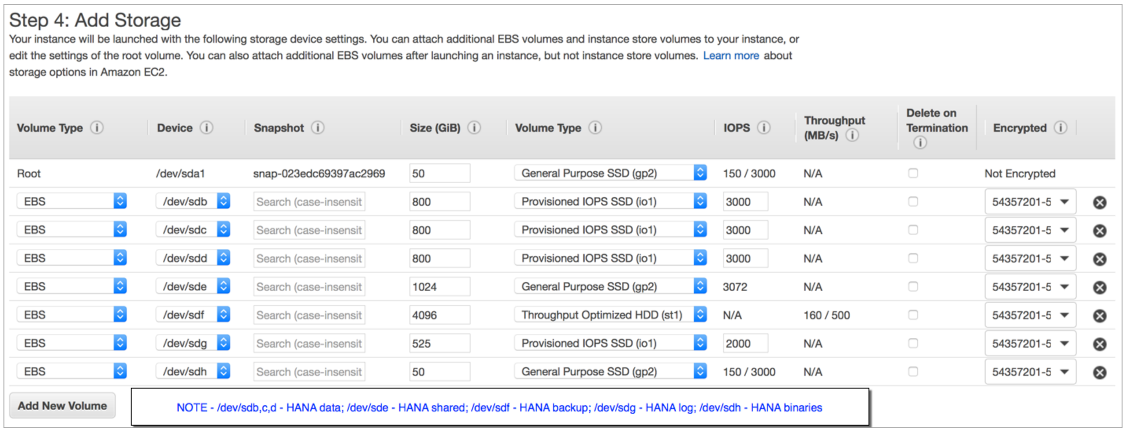
- After the instance and volumes are created, you can adjust the values of Amazon EBS volume tags to be more specific for ease of management. You can also add any additional tags that you need.
- For scale-out workloads, you can use the `--count` parameter to specify the total number of required nodes.
- Amazon EC2 High Memory Instances can be launched only through AWS CLI or APIs. After launch, however, you can manage them by using the console, AWS CLI, or APIs.

Deployment steps using the AWS Management Console

1. Log in to the console with appropriate permissions and ensure that you have the right Region selected.
2. Choose **Services**, and then choose **EC2** (under **Compute**).
3. Choose **Launch Instance**.
4. Search for the image that you want to use:
    - Choose **AWS Marketplace** to search for RHEL for SAP and SLES for SAP images.
    - Choose **My AMIs** to search for your BYOS or custom AMI ID.

    When you find the image, choose **Select**, and then confirm to continue.
5. On the **Choose an Instance Type** page, select the instance type that you identified when planning the deployment (p. 67), and choose **Configure Instance Details** to proceed with instance configuration.
6. On the **Configure Instance Details** page, do the following:
    a. Enter the number of instances (typically 1). For scale-out workloads, specify the number of nodes.
    b. Select the VPC ID and subnet for the network.
    c. Turn off the **Auto-assign Public IP** option.
    d. Select **Add instance to placement group** if needed (recommended for scale-out workloads; for details, see the AWS documentation).
    e. Select any IAM role that you want to assign to the instance to access AWS services from the instance.
    f. Select **Stop** for **Shutdown behavior**.
    g. Enable termination protection if needed (strongly recommended).
    h. Enable Amazon CloudWatch detailed monitoring (strongly recommended; for details, see the AWS documentation).
    i. Select the **Tenancy** or proceed with the default (**Shared**). For dedicated hosts, select the **Dedicated host** option.
    j. Choose **Add Storage** to proceed with storage configuration.
7. On the **Add Storage** page, choose **Add New Volume** to add volumes required for SAP HANA with the appropriate device, size, volume type, IOPS (for io1 only), and the **Delete on Termination** flag. Ensure that you follow the storage guidance (p. 68) discussed earlier in this document. Add volumes for SAP HANA data, log, shared, backup, and binaries.

    Figure 3 shows the storage configuration for x1.32xlarge instance type with io1 volume type for SAP HANA data and log.



Step 4: Add Storage

Your instance will be launched with the following storage device settings. You can attach additional EBS volumes and instance store volumes to your instance, or edit the settings of the root volume. You can also attach additional EBS volumes after launching an instance, but not instance store volumes. Learn more about storage options in Amazon EC2.

Volume Type	Device	Snapshot	Size (GiB)	Volume Type	IOPS	Throughput (MB/s)	Delete on Termination	Encrypted	
Root	/dev/sda1	snap-023edc69397ac2969	50	General Purpose SSD (gp2)	150 / 3000	N/A	□	Not Encrypted	
EBS	/dev/sdb	Search (case-insensit	800	Provisioned IOPS SSD (io1)	3000	N/A	□	54357201-5	⊗
EBS	/dev/sdc	Search (case-insensit	800	Provisioned IOPS SSD (io1)	3000	N/A	□	54357201-5	⊗
EBS	/dev/sdd	Search (case-insensit	800	Provisioned IOPS SSD (io1)	3000	N/A	□	54357201-5	⊗
EBS	/dev/sde	Search (case-insensit	1024	General Purpose SSD (gp2)	3072	N/A	□	54357201-5	⊗
EBS	/dev/sdf	Search (case-insensit	4096	Throughput Optimized HDD (st1)	N/A	160 / 500	□	54357201-5	⊗
EBS	/dev/sdg	Search (case-insensit	525	Provisioned IOPS SSD (io1)	2000	N/A	□	54357201-5	⊗
EBS	/dev/sdh	Search (case-insensit	50	General Purpose SSD (gp2)	150 / 3000	N/A	□	54357201-5	⊗

NOTE - /dev/sdb,c,d - HANA data; /dev/sde - HANA shared; /dev/sdf - HANA backup; /dev/sdg - HANA log; /dev/sdh - HANA binaries

Figure 3: SAP HANA Storage Configuration with the console

> **Note**
> If you are planning to deploy scale-out workloads, you don't have to include Amazon EBS volumes for SAP HANA shared and backup volumes. You can use Amazon EFS with NFS to mount the HANA shared and backup volumes to your master and worker nodes.

Choose **Add Tags** to proceed with configuring tags

8. Choose **Add Tag** and add the key-value pair to track and manage your resources. We recommend adding `Name` as a minimum key to easily identify your resources.

   Next, choose **Configure Security Group**.
9. Choose **Select an existing security group** and select a security group, if you have one, to attach to your instance. Otherwise, choose **Create a new security group** and configure the **Type**, **Protocol**, **Port Range**, and the **Source IP address** from where you want to allow traffic to your SAP HANA instance. Refer to Appendix C of the SAP HANA on AWS Quick Start guide for a list of ports that we recommend. You can change the port as needed to meet your security requirements.
10. Choose **Review and Launch** to review your selections, and then choose **Launch**.
11. Select an existing key pair if you have one. Otherwise, create a new key pair, acknowledge it, and choose **Launch Instances**.
12. Your instance should be launching now with the selected configuration. After the instance is launched, you can proceed with the operating system and storage configuration steps.

> **Note**
> Amazon EBS volumes are presented as NVME block devices on Nitro-based instances. You need to perform additional mapping at the operating system level when you configure these volumes.

Operating System and Storage Configuration

Use the instructions for your operating system:

- SLES for SAP 12.x (p. 72)
- RHEL for SAP 7.x (p. 74)

> **Note**
> For scale-out workloads, repeat these steps for every node in the cluster.

Configure Operating System – SLES for SAP 12.x

Important
In the following steps, you need to update several configuration files. We recommend taking a backup of the files before you modify them. This will help you to revert to the previous configuration if needed.

1. After your instance is up and running, connect to the instance by using Secure Shell (SSH) and the key pair that you used to launch the instance.

   Note
   Depending on your network and security settings, you might have to first connect by using SSH to a bastion host before accessing your SAP HANA instance, or you might have to add IP addresses or ports to the security group to allow SSH access.
2. Switch to root user.

   Alternatively, you can use `sudo` to execute the following commands as ec2-user.
3. Set a hostname and fully qualified domain name (FQDN) for your instance by executing the `hostnamectl` command and updating the `/etc/hostname` file.

   ```
   # hostnamectl set-hostname --static your_hostname
   # echo your_hostname.example.com > /etc/hostname
   ```

   Open a new session to verify the hostname change.
4. Ensure that the `DHCLIENT_SET_HOSTNAME` parameter is set to **no** to prevent DHCP from changing the hostname during restart.

   ```
   # grep DHCLIENT_SET_HOSTNAME /etc/sysconfig/network/dhcp
   ```
5. Set the `preserve_hostname` parameter to true to ensure your hostname is preserved during restart.

   ```
   # sed -i '/preserve_hostname/ c\preserve_hostname: true' /etc/cloud/cloud.cfg
   ```
6. Add an entry to the `/etc/hosts` file with the new hostname and IP address.

   ```
   ip_address hostname.example.com hostname
   ```
7. If you are using a BYOS SLES for SAP image, register your instance with SUSE. Ensure that your subscription is for SLES for SAP.

   ```
   # SUSEConnect -r Your_Registration_Code
   # SUSEConnect -s
   ```
8. Ensure that the following packages are installed:

   `systemd`, `tuned`, `saptune`, `libgcc_s1`, `libstdc++6`, `cpupower`, `autofs`, `nvme-cli`

   You can use the `rpm` command to check whether a package is installed.

   ```
   # rpm -qi package_name
   ```

   You can then use the zypper install command to install the missing packages.

```
# zypper install package_name
```

> **Note**
> If you are importing your own SLES image, additional packages might be required to ensure that your instance is optimally setup. For the latest information, refer to the Package List section in the SLES for SAP Application Configuration Guide for SAP HANA, which is attached to SAP OSS Note 1944799

9. Ensure that your instance is running on a kernel version that is recommended in SAP OSS Note 2205917. If needed, update your system to meet the minimum kernel version. You can check the version of the kernel and other packages by using the following command:

```
# rpm -qi kernel*
```

10. Start `saptune daemon` and use the following command to set it to automatically start when the system reboots.

```
# saptune daemon start
```

11. Check whether the `force_latency` parameter is set in the `saptune` configuration file.

```
# grep force_latency /usr/lib/tuned/saptune/tuned.conf
```

    If the parameter is set, skip the next step and proceed with activating the HANA profile with `saptune`.

12. Update the `saptune HANA` profile according to SAP OSS Note 2205917, and then run the following commands to create a custom profile for SAP HANA. This step is not required if the `force_latency` parameter is already set.

```
# mkdir /etc/tuned/saptune
# cp /usr/lib/tuned/saptune/tuned.conf /etc/tuned/saptune/tuned.conf
# sed -i "/\[cpu\]/ a force_latency=70" /etc/tuned/saptune/tuned.conf
# sed -i "s/script.sh/\/usr\/lib\/tuned\/saptune\/script.sh/"
```

13. Switch the `tuned` profile to HANA and verify that all settings are configured appropriately.

```
# saptune solution apply HANA
# saptune solution verify HANA
```

14. Configure and start the Network Time Protocol (NTP) service. You can adjust the NTP server pool based on your requirements; for example:

> **Note**
> Remove any existing invalid NTP server pools from `/etc/ntp.conf` before adding the following.

```
# echo "server 0.pool.ntp.org" >> /etc/ntp.conf
# echo "server 1.pool.ntp.org" >> /etc/ntp.conf
# echo "server 2.pool.ntp.org" >> /etc/ntp.conf
# echo "server 3.pool.ntp.org" >> /etc/ntp.conf
# systemctl enable ntpd.service
# systemctl start ntpd.service
```

> **Tip**
>
> Instead of connecting to the global NTP server pool, you can connect to your internal NTP server if needed. Or you can use Amazon Time Sync Service to keep your system time in sync.

15. Set the clocksource to `tsc` by updating the `current_clocksource` file and the GRUB2 boot loader.

    ```
    # echo "tsc" > /sys/devices/system/clocksource/*/current_clocksource
    # cp /etc/default/grub /etc/default/grub.backup
    # sed -i '/GRUB_CMDLINE_LINUX/ s|"| clocksource=tsc"|2' /etc/default/grub
    # grub2-mkconfig -o /boot/grub2/grub.cfg
    ```

16. Reboot your system for the changes to take effect.
17. Continue with storage configuration for SAP HANA (p. 76).

Configure Operating System – RHEL for SAP 7.x

> **Important**
>
> In the following steps, you need to update several configuration files. We recommend taking a backup of the files before you modify them. This will help you to revert to the previous configuration if needed.

1. After your instance is up and running, connect to the instance by using Secure Shell (SSH) and the key pair that you used to launch the instance.

    > **Note**
    >
    > Depending on your network and security settings, you might have to first connect by using SSH to a bastion host before accessing your SAP HANA instance, or you might have to add IP addresses or ports to the security group to allow SSH access.

2. Switch to root user.

    Alternatively, you can use sudo to execute the following commands as ec2-user.

3. Set a hostname for your instance by executing the `hostnamectl` command and update the `/etc/cloud/cloud.cfg` file to ensure that your hostname is preserved during system reboots.

    ```
    # hostnamectl set-hostname --static your_hostname
    # echo "preserve_hostname: true" >> /etc/cloud/cloud.cfg
    ```

    Open a new session to verify the hostname change.

4. Add an entry to the `/etc/hosts` file with the new hostname and IP address.

    ```
    ip address hostname.example.com hostname
    ```

    Ensure that the following packages are installed:

    `xfsprogs`, `gcc`, `compat-sap-c++-5`, `compat-sap-c++-6`, `tuned-profiles-sap-hana`, `glibc.x86_64`, `autofs`, and `nvme-cli`

    Note that your instance should have access to the SAP HANA channel to install libraries requires for SAP HANA installations.

    You can use the `rpm` command to check whether a package is installed:

```
# rpm -qi package_name
```

You can then install any missing packages by using the `yum -y install` command.

```
# yum -y install package name
```

Note
Depending on your base RHEL image, additional packages might be required to ensure that your instance is optimally setup. (You can skip this step if you are using the RHEL for SAP with HA & US image.) For the latest information, refer to the RHEL configuration guide that is attached to SAP OSS Note 2009879. Review the packages in the Install Additional Required Packages section and the Appendix–Required Packages for SAP HANA on RHEL 7 section.

5. Ensure that your instance is running on a kernel version that is recommended in SAP OSS Note 2292690. If needed, update your system to meet the minimum kernel version. You can check the version of the kernel and other packages using the following command.

```
# rpm -qi kernel*
```

6. Start `tuned daemon` and use the following commands to set it to automatically start when the system reboots.

```
# systemctl start tuned

# systemctl enable tuned
```

7. Configure the `tuned HANA` profile to optimize your instance for SAP HANA workloads.

   Check whether the `force_latency` parameter is already set in the `/usr/lib/tuned/sap-hana/tuned.conf` file. If the parameter is set, execute the following commands to apply and activate the `sap-hana` profile.

```
# tuned-adm profile sap-hana
# tuned-adm active
```

   If the `force_latency` parameter is not set, execute the following steps to modify and activate the `sap-hana` profile.

```
# mkdir /etc/tuned/sap-hana
# cp /usr/lib/tuned/sap-hana/tuned.conf /etc/tuned/sap-hana/tuned.conf
# sed -i '/force_latency/ c\force_latency=70' /etc/tuned/sap-hana/tuned.conf
# tuned-adm profile sap-hana
# tuned-adm active
```

8. Disable Security-Enhanced Linux (SELinux) by running the following command. (Skip this step if you are using the RHEL for SAP with HA & US image.)

```
# sed -i 's/\(SELINUX=enforcing\|SELINUX=permissive\)/SELINUX=disabled/g' \/etc/
selinux/config
```

9. Disable Transparent Hugepages (THP) at boot time by adding the following to the line that starts with GRUB_CMDLINE_LINUX in the `/etc/default/grub` file. Execute the following commands to add the required parameter and to re-configure grub (Skip this step if you are using the RHEL for SAP with HA & US image.)

```
# sed -i '/GRUB_CMDLINE_LINUX/ s|"| transparent_hugepage=never"|2' /etc/default/grub
# cat /etc/default/grub
# grub2-mkconfig -o /boot/grub2/grub.cfg
```

10. Add symbolic links by executing following commands. (Skip this step if you are using the RHEL for SAP with HA & US image.)

```
# ln -s /usr/lib64/libssl.so.10 /usr/lib64/libssl.so.1.0.1
# ln -s /usr/lib64/libcrypto.so.10 /usr/lib64/libcrypto.so.1.0.1
```

11. Configure and start the Network Time Protocol (NTP) service. You can adjust the NTP server pool based on your requirements. The following is just an example.

    Note
    Remove any existing invalid NTP server pools from `/etc/ntp.conf` before adding the following.

```
# echo "server 0.pool.ntp.org" >> /etc/ntp.conf
# echo "server 1.pool.ntp.org" >> /etc/ntp.conf
# echo "server 2.pool.ntp.org" >> /etc/ntp.conf
# echo "server 3.pool.ntp.org" >> /etc/ntp.conf
# systemctl enable ntpd.service
# systemctl start ntpd.service
# systemctl restart systemd-timedated.service
```

    Tip
    Instead of connecting to the global NTP server pool, you can connect to your internal NTP server if needed. Alternatively, you can also use Amazon Time Sync Service to keep your system time in sync.

12. Set clocksource to `tsc` by the updating the `current_clocksource` file and the GRUB2 boot loader.

```
# echo "tsc" > /sys/devices/system/clocksource/*/current_clocksource
# cp /etc/default/grub /etc/default/grub.backup
# sed -i '/GRUB_CMDLINE_LINUX/ s|"| clocksource=tsc"|2' /etc/default/grub
# grub2-mkconfig -o /boot/grub2/grub.cfg
```

13. Reboot your system for the changes to take effect.

14. After the reboot, log in as root and execute the `tuned-adm` command to verify that all SAP recommended settings are in place.

```
 # tuned-adm verify

 “tuned-adm verify” creates a log file under /var/log/tuned/tuned.log Review this log
file and ensure that  all checks have passed.
```

15. Continue with storage configuration.

Configure Storage for SAP HANA

1. Amazon EBS volumes should have been created and attached when you launched the Amazon EC2 instance. Confirm that all the required volumes are attached to the instance by running the `lsblk` command, which returns a list of the storage devices that are attached to the instance.

Note
On Nitro-based instances, Amazon EBS volumes are presented as NVME block devices. You need to perform additional mapping when configuring these volumes.

Depending on the instance and storage volume types, your block device mapping will look similar to the following examples.

Example from a non-Nitro instance

```
# lsblk
NAME     MAJ:MIN  RM  SIZE RO TYPE MOUNTPOINT
xvda     202:0     0   50G  0 disk
##xvda1 202:1     0    1M  0 part
##xvda2 202:2     0   50G  0 part /
xvdb     202:16    0  800G  0 disk
xvdc     202:32    0  800G  0 disk
xvdd     202:48    0  800G  0 disk
xvde     202:64    0    1T  0 disk
xvdf     202:80    0    4T  0 disk
xvdh     202:112   0  525G  0 disk
xvdr     202:4352  0   50G  0 disk
#
```

Example from a Nitro instance

```
## lsblk
NAME          MAJ:MIN  RM  SIZE RO TYPE MOUNTPOINT
nvme0n1       259:0     0   50G 0  disk
##nvme0n1p1  259:1     0   50G 0  part /
nvme1n1       259:2     0    4T 0  disk
nvme2n1       259:3     0  800G 0  disk
nvme3n1       259:4     0  800G 0  disk
nvme4n1       259:5     0  800G 0  disk
nvme5n1       259:6     0  525G 0  disk
nvme6n1       259:7     0    1T 0  disk
nvme7n1       259:8     0   50G 0  disk
#
```

2. Initialize the volumes of SAP HANA data, log, and backup to use with Linux Logical Volume Manager (LVM).

   Note
   Ensure you are choosing the devices that are associated with the SAP HANA data, log, and backup volumes. The device names might be different in your environment.

   Example from a non-Nitro instance

```
# pvcreate /dev/xvdb /dev/xvdc /dev/xvdd /dev/xvdf /dev/xvdh
  Physical volume "/dev/xvdb" successfully created.
  Physical volume "/dev/xvdc" successfully created.
  Physical volume "/dev/xvdd" successfully created.
  Physical volume "/dev/xvdf" successfully created.
  Physical volume "/dev/xvdh" successfully created.
#
```

   Example from a Nitro instance

```
# pvcreate /dev/nvme2n1 /dev/nvme3n1 /dev/nvme4n1 /dev/nvme5n1 /dev/nvme1n1
  Physical volume "/dev/nvme2n1" successfully created.
  Physical volume "/dev/nvme3n1" successfully created.
  Physical volume "/dev/nvme4n1" successfully created.
  Physical volume "/dev/nvme5n1" successfully created.
  Physical volume "/dev/nvme1n1" successfully created.
#
```

3. Create volume groups for SAP HANA data, log, and backup. Ensure that device IDs are associated correctly with the appropriate volume group.

   Example from a non-Nitro instance

   ```
   # vgcreate vghanadata /dev/xvdb /dev/xvdc /dev/xvdd
     Volume group "vghanadata" successfully created
   # vgcreate vghanalog /dev/xvdh
     Volume group "vghanalog" successfully created
   # vgcreate vghanaback /dev/xvdf
     Volume group "vghanaback" successfully created
   #
   ```

   Example from a Nitro instance

   ```
   # vgcreate vghanadata /dev/nvme2n1 /dev/nvme3n1 /dev/nvme4n1
     Volume group "vghanadata" successfully created
   # vgcreate vghanalog /dev/nvme5n1
     Volume group "vghanalog" successfully created
   # vgcreate vghanaback /dev/nvme1n1
     Volume group "vghanaback" successfully created
   #
   ```

4. Create a logical volume for SAP HANA data.

   In the following command, `-i 3` represents stripes based on the number of volumes that are used for a HANA data volume group. Adjust the number depending on the number of volumes that are allocated to the HANA data volume group, based on instance and storage type.

   ```
    # lvcreate -n lvhanadata -i 3 -I 256 -L 2350G vghanadata
      Rounding size 2.29 TiB (601600 extents) up to stripe boundary size 2.29 TiB (601602
   extents).
      Logical volume "lvhanadata" created.
    #
   ```

5. Create a logical volume for SAP HANA log.

   In the following command, `-i 1` represents stripes based on the number of volumes that are used for a HANA log volume group. Adjust the number depending on the number of volumes that are allocated to the HANA log volume group, based on instance and storage type.

   ```
   # lvcreate -n lvhanalog -i 1 -I 256 -L 512G vghanalog
     Ignoring stripesize argument with single stripe.
     Logical volume "lvhanalog" created.
   #
   ```

6. Create a logical volume for SAP HANA backup.

   ```
   # lvcreate -n lvhanaback -i 1 -I 256 -L 4095G vghanaback
     Ignoring stripesize argument with single stripe.
     Logical volume "lvhanaback" created.
   #
   ```

7. Construct XFS file systems with the newly created logical volumes for HANA data, log, and backup by using the following commands:

```
# mkfs.xfs -f /dev/mapper/vghanadata-lvhanadata
# mkfs.xfs -f /dev/mapper/vghanalog-lvhanalog
# mkfs.xfs -f /dev/mapper/vghanaback-lvhanaback
```

8. Construct XFS file systems for HANA shared and HANA binaries.

```
# mkfs.xfs -f /dev/xvde -L HANA_SHARE
# mkfs.xfs -f /dev/xvdr -L USR_SAP
```

Note
On Nitro-based instance types, device names can change during instance restarts. To prevent file system mount issues, it is important to create labels for devices that aren't part of logical volumes so that the devices can be mounted by using labels instead of the actual device names.

9. Create directories for HANA data, log, backup, shared, and binaries.

```
# mkdir /hana /hana/data /hana/log /hana/shared /backup /usr/sap
```

10. Use the `echo` command to add entries to the `/etc/fstab` file with the following mount options to automatically mount these file systems during restart.

```
 # echo "/dev/mapper/vghanadata-lvhanadata /hana/data xfs
noatime,nodiratime,logbsize=256k 0 0" >> /etc/fstab
 # echo "/dev/mapper/vghanalog-lvhanalog /hana/log xfs
noatime,nodiratime,logbsize=256k 0 0" >> /etc/fstab
 # echo "/dev/mapper/vghanaback-lvhanaback /backup xfs
noatime,nodiratime,logbsize=256k 0 0" >> /etc/fstab
 # echo "/dev/disk/by-label/HANA_SHARE /hana/shared xfs
noatime,nodiratime,logbsize=256k 0 0" >> /etc/fstab
 # echo "/dev/disk/by-label/USR_SAP /usr/sap xfs noatime,nodiratime,logbsize=256k 0 0"
>> /etc/fstab
```

11. Mount the file systems.

```
# mount -a
```

12. Check to make sure that all file systems are mounted appropriately; for example, here is the output from an x1.32xlarge system:

```
# df -h
Filesystem                         Size  Used Avail Use% Mounted on
/dev/xvda2                          50G  1.8G  49G    4% /
devtmpfs                           961G     0 961G    0% /dev
tmpfs                              960G     0 960G    0% /dev/shm
tmpfs                              960G   17M 960G    1% /run
tmpfs                              960G     0 960G    0% /sys/fs/cgroup
tmpfs                              192G     0 192G    0% /run/user/1000
/dev/mapper/vghanadata-lvhanadata 2.3T   34M 2.3T    1% /hana/data
/dev/mapper/vghanalog-lvhanalog   512G   33M 512G    1% /hana/log
/dev/mapper/vghanaback-lvhanaback 4.0T   33M 4.0T    1% /backup
/dev/xvde                          1.0T   33M 1.0T    1% /hana/shared
/dev/xvdr                           50G   33M 50G     1% /usr/sap
#
```

13. At this time, we recommend rebooting the system and confirming that all the file systems mount automatically after the restart.

14. If you are deploying a scale-out workload, follow the steps specified in Configure NFS for scale-out workloads (p. 80) to set up SAP HANA shared and backup NFS file systems with Amazon EFS.

If you are not deploying a scale-out workload, you can now proceed with your SAP HANA software installation.

Configure NFS for scale-out workloads

Amazon EFS provides easy-to-set-up, scalable, and highly available shared file systems that can be mounted with the NFSv4 client. For scale-out workloads, we recommend using Amazon EFS for SAP HANA shared and backup volumes. You can choose between different performance options for your file systems depending on your requirements. We recommend starting with the General Purpose and Provisioned Throughput options, with approximately 100 MiB/s to 200 MiB/s throughput. To set up your file systems, do the following:

1. Install the `nfs-utils` package in all the nodes in your scale-out cluster.
   - For RHEL, use `yum install nfs-utils`.
   - For SLES, use `zypper install nfs-utils`.
2. Create two Amazon EFS file systems and target mounts for SAP HANA shared and backup in your target VPC and subnet. For detailed steps, follow the instructions specified in the AWS documentation.
3. After the file systems are created, mount the newly created file systems in all the nodes by using the following commands:

```
  # mount -t nfs -o
 nfsvers=4.1,rsize=1048576,wsize=1048576,hard,timeo=600,retrans=2 EFS DNS Name:/ /hana/
shared

  # mount -t nfs -o
 nfsvers=4.1,rsize=1048576,wsize=1048576,hard,timeo=600,retrans=2 EFS DNS Name:/ /
backup
```

   Note
   If you have trouble mounting the NFS file systems, you might need to adjust your security groups to allow access to port 2049. For details, see Security Groups for Amazon EC2 Instances and Mount Targets in the AWS documentation.

4. Add NFS mount entries to the `/etc/fstab` file in all the nodes to automatically mount these file systems during system restart; for example:

```
  # echo “nfsvers=4.1,rsize=1048576,wsize=1048576,hard,timeo=600,retrans=2 EFS DNS
 Name:/ /hana/shared” >> /etc/fstab
  # echo “nfsvers=4.1,rsize=1048576,wsize=1048576,hard,timeo=600,retrans=2 EFS DNS
 Name:/ /backup” >> /etc/fstab
```

5. Set appropriate permissions and ownership for your target mount points.

Post Deployment Steps

1. Complete the steps required to connect your instance to your corporate directory service, such as Microsoft Active Directory, if needed.
2. Set up any monitoring required for your environment.

3. Set up a CloudWatch alarm and Amazon EC2 automatic recovery to automatically recover your instance from hardware failures. For details, see Recover Your Instance in the AWS documentation. You can also refer to the Knowledge Center video for detailed instructions.

   Note
   Automatic recovery is not supported for Amazon EC2 instances running in dedicated hosts.

4. Create an AMI of your newly deployed system to take a full backup of your instance. For details, see Create an AMI from an Amazon EC2 Instance in the AWS documentation.
5. If you have deployed an SAP HANA scale-out cluster, consider adding additional elastic network interfaces and security groups to logically separate network traffic for client, inter-node, and optional SAP HANA System Replication (HSR) communications. For details, see the SAP HANA Operations Guide.

Additional Reading

AWS services

- Amazon EC2
- Amazon EBS
- Amazon VPC
- Amazon EFS

SAP document reference

- SAP OSS Note 2292690 - SAP HANA DB: Recommended OS settings for RHEL 7
- SAP OSS Note 2009879 - SAP HANA Guidelines for Red Hat Enterprise Linux (RHEL) Operating System
- SAP OSS Note 2205917 - SAP HANA DB: Recommended OS settings for SLES 12 / SLES for SAP Applications 12
- SAP OSS Note 1944799 - SAP HANA Guidelines for SLES Operating System Installation

Appendix A: Sample Block Device Mapping Configuration

Following are two block device mapping examples for your reference. You can find details of the recommended storage configuration for different types in the SAP HANA on AWS Quick Start deployment guide.

Example with x1.16xlarge instance type, GP2 storage type

```
  [
  {"DeviceName":"/dev/sda1","Ebs":
{"VolumeSize":50,"VolumeType":"gp2","DeleteOnTermination":false}},
  {"DeviceName":"/dev/sdb","Ebs":
{"VolumeSize":400,"VolumeType":"gp2,"Encrypted":true,"DeleteOnTermination":false}},
  {"DeviceName":"/dev/sdc","Ebs":
{"VolumeSize":400,"VolumeType":"gp2","Encrypted":true,"DeleteOnTermination":false}},
  {"DeviceName":"/dev/sdd","Ebs":
{"VolumeSize":400,"VolumeType":"gp2", ,"Encrypted":true,"DeleteOnTermination":false}},
  {"DeviceName":"/dev/sde","Ebs":
{"VolumeSize":1024,"VolumeType":"gp2","Encrypted":true,"DeleteOnTermination":false}},
  {"DeviceName":"/dev/sdf","Ebs":
{"VolumeSize":2048,"VolumeType":"st1","Encrypted":true,"DeleteOnTermination":false}},
  {"DeviceName":"/dev/sdh","Ebs":{"VolumeSize":300,"VolumeType":"gp2",
 "Encrypted":true,"DeleteOnTermination":false}},
  {"DeviceName":"/dev/sdh","Ebs":
{"VolumeSize":300,"VolumeType":"gp2","Encrypted":true,"DeleteOnTermination":false}},
  {"DeviceName":"/dev/sdr","Ebs":
{"VolumeSize":50,"VolumeType":"gp2","Encrypted":true,"DeleteOnTermination":false}}
  ]
```

Example with r4.16xlarge instance type, io1 storage type

```
  [
  {"DeviceName":"/dev/sda1","Ebs":
{"VolumeSize":50,"VolumeType":"gp2","DeleteOnTermination":false}},
  {"DeviceName":"/dev/sdb","Ebs":
{"VolumeSize":600,"VolumeType":"io1","Iops":7500,"Encrypted":true,"DeleteOnTermination":false}},
  {"DeviceName":"/dev/sde","Ebs":
{"VolumeSize":512,"VolumeType":"gp2","Encrypted":true,"DeleteOnTermination":false}},
  {"DeviceName":"/dev/sdf","Ebs":
{"VolumeSize":1024,"VolumeType":"st1","Encrypted":true,"DeleteOnTermination":false}},
  {"DeviceName":"/dev/sdh","Ebs":
{"VolumeSize":260,"VolumeType":"io1","Iops":2000,"Encrypted":true,"DeleteOnTermination":false}},
  {"DeviceName":"/dev/sdr","Ebs":
{"VolumeSize":50,"VolumeType":"gp2","Encrypted":true,"DeleteOnTermination":false}}
  ]
```

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February 2019	Initial publication	—

SAP HANA on AWS Operations Guide

SAP specialists, Amazon Web Services

Last updated: December 2017

Amazon Web Services offers you the ability to run your SAP HANA systems of various sizes and operating systems. Running SAP systems on AWS is very similar to running SAP systems in your data center. To a SAP Basis or NetWeaver administrator, there are minimal differences between the two environments. There are a number of AWS Cloud considerations relating to security, storage, compute configurations, management, and monitoring that will help you get the most out of your SAP HANA implementation on AWS.

This technical article provides the best practices for deployment, operations, and management of SAP HANA systems on AWS. The target audience is SAP Basis and NetWeaver administrators who have experience running SAP HANA systems in an on-premises environment and want to run their SAP HANA systems on AWS.

> **Note**
> The SAP notes and Knowledge Base articles (KBA) referenced in this guide require an SAP ONE Support Launchpad user account. For more information, see the SAP Support website.

About this Guide

This guide is part of a content series that provides detailed information about hosting, configuring, and using SAP technologies in the AWS Cloud. For the other guides in the series, ranging from overviews to advanced topics, see the SAP on AWS Technical Documentation home page.

Introduction

This guide provides best practices for operating SAP HANA systems that have been deployed on AWS either by using the SAP HANA Quick Start reference deployment process or by manually following the instructions in Setting up AWS Resources and the SLES Operating System for SAP HANA Installation. This guide is not intended to replace any of the standard SAP documentation. See the following SAP guides and notes:

- SAP Library (help.sap.com) - SAP HANA Administration Guide
- SAP installation guides (these require an SAP One Support Launchpad user account)
- SAP notes (these require an SAP One Support Launchpad user account)

This guide assumes that you have a basic knowledge of AWS. If you are new to AWS, see the following on the AWS website before continuing:

- AWS Getting Started Resource Center
- What is Amazon EC2?

In addition, see the following SAP on AWS guides:

- SAP on AWS Implementation and Operations Guide provides best practices for achieving optimal performance, availability, and reliability, and lower total cost of ownership (TCO) while running SAP solutions on AWS.

- SAP on AWS High Availability Guide explains how to configure SAP systems on Amazon Elastic Compute Cloud (Amazon EC2) to protect your application from various single points of failure.
- SAP on AWS Backup and Recovery Guide explains how to back up SAP systems running on AWS, in contrast to backing up SAP systems on traditional infrastructure.

Administration

This section provides guidance on common administrative tasks required to operate an SAP HANA system, including information about starting, stopping, and cloning systems.

Starting and Stopping EC2 Instances Running SAP HANA Hosts

At any time, you can stop one or multiple SAP HANA hosts. Before stopping the EC2 instance of an SAP HANA host, first stop SAP HANA on that instance.

When you resume the instance, it will automatically start with the same IP address, network, and storage configuration as before. You also have the option of using the EC2 Scheduler to schedule starts and stops of your EC2 instances. The EC2 Scheduler relies on the native shutdown and start-up mechanisms of the operating system. These native mechanisms will invoke the orderly shutdown and startup of your SAP HANA instance. Here is an architectural diagram of how the EC2 Scheduler works:

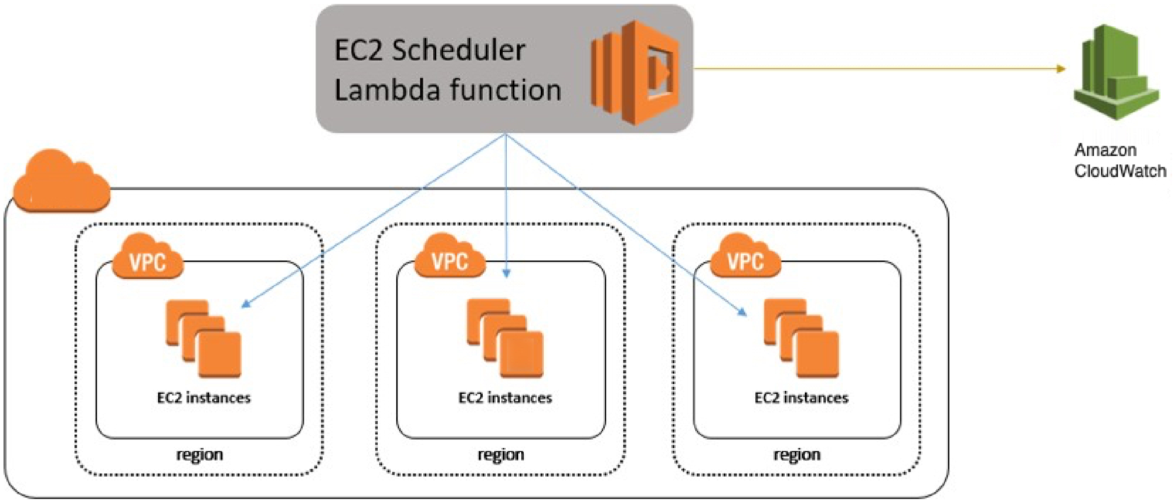


Figure 1: EC2 Scheduler

Tagging SAP Resources on AWS

Tagging your SAP resources on AWS can significantly simplify identification, security, manageability, and billing of those resources. You can tag your resources using the AWS Management Console or by using the `create-tags` functionality of the AWS Command Line Interface (AWS CLI). This table lists some example tag names and tag values:

Tag name	Tag value
Name	SAP server’s virtual (host) name

Tag name	Tag value
Environment	SAP server’s landscape role; for example: SBX, DEV, QAT, STG, PRD.
Application	SAP solution or product; for example: ECC, CRM, BW, PI, SCM, SRM, EP
Owner	SAP point of contact
Service level	Known uptime and downtime schedule

After you have tagged your resources, you can apply specific security restrictions such as access control, based on the tag values. Here is an example of such a policy from the AWS Security blog:

```
{
   "Version" : "2012-10-17",
   "Statement" : [
      {
         "Sid" : "LaunchEC2Instances", "Effect" : "Allow",
         "Action" : [
            "ec2:Describe*", "ec2:RunInstances"
         ],
         "Resource" : [
            "*"
         ]
      },
      {
         "Sid" : "AllowActionsIfYouAreTheOwner",
         "Effect" : "Allow",
         "Action" : [
            "ec2:StopInstances",
            "ec2:StartInstances",
            "ec2:RebootInstances",
            "ec2:TerminateInstances"
         ],
         "Condition" : {
            "StringEquals" : {
               "ec2:ResourceTag/PrincipalId" : "${aws:userid}"
            }
         },
         "Resource" : [
            "*"
         ]
      }
   ]
}
```

The AWS Identity and Access Management (IAM) policy allows only specific permissions based on the tag value. In this scenario, the current user ID must match the tag value in order for the user to be granted permissions. For more information on tagging, see the AWS documentation and AWS blog.

Monitoring

You can use various AWS, SAP, and third-party solutions to monitor your SAP workloads. Here are some of the core AWS monitoring services:

- Amazon CloudWatch – CloudWatch is a monitoring service for AWS resources. It’s critical for SAP workloads where it’s used to collect resource utilization logs and to create alarms to automatically react to changes in AWS resources.

- AWS CloudTrail – CloudTrail keeps track of all API calls made within your AWS account. It captures key metrics about the API calls and can be useful for automating trail creation for your SAP resources.

Configuring CloudWatch detailed monitoring for SAP resources is mandatory for getting AWS and SAP support. You can use native AWS monitoring services in a complementary fashion with the SAP Solution Manager. You can find third-party monitoring tools in AWS Marketplace.

Automation

AWS offers multiple options for programmatically scripting your resources to operate or scale them in a predictable and repeatable manner. You can use AWS CloudFormation to automate and operate SAP systems on AWS. Here are some examples for automating your SAP environment on AWS:

Area	Activities	AWS services
Infrastructure deployment	Provision new SAP environment SAP system cloning	AWS CloudFormation AWS CLI
Capacity management	Automate scale-up/scale-out of SAP application servers	AWS Lambda AWS CloudFormation
Operations	SAP backup automation (see the backup (p. 91) example (p. 91)) Performing monitoring and visualization	Amazon CloudWatch AWS Systems Manager

Patching

There are two ways for you to patch your SAP HANA database, with options for minimizing cost and/or downtime. With AWS, you can provision additional servers as needed to minimize downtime for patching in a cost-effective manner. You can also minimize risks by creating on-demand copies of your existing production SAP HANA databases for lifelike production readiness testing.

This table summarizes the tradeoffs of the two patching methods:

Patching method	Benefits	Technologies available
Patch an existing server	[x] Patch existing OS and DB [x] Longest downtime to existing server and DB [#] No costs for additional on-demand instances [✓] Lowest levels of relative complexity and setup tasks involved	Native OS patching tools Patch Manager Native SAP HANA patching tools
Provision and patch a new server	[✓] Leverage latest AMIs (only DB patch needed)	Amazon Machine Image (AMI) AWS CLI AWS CloudFormation

Patching method	Benefits	Technologies available
	[✓] Shortest downtime to existing server and DB [✓] Can patch and test OS and DB separately and together [x] More costs for additional on-demand instances [x] More complexity and setup tasks involved	SAP HANA System Replication SAP HANA System Cloning SAP HANA backups SAP Notes: 1984882 - Using HANA System Replication for Hardware Exchange with minimum/zero downtime 1913302 - HANA: Suspend DB connections for short maintenance tasks

The first method (patch an existing server) involves patching the operating system (OS) and database (DB) components of your SAP HANA server. The goal of this method is to minimize any additional server costs and to avoid any tasks needed to set up additional systems or tests. This method may be most appropriate if you have a well-defined patching process and are satisfied with your current downtime and costs. With this method you must use the correct operating system (OS) update process and tools for your Linux distribution. See this SUSE blog and Red Hat FAQ, or check each vendor's documentation for their specific processes and procedures.

In addition to patching tools provided by our Linux partners,AWS offers a free of charge patching service called Patch Manager. Patch Manager is an automated tool that helps you simplify your OS patching process. You can scan your EC2 instances for missing patches and automatically install them, select the timing for patch rollouts, control instance reboots, and many other tasks. You can also define auto-approval rules for patches with an added ability to black-list or white-list specific patches, control how the patches are deployed on the target instances (e.g., stop services before applying the patch), and schedule the automatic rollout through maintenance windows.

The second method (provision and patch a new server) involves provisioning a new EC2 instance that will receive a copy of your source system and database. The goal of the method is to minimize downtime, minimize risks (by having production data and executing production-like testing), and have repeatable processes. This method may be most appropriate if you are looking for higher degrees of automation to enable these goals and are comfortable with the trade- offs. This method is more complex and has a many more options to fit your requirements. Certain options are not exclusive and can be used together. For example, your AWS CloudFormation template can include the latest Amazon Machine Images (AMIs), which you can then use to automate the provisioning, set up, and configuration of a new SAP HANA server.

Here is an example of a process that can be used to automate OS/HANA patching/upgrade:

1. Download the AWS CloudFormation template offered in the SAP HANA Quick Start.
2. Update the CloudFormation template with the latest OS AMI ID and execute the updated template to provision a new SAP HANA server. The latest OS AMI ID has the specific security patches that your organization needs. As part of the provisioning process, you need to provide the latest SAP HANA installation binaries to get to the required version. This allows you to provision a new HANA system with the required OS version and security patches along with SAP HANA software versions.
3. After the new SAP HANA system is available, use one of the following methods to copy the data from the original SAP HANA instance to the newly created system:

    - Use SAP HANA native backup/restore.
    - Use SAP HANA System Replication (HSR) technology to replicate the data and then perform an HSR take-over.

- Take snapshots of the old system's Amazon Elastic Block Store (Amazon EBS) volumes and create new EBS volumes from it. Mount them in the new environment. (Make sure that the HANA SID stays the same for minimal post-processing.)
- Use new SAP HANA 2.0 functionality such as SAP HANA Cloning. The new system will become a clone of the original system.

At the end of this process, you will have a new SAP HANA system that is ready to test.

SAP Note 1984882 (*Using HANA System Replication for Hardware Exchange with Minimum/Zero Downtime*) has specific recommendations and guidelines for promoting your system to production.

Backup and Recovery

This section provides an overview of the AWS services used in the backup and recovery of SAP HANA systems and provides an example backup and recovery scenario. This guide does not include detailed instructions on how to execute database backups using native HANA backup and recovery features or third- party backup tools. Please refer to the standard OS, SAP, and SAP HANA documentation or the documentation provided by backup software vendors. In addition, backup schedules, frequency, and retention periods might vary with your system type and business requirements. See the following standard SAP documentation for guidance on these topics.

> **Note**
> For a discussion of both general and advanced backup and recovery concepts for SAP systems on AWS, see the SAP on AWS Backup and Recovery Guide.

SAP Note	Description
1642148	FAQ: SAP HANA Database Backup & Recovery
1821207	Determining required recovery files
1869119	Checking backups using hdbbackupcheck
1873247	Checking recoverability with hdbbackupdiag --check
1651055	Scheduling SAP HANA Database Backups in Linux
2484177	Scheduling backups for multi-tenant SAP HANA Cockpit 2.0

Creating an Image of an SAP HANA System

You can use the AWS Management Console or the command line to create your own AMI based on an existing instance. For more information, see the AWS documentation. You can use an AMI of your SAP HANA instance for the following purposes:

- **To create a full offline system backup** (of the OS /usr/sap, HANA shared, backup, data, and log files) – AMIs are automatically saved in multiple Availability Zones within the same AWS Region.
- **To move a HANA system from one AWS Region to another** – You can create an image of an existing EC2 instance and move it to another AWS Region by following the instructions in the AWS documentation. When the AMI has been copied to the target AWS Region, you can launch the new instance there.
- **To clone an SAP HANA system** – You can create an AMI of an existing SAP HANA system to create an exact clone of the system. See the next section for additional information.

Note

See Restoring SAP HANA Backups and Snapshots (p. 96) later in this whitepaper to view the recommended restoration steps for production environments.

Tip

The SAP HANA system should be in a consistent state before you create an AMI. To do this, stop the SAP HANA instance before creating the AMI or by following the instructions in SAP Note 1703435.

AWS Services and Components for Backup Solutions

AWS provides a number of services and options for storage and backup, including Amazon Simple Storage Service (Amazon S3), AWS Identity and Access Management (IAM), and S3 Glacier.

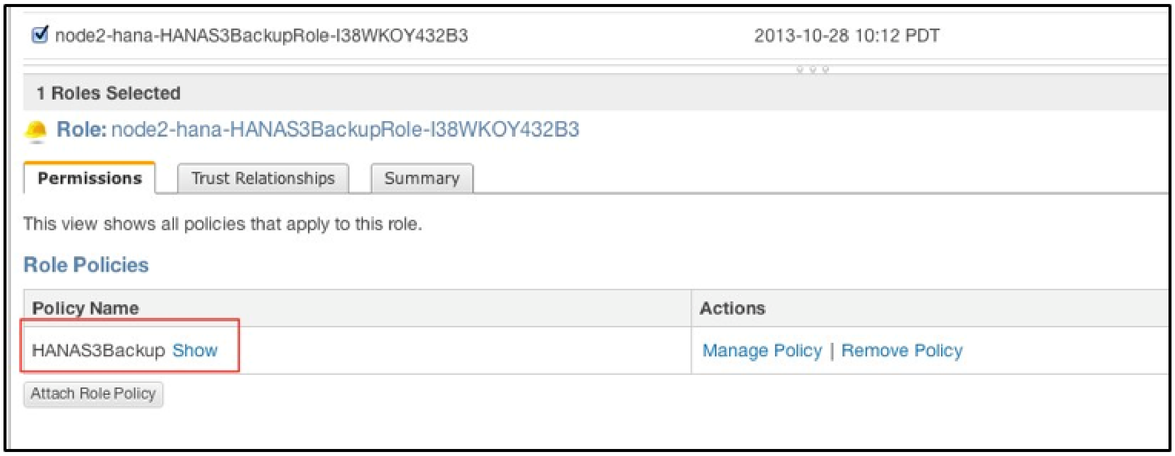
Amazon S3

Amazon S3 is the center of any SAP backup and recovery solution on AWS. It provides a highly durable storage infrastructure designed for mission-critical and primary data storage. It is designed to provide 99.999999999% durability and 99.99% availability over a given year. See the Amazon S3 documentation for detailed instructions on how to create and configure an S3 bucket to store your SAP HANA backup files.

IAM

With IAM, you can securely control access to AWS services and resources for your users. You can create and manage AWS users and groups and use permissions to grant user access to AWS resources. You can create roles in IAM and manage permissions to control which operations can be performed by the entity, or AWS service, that assumes the role. You can also define which entity is allowed to assume the role.

During the deployment process, AWS CloudFormation creates an IAM role that allows access to get objects from and/or put objects into Amazon S3. That role is subsequently assigned to each EC2 instance that is hosting SAP HANA master and worker nodes at launch time as they are deployed.



☑ node2-hana-HANAS3BackupRole-I38WKOY432B3 2013-10-28 10:12 PDT

1 Roles Selected

Role: node2-hana-HANAS3BackupRole-I38WKOY432B3

This view shows all policies that apply to this role.

Role Policies

Policy Name	Actions
HANAS3Backup Show	Manage Policy | Remove Policy

Figure 2: IAM role example

To ensure security that applies the principle of least privilege, permissions for this role are limited only to actions that are required for backup and recovery.

```
{"Statement":[
   {"Resource":"arn:aws:s3::: <your-s3-bucket-name>/*",
      "Action":["s3:GetObject","s3:PutObject","s3:DeleteObject",
"s3:ListBucket","s3:Get*","s3:List*"], "Effect":"Allow"},
{"Resource":"*","Action":["s3:List*","ec2:Describe*","ec2:Attach NetworkInterface",

"ec2:AttachVolume","ec2:CreateTags","ec2:CreateVolume","ec2:RunI nstances",
   "ec2:StartInstances"],"Effect":"Allow"}]}
```

To add functions later, you can use the AWS Management Console to modify the IAM role.

S3 Glacier

S3 Glacier is an extremely low-cost service that provides secure and durable storage for data archiving and backup. S3 Glacier is optimized for data that is infrequently accessed and provides multiple options such as expedited, standard, and bulk methods for data retrieval. With standard and bulk retrievals, data is available in 3-5 hours or 5-12 hours, respectively.

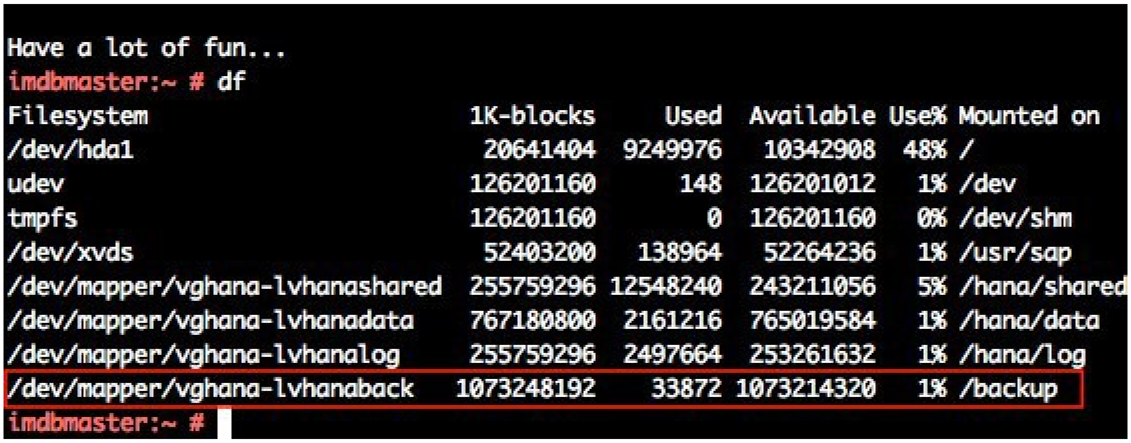
However, with expedited retrieval, S3 Glacier provides you with an option to retrieve data in 3-5 minutes, which can be ideal for occasional urgent requests. With S3 Glacier, you can reliably store large or small amounts of data for as little as $0.01 per gigabyte per month, a significant savings compared to on-premises solutions. You can use lifecycle policies, as explained in the *Amazon S3 Developer Guide*, to push SAP HANA backups to S3 Glacier for long-term archiving.

Backup Destination

The primary difference between backing up SAP systems on AWS compared with traditional on-premises infrastructure is the backup destination. Tape is the typical backup destination used with on-premises infrastructure. On AWS, backups are stored in Amazon S3. Amazon S3 has many benefits over tape, including the ability to automatically store backups offsite from the source system, since data in Amazon S3 is replicated across multiple facilities within the AWS Region.

SAP HANA systems provisioned by using the SAP HANA Quick Start reference deployment are configured with a set of EBS volumes to be used as an initial local backup destination. HANA backups are first stored on these local EBS volumes and then copied to Amazon S3 for long-term storage.

You can use SAP HANA Studio, SQL commands, or the DBA Cockpit to start or schedule SAP HANA data backups. Log backups are written automatically unless disabled. The /backup file system is configured as part of the deployment process.



```
Have a lot of fun...
imdbmaster:~ # df
Filesystem                       1K-blocks     Used  Available Use% Mounted on
/dev/hda1                         20641404  9249976   10342908  48% /
udev                             126201160      148  126201012   1% /dev
tmpfs                            126201160        0  126201160   0% /dev/shm
/dev/xvds                         52403200   138964   52264236   1% /usr/sap
/dev/mapper/vghana-lvhanashared  255759296 12548240  243211056   5% /hana/shared
/dev/mapper/vghana-lvhanadata    767180800  2161216  765019584   1% /hana/data
/dev/mapper/vghana-lvhanalog     255759296  2497664  253261632   1% /hana/log
/dev/mapper/vghana-lvhanaback   1073248192    33872 1073214320   1% /backup
imdbmaster:~ #
```

Figure 3: SAP HANA file system layout

The SAP HANA global.ini configuration file has been customized by the SAP HANA Quick Start reference deployment process as follows: database backups go directly to `/backup/data/<SID>`, while automatic log archival files go to `/backup/log/<SID>`.

```
[persistence]
basepath_shared = no
savepoint_intervals = 300
basepath_datavolumes = /hana/data/<SID>
basepath_logvolumes = /hana/log/<SID>
basepath_databackup = /backup/data/<SID>
basepath_logbackup = /backup/log/<SID>
```

Some third-party backup tools like Commvault, NetBackup, and IBM Tivoli Storage Manager (IBM TSM) are integrated with Amazon S3 capabilities and can be used to trigger and save SAP HANA backups directly into Amazon S3 without needing to store the backups on EBS volumes first.

AWS CLI

The AWS Command Line Interface (AWS CLI), which is a unified tool to manage AWS services, is installed as part of the base image. Using various commands, you can control multiple AWS services from the command line directly and automate them through scripts. Access to your S3 bucket is available through the IAM role assigned to the instance (as discussed earlier (p. 89)). Using the AWS CLI commands for Amazon S3, you can list the contents of the previously created bucket, back up files, and restore files, as explained in the AWS CLI documentation.

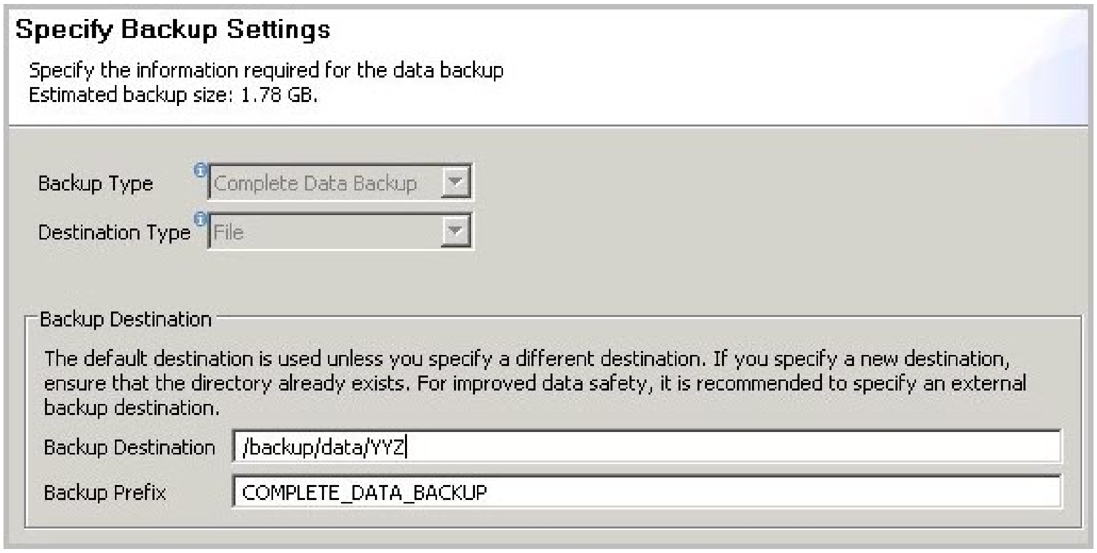
```
imdbmaster:/backup # aws s3 ls --region=us-east-1 s3://node2- hana-s3bucket-gcynh5v2nqs3

Bucket: node2-hana-s3bucket-gcynh5v2nqs3
Prefix:
      LastWriteTime      Length      Name
      -------------      ------      ----
```

Backup Example

Here are the steps you can take for a typical backup task:

1. In the SAP HANA Backup Editor, choose **Open Backup Wizard**. You can also open the Backup Wizard by right-clicking the system that you want to back up and choosing **Back Up**.

   1. Select the destination type **File**. This will back up the database to files in the specified file system.
   2. Specify the backup destination (`/backup/data/<SID>`) and the backup prefix.



Specify Backup Settings

Specify the information required for the data backup
Estimated backup size: 1.78 GB.

Backup Type: Complete Data Backup
Destination Type: File

Backup Destination

The default destination is used unless you specify a different destination. If you specify a new destination, ensure that the directory already exists. For improved data safety, it is recommended to specify an external backup destination.

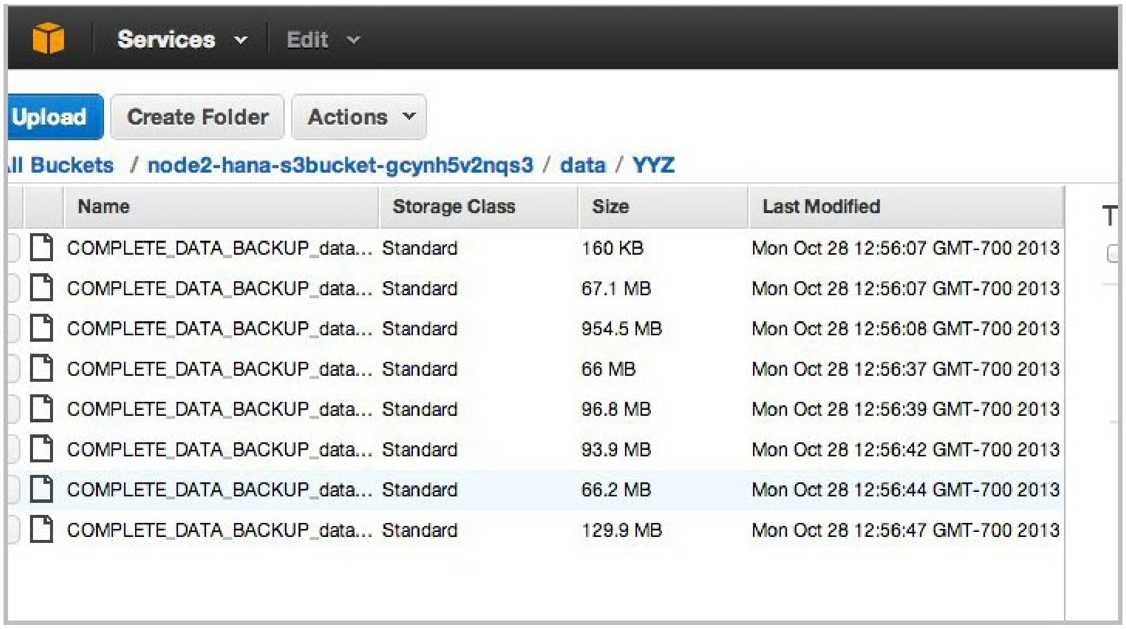
Backup Destination: /backup/data/YYZ
Backup Prefix: COMPLETE_DATA_BACKUP

Figure 4: SAP HANA backup example

3. Choose **Next** and then **Finish**. A confirmation message will appear when the backup is complete.
4. Verify that the backup files are available at the OS level. The next step is to push or synchronize the backup files from the /backup file system to Amazon S3 by using the aws s3 sync command.

```
imdbmaster:/ # aws s3 sync backup s3://node2-hana-s3bucket- gcynh5v2nqs3 --region=us-
east-1
```

2. Use the AWS Management Console to verify that the files have been pushed to Amazon S3. You can also use the aws s3 ls command shown previously in the AWS Command Line Interface section (p. 91).



Name	Storage Class	Size	Last Modified
COMPLETE_DATA_BACKUP_data...	Standard	160 KB	Mon Oct 28 12:56:07 GMT-700 2013
COMPLETE_DATA_BACKUP_data...	Standard	67.1 MB	Mon Oct 28 12:56:07 GMT-700 2013
COMPLETE_DATA_BACKUP_data...	Standard	954.5 MB	Mon Oct 28 12:56:08 GMT-700 2013
COMPLETE_DATA_BACKUP_data...	Standard	66 MB	Mon Oct 28 12:56:37 GMT-700 2013
COMPLETE_DATA_BACKUP_data...	Standard	96.8 MB	Mon Oct 28 12:56:39 GMT-700 2013
COMPLETE_DATA_BACKUP_data...	Standard	93.9 MB	Mon Oct 28 12:56:42 GMT-700 2013
COMPLETE_DATA_BACKUP_data...	Standard	66.2 MB	Mon Oct 28 12:56:44 GMT-700 2013
COMPLETE_DATA_BACKUP_data...	Standard	129.9 MB	Mon Oct 28 12:56:47 GMT-700 2013

Figure 5: Amazon S3 bucket contents after backup

Tip

The `aws s3 sync` command will only upload new files that don't exist in Amazon S3. Use a periodically scheduled `cron` job to sync, and then delete files that have been uploaded. See SAP Note 1651055 for scheduling periodic backup jobs in Linux, and extend the supplied scripts with `aws s3 sync` commands.

Scheduling and Executing Backups Remotely

You can use the AWS Systems Manager Run Command, along with Amazon CloudWatch Events, to schedule backups of your SAP HANA system remotely without the need to log in to the EC2 instances. You can also use `cron` or any other instance-level scheduling mechanism.

The Systems Manager Run Command lets you remotely and securely manage the configuration of your managed instances. A managed instance is any EC2 instance or on-premises machine in your hybrid environment that has been configured for Systems Manager. The Run Command enables you to automate common administrative tasks and perform ad hoc configuration changes at

scale. You can use the Run Command from the Amazon EC2 console, the AWS CLI, Windows PowerShell, or the AWS SDKs.

Systems Manager Prerequisites

Systems Manager has the following prerequisites.

Supported operating system (Linux)	Instances must run a supported version of Linux. 64-bit and 32-bit systems: • Amazon Linux 2014.09, 2014.03 or later • Ubuntu Server 16.04 LTS, 14.04 LTS, or 12.04 LTS • Red Hat Enterprise Linux (RHEL) 6.5 or later • CentOS 6.3 or later 64-bit systems only: • Amazon Linux 2015.09, 2015.03 or later • Red Hat Enterprise Linux (RHEL) 7.x or later • CentOS 7.1 or later • SUSE Linux Enterprise Server (SLES) 12 or higher For the latest information about supported operating systems, see the AWS Systems Manager documentation.
Roles for Systems Manager	Systems Manager requires an IAM role for instances that will process commands and a separate role for users who are executing commands. Both roles require permission policies that enable them to communicate with the Systems Manager API. You can choose to use Systems Manager managed policies or you can create your own roles and specify permissions. For more information, see Configuring Security Roles for Systems Manager in the AWS documentation. If you are configuring on-premises servers or virtual machines (VMs) that you want to configure using Systems Manager, you must also configure an IAM service role. For more information, see Create an IAM Service Role in the AWS documentation.
SSM Agent (EC2 Linux instances)	AWS Systems Manager Agent (SSM Agent) processes Systems Manager requests and configures your machine as specified in the request. You must download and install SSM Agent to your EC2 Linux instances. For more information, see Installing SSM Agent on Linux in the AWS documentation.

To schedule remote backups, follow these high-level steps:

1. Install and configure SSM Agent on the EC2 instance. For detailed installation steps, see the AWS Systems Manager documentation.
2. Provide SSM access to the EC2 instance role that is assigned to the SAP HANA instance. For detailed information on how to assign SSM access to a role, see the AWS Systems Manager documentation.
3. Create an SAP HANA backup script. You can use the following sample script as a starting point and modify it to meet your requirements.

```
#!/bin/sh
set -x
S3Bucket_Name=<Name of the S3 bucket where backup files will be copied>
TIMESTAMP=$(date +\%F\_%H\%M)
exec 1>/backup/data/${SAPSYSTEMNAME}/${TIMESTAMP}_backup_log.out 2>&1
echo "Starting to take backup of Hana Database and Upload the backup files to S3"
echo "Backup Timestamp for $SAPSYSTEMNAME is $TIMESTAMP" BACKUP_PREFIX=
${SAPSYSTEMNAME}_${TIMESTAMP}
echo $BACKUP_PREFIX
# source HANA environment
source $DIR_INSTANCE/hdbenv.sh
# execute command with user key
hdbsql -U BACKUP "backup data using file ('$BACKUP_PREFIX')" echo "HANA Backup is
 completed"
echo "Continue with copying the backup files in to S3" echo $BACKUP_PREFIX
sudo -u root /usr/local/bin/aws s3 cp --recursive
/backup/data/${SAPSYSTEMNAME}/ s3://${S3Bucket_Name}/bkps/${SAPSYSTEMNAME}/data/ --
exclude "*" --include "${BACKUP_PREFIX}*"
echo "Copying HANA Database log files in to S3"
sudo -u root /usr/local/bin/aws s3 sync
/backup/log/${SAPSYSTEMNAME}/ s3://${S3Bucket_Name}/bkps/${SAPSYSTEMNAME}/log/ --
exclude "*" --include "log_backup*"
sudo -u root /usr/local/bin/aws s3 cp
/backup/data/${SAPSYSTEMNAME}/${TIMESTAMP}_backup_log.out
s3://${S3Bucket_Name}/bkps/${SAPSYSTEMNAME}
```

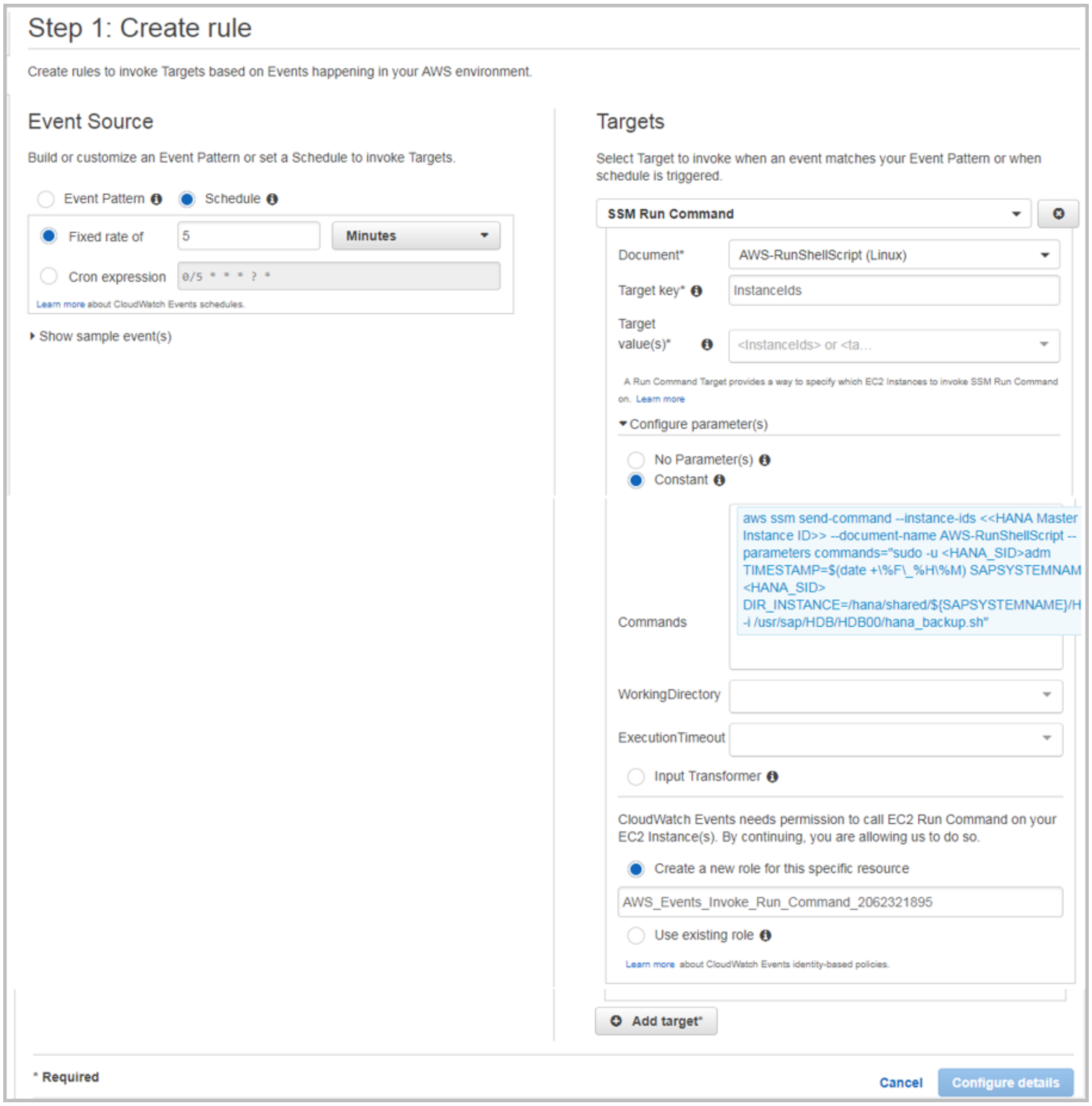
   Note
   This script takes into consideration that `hdbuserstore` has a key named `Backup`.

4. Test a one-time backup by executing an `ssm` command directly.

   Note
   For this command to execute successfully, you will have to enable `<sid>adm login` using `sudo`.

```
aws ssm send-command --instance-ids <HANA master instance ID> --document-name AWS-
RunShellScript
--parameters commands="sudo - u <HANA_SID>adm TIMESTAMP=$(date +\%F\_%H\%M)
 SAPSYSTEMNAME=<HANA_SID>
DIR_INSTANCE=/hana/shared/${SAPSYSTEMNAME}/HDB00 -i /usr/sap/HDB/HDB00/hana_backup.sh"
```

5. Using CloudWatch Events, you can schedule backups remotely at any desired frequency. Navigate to the CloudWatch Events page and create a rule.



Step 1: Create rule

Create rules to invoke Targets based on Events happening in your AWS environment.

Event Source

Build or customize an Event Pattern or set a Schedule to invoke Targets.

○ Event Pattern ● Schedule

● Fixed rate of 5 Minutes

○ Cron expression 0/5 * * * ? *

Learn more about CloudWatch Events schedules.

Show sample event(s)

Targets

Select Target to invoke when an event matches your Event Pattern or when schedule is triggered.

SSM Run Command

Document* AWS-RunShellScript (Linux)

Target key* InstanceIds

Target value(s)* <InstanceIds> or <ta...

A Run Command Target provides a way to specify which EC2 Instances to invoke SSM Run Command on. Learn more

Configure parameter(s)

○ No Parameter(s)
● Constant

Commands

```
aws ssm send-command --instance-ids <<HANA Master
Instance ID>> --document-name AWS-RunShellScript --
parameters commands="sudo -u <HANA_SID>adm
TIMESTAMP=$(date +\%F\_%H\%M) SAPSYSTEMNAM
<HANA_SID>
DIR_INSTANCE=/hana/shared/${SAPSYSTEMNAME}/H
-i /usr/sap/HDB/HDB00/hana_backup.sh"
```

WorkingDirectory

ExecutionTimeout

○ Input Transformer

CloudWatch Events needs permission to call EC2 Run Command on your EC2 Instance(s). By continuing, you are allowing us to do so.

● Create a new role for this specific resource

AWS_Events_Invoke_Run_Command_2062321895

○ Use existing role

Learn more about CloudWatch Events identity-based policies.

Figure 6: Creating Amazon CloudWatch Events rules

When configuring the rule:

1. Choose **Schedule**.
2. Select **SSM Run Command** as the target.
3. Select **AWS-RunShellScript (Linux)** as the document type.
4. Choose **InstanceIds** or **Tags** as the target key.
5. Choose **Constant** under **Configure Parameters**, and type the `run` command.

Restoring SAP HANA Backups and Snapshots

Restoring SAP Backups

To restore your SAP HANA database from a backup, perform the following steps:

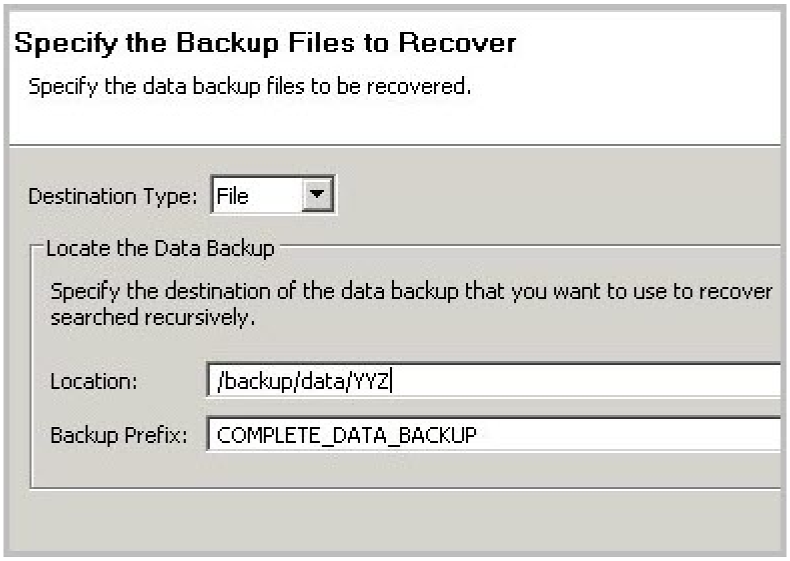
1. If the backup files are not already available in the /backup file system but are in Amazon S3, restore the files from Amazon S3 by using the aws s3 cp command. This command has the following syntax:

   ```
   aws --region <region> cp <s3-bucket/path> --recursive <backup- prefix>*.
   ```

   For example:

   ```
   imdbmaster:/backup/data/YYZ # aws --region us-east-1 s3 cp s3://node2-hana-s3bucket-
   gcynh5v2nqs3/data/YYZ . --recursive -- include COMPLETE*
   ```

2. Recover the SAP HANA database by using the Recovery Wizard as outlined in the SAP HANA Administration Guide. Specify **File** as the destination type and enter the correct backup prefix.

   Specify the Backup Files to Recover

   Specify the data backup files to be recovered.

   Destination Type: File

   Locate the Data Backup

   Specify the destination of the data backup that you want to use to recover
   searched recursively.

   Location: /backup/data/YYZ

   Backup Prefix: COMPLETE_DATA_BACKUP

   Figure 7: Restore example

3. When the recovery is complete, you can resume normal operations and clean up backup files from the `/backup/<SID>/*` directories.

Restoring EBS Snapshots

To restore EBS snapshots, perform the following steps:

1. Create a new volume from the snapshot:

   ```
   aws ec2 create-volume --region us-west-2 --availability-zone us- west-2a --snapshot-id
    snap-1234abc123a12345a --volume-type gp2
   ```

2. Attach the newly created volume to your EC2 host:

```
aws ec2 attach-volume --region=us-west-2 --volume-id vol- 4567c123e45678dd9 --instance-id i-03add123456789012 --device /dev/sdf
```

3. Mount the logical volume associated with SAP HANA data on the host:

```
mount /dev/sdf /hana/data
```

4. Start your SAP HANA instance.

Note
For large mission-critical systems, we highly recommend that you execute the volume initialization command on the database data and log volumes after restoring the AMI but before starting the database. Executing the volume initialization command will help you avoid extensive wait times before the database is available. Here is the sample `fio` command that you can use:

```
sudo fio -filename=/dev/xvdf -rw=read -bs=128K -iodepth=32 -
 ioengine=libaiodirect=1 -name=volume-initialize
```

For more information about initializing Amazon EBS volumes, see the AWS documentation.

Restoring AMI Snapshots

You can restore your SAP HANA AMI snapshots through the AWS Management Console. Open the Amazon EC2 console, and choose **AMIs** in the navigation pane.

Choose the AMI that you want to restore, expand **Actions**, and then choose **Launch**.

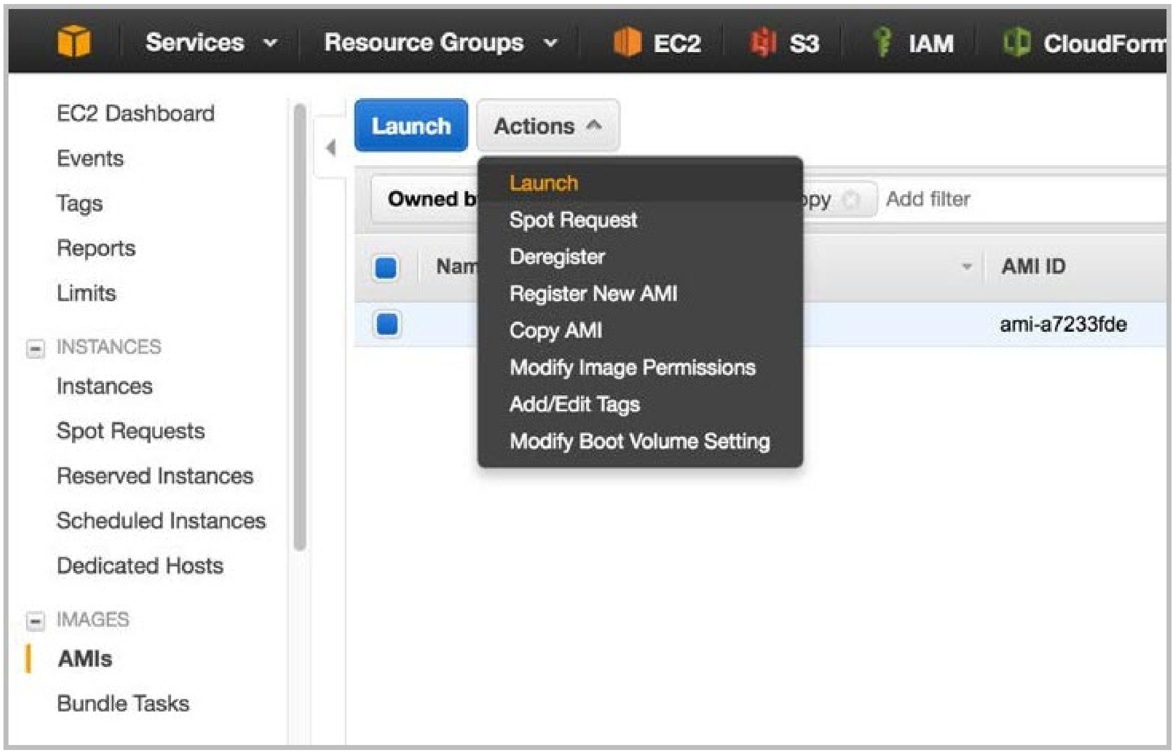


Figure 8: Restoring an AMI snapshot

Storage Configuration for SAP HANA

SAP HANA stores and processes all or most of its data in memory, and provides protection against data loss by saving the data in persistent storage locations. To achieve optimal performance, the storage solution used for SAP HANA data and log volumes should meet SAP's storage KPI. AWS has worked with SAP to certify both Amazon EBS General Purpose SSD (`gp2` and `gp3`) and Provisioned IOPS SSD (`io1` and `io2`) storage solutions for SAP HANA workloads.

`gp2` and `gp3` volumes balance price and performance for a variety of workloads, while `io1` and `io2` volumes provide the highest performance for mission-critical applications. From these options, you can choose the best storage solution that meets your performance and cost requirements. We recommend the `io2` configuration for mission-critical SAP HANA production workloads.

Note that only the following instances are certified for production use: `r3.8xlarge`, `r4.8xlarge`, `r4.16xlarge`, `r5.8xlarge`, `r5.12xlarge`, `r5.16xlarge`, `r5.24xlarge`, `r5.metal`, `r5b.8xlarge`, `r5b.12xlarge`, `r5b.16xlarge`, `r5b.24xlarge`, `r5b.metal`, `x1.16xlarge`, `x1.32xlarge`, `x1e.32xlarge`, `u-6tb1.56xlarge`, `u-6tb1.112xlarge`, `u-9tb1.112xlarge`, `u-12tb1.112xlarge`, `u-6tb1.metal`, `u-9tb1.metal`, `u-12tb1.metal`, `u-18tb1.metal`, and `u-24tb1.metal`. For nonproduction use, all of the instance types in this guide are supported.

For multinode deployments, storage volumes for SAP HANA data and logs are provisioned in the master and worker nodes.

In the following configurations, we intentionally kept the same storage configuration for SAP HANA data and log volumes for all R3, certain R4 and R5, and smaller X1e instance types so you can scale up from smaller instances to larger instances without having to reconfigure your storage.

gp2 for HANA data

Instance type	Memory (GiB)	vCPUs / logical processors*	General Purpose SSD (gp2) storage for SAP HANA data (striped with LVM)	Total maximum throughput (MiB/s)	Total baseline IOPS	Total burst IOPS
Certified for production use						
u-24tb1.metal	24,576	448	6 x 4,800 GiB	1,500	86,400	N/A
u-18tb1.metal	18,432	448	6 x 3,600 GiB	1,500	64,800	N/A
u-12tb1.112xlarge	12,288	448	6 x 2,400 GiB	1,500	43,200	N/A
u-12tb1.metal	12,288	448	6 x 2,400 GiB	1,500	43,200	N/A
u-9tb1.112xlarge	9,216	448	6 x 1,800 GiB	1,500	32,400	N/A
u-9tb1.metal	9,216	448	6 x 1,800 GiB	1,500	32,400	N/A

Instance type	Memory (GiB)	vCPUs / logical processors*	General Purpose SSD (gp2) storage for SAP HANA data (striped with LVM)	Total maximum throughput (MiB/s)	Total baseline IOPS	Total burst IOPS
u-6tb1.112xlarge	6,144	448	6 x 1,200 GiB	1,500	21,600	N/A
u-6tb1.56xlarge	6,144	224	6 x 1,200 GiB	1,500	21,600	N/A
u-6tb1.metal	6,144	448	6 x 1,200 GiB	1,500	21,600	N/A
x1e.32xlarge	3,904	128	3 x 1,600 GiB	750	14,400	N/A
x1.32xlarge	1,952	128	3 x 800 GiB	750	7,200	9,000
x1.16xlarge	976	64	3 x 400 GiB	750	3,600	9,000
r5.metal	768	96	3 x 400 GiB	750	3,600	9,000
r5b.metal	768	96	3 x 400 GiB	750	3,600	9,000
r5.24xlarge	768	96	3 x 400 GiB	750	3,600	9,000
r5b.24xlarge	768	96	3 x 400 GiB	750	3,600	9,000
r5.16xlarge	512	64	3 x 225 GiB	750	2,025	9,000
r5b.16xlarge	512	64	3 x 225 GiB	750	2,025	9,000
r4.16xlarge	488	64	3 x 225 GiB	750	2,025	9,000
r5.12xlarge	384	48	3 x 225 GiB	750	2,025	9,000
r5b.12xlarge	384	48	3 x 225 GiB	750	2,025	9,000
r5.8xlarge	256	32	3 x 225 GiB	750	2,025	9,000
r5b.8xlarge	256	32	3 x 225 GiB	750	2,025	9,000
r4.8xlarge	244	32	3 x 225 GiB	750	2,025	9,000
r3.8xlarge						
Supported for nonproduction use only						
x1e.4xlarge	488	16	3 x 225 GiB	750**	2,025	9,000
x1e.2xlarge	244	8	3 x 225 GiB	750**	2,025	9,000
x1e.xlarge	122	4	3 x 225 GiB	750**	2,025	9,000
r5.4xlarge	128	16	3 x 225 GiB	750**	2,025	9,000
r5b.4xlarge	128	16	3 x 225 GiB	750**	2,025	9,000

Instance type	Memory (GiB)	vCPUs / logical processors*	General Purpose SSD (gp2) storage for SAP HANA data (striped with LVM)	Total maximum throughput (MiB/s)	Total baseline IOPS	Total burst IOPS
r5.2xlarge	64	8	3 x 225 GiB	750**	2,025	9,000
r5b.2xlarge	64	8	3 x 225 GiB	750**	2,025	9,000
r4.4xlarge	122	16	3 x 225 GiB	750**	2,025	9,000
r3.4xlarge						
r4.2xlarge	61	8	3 x 225 GiB	750**	2,025	9,000
r3.2xlarge						

* Each logical processor offered by Amazon EC2 High Memory Instances is a hyperthread on a physical CPU core.

** This value represents the maximum throughput that could be achieved when striping multiple EBS volumes. Actual throughput depends on the instance type. Every instance type has its own Amazon EBS throughput maximum. For details, see Amazon EBS-Optimized Instances in the AWS documentation.

***gp3 based configurations are only supported in production for Nitro based instances, not for Xen based instances.

gp2 for HANA logs

Instance type	Memory (GiB)	vCPUs / logical processors*	General Purpose SSD (gp2) storage for SAP HANA logs(striped with LVM)	Total maximum throughput (MiB/s)	Total baseline IOPS	Total burst IOPS
Certified for production use						
u-24tb1.metal	24,576	448	2 x 300 GiB	500	1,800	6,000
u-18tb1.metal	18,432	448	2 x 300 GiB	500	1,800	6,000
u-12tb1.112xlarge	12,288	448	2 x 300 GiB	500	1,800	6,000
u-12tb1.metal	12,288	448	2 x 300 GiB	500	1,800	6,000
u-9tb1.112xlarge	9,216	448	2 x 300 GiB	500	1,800	6,000
u-9tb1.metal	9,216	448	2 x 300 GiB	500	1,800	6,000
u-6tb1.112xlarge	6,144	448	2 x 300 GiB	500	1,800	6,000
u-6tb1.56xlarge	6,144	224	2 x 300 GiB	500	1,800	6,000

Instance type	Memory (GiB)	vCPUs / logical processors*	General Purpose SSD (gp2) storage for SAP HANA logs(striped with LVM)	Total maximum throughput (MiB/s)	Total baseline IOPS	Total burst IOPS
u-6tb1.metal	6,144	448	2 x 300 GiB	500	1,800	6,000
x1e.32xlarge	3,904	128	2 x 300 GiB	500	1,800	6,000
x1.32xlarge	1,952	128	2 x 300 GiB	500	1,800	6,000
x1.16xlarge	976	64	2 x 300 GiB	500	1,800	6,000
r5.metal	768	96	2 x 300 GiB	500	1,800	6,000
r5b.metal	768	96	2 x 300 GiB	500	1,800	6,000
r5.24xlarge	768	96	2 x 300 GiB	500	1,800	6,000
r5b.24xlarge	768	96	2 x 300 GiB	500	1,800	6,000
r5.16xlarge	512	64	2 x 300 GiB	500	1,800	6,000
r5b.16xlarge	512	64	2 x 300 GiB	500	1,800	6,000
r4.16xlarge	488	64	2 x 300 GiB	500	1,800	6,000
r5.12xlarge	384	48	2 x 300 GiB	500	1,800	6,000
r5b.12xlarge	384	48	2 x 300 GiB	500	1,800	6,000
r5.8xlarge	256	32	2 x 300 GiB	500	1,800	6,000
r5b.8xlarge	256	32	2 x 300 GiB	500	1,800	6,000
r4.8xlarge	244	32	2 x 300 GiB	500	1,800	6,000
r3.8xlarge						
Supported for nonproduction use only						
x1e.4xlarge	488	16	2 x 175 GiB	500**	1,050	6,000
x1e.2xlarge	244	8	2 x 175 GiB	500**	1,050	6,000
x1e.xlarge	122	4	2 x 175 GiB	500**	1,050	6,000
r5.4xlarge	128	16	2 x 175 GiB	500**	1,050	6,000
r5b.4xlarge	128	16	2 x 175 GiB	500**	1,050	6,000
r5.2xlarge	64	8	2 x 175 GiB	500**	1,050	6,000
r5b.2xlarge	64	8	2 x 175 GiB	500**	1,050	6,000
r4.4xlarge	122	16	2 x 175 GiB	500**	1,050	6,000
r3.4xlarge						
r4.2xlarge	61	8	2 x 175 GiB	500**	1,050	6,000

Instance type	Memory (GiB)	vCPUs / logical processors*	General Purpose SSD (gp2) storage for SAP HANA logs(striped with LVM)	Total maximum throughput (MiB/s)	Total baseline IOPS	Total burst IOPS
r3.2xlarge						

* Each logical processor offered by Amazon EC2 High Memory Instances is a hyperthread on a physical CPU core.

** This value represents the maximum throughput that could be achieved when striping multiple EBS volumes. Actual throughput depends on the instance type. Every instance type has its own Amazon EBS throughput maximum. For details, see Amazon EBS-Optimized Instances in the AWS documentation.

***gp3 based configurations are only supported in production for Nitro based instances, not for Xen based instances.

gp3 for HANA data

Instance type	Memory (GiB)	vCPUs / logical processors*	General Purpose SSD (gp3) storage for SAP HANA data(stripe with LVM)	Configured throughput per volume (MiB/s)	Configured IOPS per volume	Total throughput (MiB/s)	Total IOPS
Certified for production use							
u-24tb1.metal	24,576	448	2 x 14,400 GiB	1,000	9,000	2,000	18,000
u-18tb1.metal	18,432	448	2 x 10,800 GiB	1,000	9,000	2,000	18,000
u-12tb1.112xlarge	12,288	448	2 x 7,200 GiB	1,000	6,000	2,000	12,000
u-12tb1.metal	12,228	448	2 x 7,200 GiB	1,000	6,000	2,000	12,000
u-9tb1.112xlarge	9,216	448	2 x 5,400 GiB	1,000	6,000	2,000	12,000
u-9tb1.metal	9,216	448	2 x 5,400 GiB	1,000	6,000	2,000	12,000
u-6tb1.112xlarge	6,144	448	2 x 3,600 GiB	1,000	6,000	2,000	12,000
u-6tb1.56xlarge	6,144	224	2 x 3,600 GiB	1,000	6,000	2,000	12,000

Instance type	Memory (GiB)	vCPUs / logical processors*	General Purpose SSD (gp3) storage for SAP HANA data(stripe with LVM)	Configured throughput per volume (MiB/s)	Configured IOPS per volume	Total throughput (MiB/s)	Total IOPS
u-6tb1.metal	6,114	448	2 x 3,600 GiB	1,000	6,000	2,000	12,000
x1e.32xlarge ***	3,904	128	2 x 2,400 GiB	750	4,500	1,500	9,000
x1.32xlarge***	1,952	128	2 x 1,200 GiB	750	4,500	1,500	9,000
x1.16xlarge***	976	64	1 x 1,200 GiB	500	7,500	500	7,500
r5.metal	768	96	1 x 920 GiB	500	7,500	500	7,500
r5b.metal	768	96	1 x 920 GiB	500	7,500	500	7,500
r5.24xlarge	768	96	1 x 920 GiB	500	7,500	500	7,500
r5b.24xlarge	768	96	1 x 920 GiB	500	7,500	500	7,500
r5.16xlarge	512	64	1 x 615 GiB	500	7,500	500	7,500
r5b.16xlarge	512	64	1 x 615 GiB	500	7,500	500	7,500
r4.16xlarge ***	488	64	1 x 585 GiB	500	7,500	500	7,500
r5.12xlarge	384	48	1 x 460 GiB	500	7,500	500	7,500
r5b.12xlarge	384	48	1 x 460 GiB	500	7,500	500	7,500
r5.8xlarge	256	32	1 x 320 GiB	500	7,500	500	7,500
r5b.8xlarge	256	32	1 x 320 GiB	500	7,500	500	7,500
r4.8xlarge ***	244	32	1 x 300 GiB	500	7,500	500	7,500
r3.8xlarge***							
Supported for nonproduction use only							

Instance type	Memory (GiB)	vCPUs / logical processors*	General Purpose SSD (gp3) storage for SAP HANA data(stripe with LVM)	Configured throughput per volume (MiB/s)	Configured IOPS per volume	Total throughput (MiB/s)	Total IOPS
x1e.4xlarge	488	16	1 x 585 GiB	125	3,000	125	3,000
x1e.2xlarge	244	8	1 x 295 GiB	125	3,000	125	3,000
x1e.xlarge	122	4	1 x 150 GiB	125	3,000	125	3,000
r5.4xlarge	128	16	1 x 150 GiB	256	3,000	256	3,000
r5b.4xlarge	128	16	1 x 150 GiB	256	3,000	256	3,000
r5.2xlarge	64	8	1 x 80 GiB	125	3,000	125	3,000
r5b.2xlarge	64	8	1 x 80 GiB	125	3,000	125	3,000
r4.4xlarge	122	16	1 x 150 GiB	256	3,000	256	3,000
r3.4xlarge							
r4.2xlarge	61	8	1 x 80 GiB	125	3,000	125	3,000
r3.2xlarge							

* Each logical processor offered by Amazon EC2 High Memory Instances is a hyperthread on a physical CPU core.

** This value represents the maximum throughput that could be achieved when striping multiple EBS volumes. Actual throughput depends on the instance type. Every instance type has its own Amazon EBS throughput maximum. For details, see Amazon EBS-Optimized Instances in the AWS documentation.

***gp3 based configurations are only supported in production for Nitro based instances, not for Xen based instances.

gp3 for HANA logs

Instance type	Memory (GiB)	vCPUs / logical processors*	General Purpose SSD (gp3) storage for SAP HANA data (striped with LVM)	Configured throughput per volume (MiB/s)	Configured IOPS per volume	Total throughput (MiB/s)	Total IOPS
Certified for production use							
u-24tb1.metal	24,576	448	1 x 512 GiB	500	3,000	500	3,000
u-18tb1.metal	18,432	448	1 x 512 GiB	500	3,000	500	3,000
u-12tb1.112xlarge	12,228	448	1 x 512 GiB	500	3,000	500	3,000
u-12tb1.metal	12,228	448	1 x 512 GiB	500	3000	500	3,000
u-9tb1.112xlarge	9,216	448	1 x 512 GiB	300	3,000	300	3,000
u-9tb1.metal	9,216	448	1 x 512 GiB	300	3,000	300	3,000
u-6tb1.112xlarge	6,114	448	1 x 512 GiB	300	3,000	300	3,000
u-6tb1.56xlarge	6,114	224	1 x 512 GiB	300	3,000	300	3,000
u-6tb1.metal	6,114	448	1 x 512 GiB	300	3,000	300	3,000
x1e.32xlarge ***	3,904	128	1 x 512 GiB	300	3,000	300	3,000
x1.32xlarge**	1,952	128	1 x 512 GiB	300	3,000	300	3,000
x1.16xlarge**	976	64	1 x 512 GiB	300	3,000	300	3,000
r5.metal	768	96	1 x 512 GiB	300	3,000	300	3,000
r5b.metal	768	96	1 x 512 GiB	300	3,000	300	3,000
r5.24xlarge	768	96	1 x 512 GiB	300	3,000	300	3,000

Instance type	Memory (GiB)	vCPUs / logical processors*	General Purpose SSD (gp3) storage for SAP HANA data (striped with LVM)	Configured throughput per volume (MiB/s)	Configured IOPS per volume	Total throughput (MiB/s)	Total IOPS
r5b.24xlarge	768	96	1 x 512 GiB	300	3,000	300	3,000
r5.16xlarge	512	64	1 x 256 GiB	300	3,000	300	3,000
r5b.16xlarge	512	64	1 x 256 GiB	300	3,000	300	3,000
r4.16xlarge ***	488	64	1 x 256 GiB	300	3,000	300	3,000
r5.12xlarge	384	48	1 x 192 GiB	300	3,000	300	3,000
r5b.12xlarge	384	48	1 x 192 GiB	300	3,000	300	3,000
r5.8xlarge	256	32	1 x 128 GiB	300	3,000	300	3,000
r5b.8xlarge	256	32	1 x 128 GiB	300	3,000	300	3,000
r4.8xlarge ***	244	32	1 x 128 GiB	300	3,000	300	3,000
r3.8xlarge***							
Supported for nonproduction use only							
x1e.4xlarge	488	16	1 x 245 GiB	125	3,000	125	3,000
x1e.2xlarge	244	8	1 x 125 GiB	125	3,000	125	3,000
x1e.xlarge	122	4	1 x 64 GiB	125	3,000	125	3,000
r5.4xlarge	128	16	1 x 64 GiB	125	3,000	125	3,000
r5b.4xlarge	128	16	1 x 64 GiB	125	3,000	125	3,000
r5.2xlarge	64	8	1 x 32 GiB	125	3,000	125	3,000
r5b.2xlarge	64	8	1 x 32 GiB	125	3,000	125	3,000
r4.4xlarge	122	16	1 x 64 GiB	125	3,000	125	3,000
r3.4xlarge							

Instance type	Memory (GiB)	vCPUs / logical processors*	General Purpose SSD (gp3) storage for SAP HANA data (striped with LVM)	Configured throughput per volume (MiB/s)	Configured IOPS per volume	Total throughput (MiB/s)	Total IOPS
r4.2xlarge	61	8	1 x 32 GiB	125	3,000	125	3,000
r3.2xlarge							

* Each logical processor offered by Amazon EC2 High Memory Instances is a hyperthread on a physical CPU core.

** This value represents the maximum throughput that could be achieved when striping multiple EBS volumes. Actual throughput depends on the instance type. Every instance type has its own Amazon EBS throughput maximum. For details, see Amazon EBS-Optimized Instances in the AWS documentation.

***gp3 based configurations are only supported in production for Nitro based instances, not for Xen based instances.

io1/io2 for HANA data

Instance type	Memory (GiB)	vCPUs / logical processors*	Provisioned IOPS SSD (io1/io2) storage for SAP HANA data (striped with LVM)	Total maximum throughput (MiB/s)	Total provisioned IOPS
Certified for production use					
u-24tb1.metal	24,576	448	6 x 4,800 GiB	3,000	18,000
u-18tb1.metal	18,432	448	6 x 3,600 GiB	3,000	18,000
u-12tb1.112xlarge	12,288	448	6 x 2,400 GiB	3,000	12,000
u-12tb1.metal	12,288	448	6 x 2,400 GiB	3,000	12,000
u-9tb1.112xlarge	9,216	448	6 x 1,800 GiB	3,000	12,000
u-9tb1.metal	9,216	448	6 x 1,800 GiB	3,000	12,000
u-6tb1.112xlarge	6,144	448	6 x 1,200 GiB	3,000	12,000
u-6tb1.56xlarge	6,144	224	6 x 1,200 GiB	3,000	12,000
u-6tb1.metal	6,144	448	6 x 1,200 GiB	3,000	12,000
x1e.32xlarge	3,904	128	3 x 1,600 GiB	1,500	9,000
x1.32xlarge	1,952	128	3 x 800 GiB	1,500	9,000

Instance type	**Memory (GiB)**	**vCPUs / logical processors***	**Provisioned IOPS SSD (`io1/io2`) storage for SAP HANA data (striped with LVM)**	**Total maximum throughput (MiB/s)**	**Total provisioned IOPS**
x1.16xlarge	976	64	1 x 1,200 GiB	500	7,500
r5.metal	768	96	1 x 1,200 GiB	500	7,500
r5b.metal	768	96	1 x 1,200 GiB	500	7,500
r5.24xlarge	768	96	1 x 1,200 GiB	500	7,500
r5b.24xlarge	768	96	1 x 1,200 GiB	500	7,500
r5.16xlarge	512	64	1 x 600 GiB	500	7,500
r5b.16xlarge	512	64	1 x 600 GiB	500	7,500
r4.16xlarge	488	64	1 x 600 GiB	500	7,500
r5.12xlarge	384	48	1 x 600 GiB	500	7,500
r5b.12xlarge	384	48	1 x 600 GiB	500	7,500
r5b.8xlarge	256	32	1 x 300 GiB	500	7,500
r5.8xlarge	256	32	1 x 300 GiB	500	7,500
r4.8xlarge	244	32	1 x 300 GiB	500	7,500
r3.8xlarge					
Supported for nonproduction use only					
x1e.4xlarge	488	16	1 x 600 GiB	500**	2,000
x1e.2xlarge	244	8	1 x 300 GiB	500**	2,000
x1e.xlarge	122	4	1 x 300 GiB	500**	2,000
r5.4xlarge	128	16	1 x 300 GiB	500**	2,000
r5b.4xlarge	128	16	1 x 300 GiB	500**	2,000
r5.2xlarge	64	8	1 x 300 GiB	500**	2,000
r5b.2xlarge	64	8	1 x 300 GiB	500**	2,000
r4.4xlarge	122	16	1 x 300 GiB	500**	2,000
r3.4xlarge					
r4.2xlarge	61	8	1 x 300 GiB	500**	2,000
r3.2xlarge					

* Each logical processor offered by Amazon EC2 High Memory Instances is a hyperthread on a physical CPU core.

** This value represents the maximum throughput that could be achieved when striping multiple EBS volumes. Actual throughput depends on the instance type. Every instance type has its own Amazon EBS throughput maximum. For details, see Amazon EBS-Optimized Instances in the AWS documentation.

***gp3 based configurations are only supported in production for Nitro based instances, not for Xen based instances.

io1/io2 for HANA logs

Instance type	Memory (GiB)	vCPUs / logical processors*	Provisioned IOPS SSD (`io1/io2`) storage for SAP HANA logs (striped with LVM)	Total maximum throughput (MiB/s)	Total provisioned IOPS
Certified for production use					
u-24tb1.metal	24,576	448	1 x 525 GiB	500	2,000
u-18tb1.metal	18,432	448	1 x 525 GiB	500	2,000
u-12tb1.112xlarge	12,288	448	1 x 525 GiB	500	2,000
u-12tb1.metal	12,288	448	1 x 525 GiB	500	2,000
u-9tb1.metal	9,216	448	1 x 525 GiB	500	2,000
u-9tb1.112xlarge	9,216	448	1 x 525 GiB	500	2,000
u-6tb1.metal	6,144	448	1 x 525 GiB	500	2,000
u-6tb1.112xlarge	6,144	448	1 x 525 GiB	500	2,000
u-6tb1.56xlarge	6,144	224	1 x 525 GiB	500	2,000
x1e.32xlarge	3,904	128	1 x 525 GiB	500	2,000
x1.32xlarge	1,952	128	1 x 525 GiB	500	2,000
x1.16xlarge	976	64	1 x 525 GiB	500	2,000
r5.metal	768	96	1 x 525 GiB	500	2,000
r5b.metal	768	96	1 x 525 GiB	500	2,000
r5.24xlarge	768	96	1 x 525 GiB	500	2,000
r5b.24xlarge	768	96	1 x 525 GiB	500	2,000
r5.16xlarge	512	64	1 x 260 GiB	500	2,000
r5b.16xlarge	512	64	1 x 260 GiB	500	2,000
r4.16xlarge	488	64	1 x 260 GiB	500	2,000
r5.12xlarge	384	48	1 x 260 GiB	500	2,000

Instance type	Memory (GiB)	vCPUs / logical processors*	Provisioned IOPS SSD (`io1`/`io2`) storage for SAP HANA logs (striped with LVM)	Total maximum throughput (MiB/s)	Total provisioned IOPS
r5b.12xlarge	384	48	1 x 260 GiB	500	2,000
r5.8xlarge	256	32	1 x 260 GiB	500	2,000
r5b.8xlarge	256	32	1 x 260 GiB	500	2,000
r4.8xlarge	244	32	1 x 260 GiB	500	2,000
r3.8xlarge					
Supported for nonproduction use only					
x1e.4xlarge	488	16	1 x 260 GiB	500**	1,000
x1e.2xlarge	244	8	1 x 260 GiB	500**	1,000
x1e.xlarge	122	4	1 x 260 GiB	500**	1,000
r5.4xlarge	128	16	1 x 260 GiB	500**	1,000
r5b.4xlarge	128	16	1 x 260 GiB	500**	1,000
r5.2xlarge	64	8	1 x 260 GiB	500**	1,000
r5b.2xlarge	64	8	1 x 260 GiB	500**	1,000
r4.4xlarge	122	16	1 x 260 GiB	500**	1,000
r3.4xlarge					
r4.2xlarge	61	8	1 x 260 GiB	500**	1,000
r3.2xlarge					

* Each logical processor offered by Amazon EC2 High Memory Instances is a hyperthread on a physical CPU core.

** This value represents the maximum achievable throughput when striping multiple EBS volumes. Actual throughput depends on the instance type. Every instance type has its own Amazon EBS throughput maximum. For more information, see Amazon EBS-Optimized Instances.

***gp3 based configurations are only supported in production for Nitro based instances, not for Xen based instances.

In addition to the SAP HANA data and log volumes, we recommend the following storage configuration for root, SAP binaries, and SAP HANA shared and backup volumes:

Instance type	Memory (GiB)	vCPUs / logical processors*	Root volume (`gp2`/`gp3`)	SAP binaries (`gp2`/`gp3`)	SAP HANA shared** (`gp2`/`gp3`)	SAP HANA backup*** (`st1`)
Certified for production use						
u-24tb1.metal	24,576	448	1 x 50 GiB	1 x 50 GiB	1 x 1,024 GiB	2 x 16,384 GiB
u-18tb1.metal	18,432	448	1 x 50 GiB	1 x 50 GiB	1 x 1,024 GiB	2 x 16,384 GiB
u-12tb1.112xlarge	12,288	448	1 x 50 GiB	1 x 50 GiB	1 x 1,024 GiB	1 x 16,384 GiB
u-12tb1.metal	12,288	448	1 x 50 GiB	1 x 50 GiB	1 x 1,024 GiB	1 x 16,384 GiB
u-9tb1.112xlarge	9,216	448	1 x 50 GiB	1 x 50 GiB	1 x 1,024 GiB	1 x 16,384 GiB
u-9tb1.metal	9,216	448	1 x 50 GiB	1 x 50 GiB	1 x 1,024 GiB	1 x 16,384 GiB
u-6tb1.metal	6,144	448	1 x 50 GiB	1 x 50 GiB	1 x 1,024 GiB	1 x 12,288 GiB
u-6tb1.112xlarge	6,144	448	1 x 50 GiB	1 x 50 GiB	1 x 1,024 GiB	1 x 12,288 GiB
u-6tb1.56xlarge	6,144	224	1 x 50 GiB	1 x 50 GiB	1 x 1,024 GiB	1 x 12,288 GiB
x1e.32xlarge	3,904	128	1 x 50 GiB	1 x 50 GiB	1 x 1,024 GiB	1 x 8,192 GiB
x1.32xlarge	1,952	128	1 x 50 GiB	1 x 50 GiB	1 x 1,024 GiB	1 x 4,096 GiB
x1.16xlarge	976	64	1 x 50 GiB	1 x 50 GiB	1 x 1,024 GiB	1 x 2,048 GiB
r5.metal	768	96	1 x 50 GiB	1 x 50 GiB	1 x 1,024 GiB	1 x 2,048 GiB
r5b.metal	768	96	1 x 50 GiB	1 x 50 GiB	1 x 1,024 GiB	1 x 2,048 GiB
r5.24xlarge	768	96	1 x 50 GiB	1 x 50 GiB	1 x 1,024 GiB	1 x 2,048 GiB
r5b.24xlarge	768	96	1 x 50 GiB	1 x 50 GiB	1 x 1,024 GiB	1 x 2,048 GiB
r5.16xlarge	512	64	1 x 50 GiB	1 x 50 GiB	1 x 512 GiB	1 x 1,024 GiB
r5b.16xlarge	512	64	1 x 50 GiB	1 x 50 GiB	1 x 512 GiB	1 x 1,024 GiB

Instance type	Memory (GiB)	vCPUs / logical processors*	Root volume (`gp2`/`gp3`)	SAP binaries (`gp2`/`gp3`)	SAP HANA shared** (`gp2`/`gp3`)	SAP HANA backup*** (`st1`)
r4.16xlarge	488	64	1 x 50 GiB	1 x 50 GiB	1 x 512 GiB	1 x 1,024 GiB
r5.12xlarge	384	48	1 x 50 GiB	1 x 50 GiB	1 x 512 GiB	1 x 1,024 GiB
r5b.12xlarge	384	48	1 x 50 GiB	1 x 50 GiB	1 x 512 GiB	1 x 1,024 GiB
r5.8xlarge	256	32	1 x 50 GiB	1 x 50 GiB	1 x 300 GiB	1 x 1,024 GiB
r5b.8xlarge	256	32	1 x 50 GiB	1 x 50 GiB	1 x 300 GiB	1 x 1,024 GiB
r4.8xlarge	244	32	1 x 50 GiB	1 x 50 GiB	1 x 300 GiB	1 x 1,024 GiB
r3.8xlarge						
Supported for nonproduction use only						
x1e.4xlarge	488	16	1 x 50 GiB	1 x 50 GiB	1 x 512 GiB	1 x 1,024 GiB
x1e.2xlarge	244	8	1 x 50 GiB	1 x 50 GiB	1 x 300 GiB	1 x 512 GiB
x1e.xlarge	122	4	1 x 50 GiB	1 x 50 GiB	1 x 300 GiB	1 x 512 GiB
r5.4xlarge	128	16	1 x 50 GiB	1 x 50 GiB	1 x 300 GiB	1 x 512 GiB
r5b.4xlarge	128	16	1 x 50 GiB	1 x 50 GiB	1 x 300 GiB	1 x 512 GiB
r5.2xlarge	64	8	1 x 50 GiB	1 x 50 GiB	1 x 300 GiB	1 x 512 GiB
r5b.2xlarge	64	8	1 x 50 GiB	1 x 50 GiB	1 x 300 GiB	1 x 512 GiB
r4.4xlarge	122	16	1 x 50 GiB	1 x 50 GiB	1 x 300 GiB	1 x 512 GiB
r3.4xlarge						
r4.2xlarge	61	8	1 x 50 GiB	1 x 50 GiB	1 x 300 GiB	1 x 512 GiB
r3.2xlarge						

* Each logical processor offered by Amazon EC2 High Memory Instances is a hyperthread on a physical CPU core.

** In a multinode architecture, the SAP HANA NFS shared volume is provisioned only once on the master node.

*** In a multinode architecture, the SAP HANA backup volume can be deployed as NFS or Amazon EFS. The size of the SAP HANA NFS backup volume is multiplied by the number of nodes. The SAP HANA backup volume is provisioned only once on the master node, and NFS is mounted on the worker nodes. There is no provision needed for Amazon EFS as it is built to scale on demand, growing and shrinking automatically as files are added and removed.

General Purpose SSD (gp2) volumes created or modified after 12/03/2018 have a throughput maximum between 128 MiB/s and 250 MiB/s depending on volume size. Volumes greater than 170 GiB and below 334 GiB deliver a maximum throughput of 250 MiB/s if burst credits are available. Volumes with 334 GiB and above deliver 250 MiB/s, irrespective of burst credits. For details, see Amazon EBS Volume Types in the AWS documentation.

General Purpose SSD gp3 volumes deliver a consistent baseline of 3,000 IOPS and 125 MiB/s. You can also purchase additional IOPS (up to 16,000) and throughput (up to 1,000 MiB/s). While we recommend you to use the configurations shown in this guide, gp3 volumes provide flexibility to customize SAP HANA's storage configuration (IOPS and throughput) according to your needs and usage.

The **minimum** gp3 configuration required to meet SAP HANA KPIs are the following:

Storage Area	IOPS	Throughput
SAP HANA Data	7,000	425 MiB/s
SAP HANA Logs	3,000	275 MiB/s

For SAP HANA backup, you can choose file-based backup with storage configuration recommended in this guide or AWS Backint for SAP HANA to backup your database on Amazon S3. AWS Backint Agent for SAP HANA is an SAP-certified backup and restore solution for SAP HANA workloads running on Amazon EC2 instances. With AWS Backint for SAP HANA as your backup solution, provisioning additional Amazon EBS storage volumes or Amazon EFS file systems becomes optional. For more details, see AWS Backint Agent for SAP HANA.

For single-node deployment, we recommend using Amazon EBS Throughput Optimized HDD (st1) volumes for SAP HANA to perform file-based backup. This volume type provides low-cost magnetic storage designed for large sequential workloads. SAP HANA uses sequential I/O with large blocks to back up the database, so st1 volumes provide a low-cost, high-performance option for this scenario. To learn more about st1 volumes, see Amazon EBS Volume Types.

The SAP HANA backup volume size is designed to provide optimal baseline and burst throughput as well as the ability to hold several backup sets. Holding multiple backup sets in the backup volume makes it easier to recover your database if necessary. You may resize your SAP HANA backup volume after initial setup if needed. To learn more about resizing your Amazon EBS volumes, see Expanding the Storage Size of an EBS Volume on Linux.

For multi-node deployment, we recommend using Amazon EFS for SAP HANA to perform file-based backup. It can support performance over 10 GB/sec and over 500,000 IOPS.

> **Note**
> The configurations recommended in this guide are used by both, AWS Launch Wizard for SAP and AWS Quick Start for SAP HANA.

Networking

SAP HANA components communicate over the following logical network zones:

- Client zone – to communicate with different clients such as SQL clients, SAP Application Server, SAP HANA Extended Application Services (XS), and SAP HANA Studio
- Internal zone – to communicate with hosts in a distributed SAP HANA system as well as for SAP HSR
- Storage zone – to persist SAP HANA data in the storage infrastructure for resumption after start or recovery after failure

Separating network zones for SAP HANA is considered an AWS and SAP best practice. It enables you to isolate the traffic required for each communication channel.

In a traditional, bare-metal setup, these different network zones are set up by having multiple physical network cards or virtual LANs (VLANs). Conversely, on the AWS Cloud, you can use elastic network interfaces combined with security groups to achieve this network isolation. Amazon EBS-optimized instances can also be used for further isolation for storage I/O.

EBS-Optimized Instances

Many newer Amazon EC2 instance types such as the X1 use an optimized configuration stack and provide additional, dedicated capacity for Amazon EBS I/O. These are called EBS-optimized instances. This optimization provides the best performance for your EBS volumes by minimizing contention between Amazon EBS I/O and other traffic from your instance.

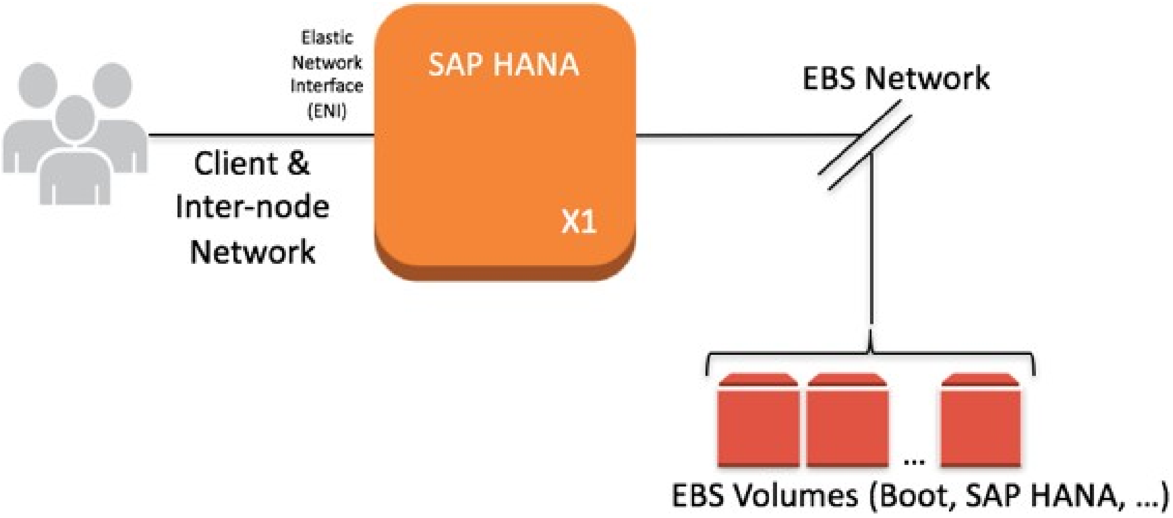

Elastic Network Interface (ENI)
SAP HANA
X1
EBS Network
Client & Inter-node Network
...
EBS Volumes (Boot, SAP HANA, ...)

Figure 9: EBS-optimized instances

Elastic Network Interfaces

An elastic network interface is a virtual network interface that you can attach to an EC2 instance in an Amazon Virtual Private Cloud (Amazon VPC). With an elastic network interface (referred to as *network interface* in the remainder of this guide), you can create different logical networks by specifying multiple private IP addresses for your instances.

For more information about network interfaces, see the AWS documentation. In the following example, two network interfaces are attached to each SAP HANA node as well as in a separate communication channel for storage.

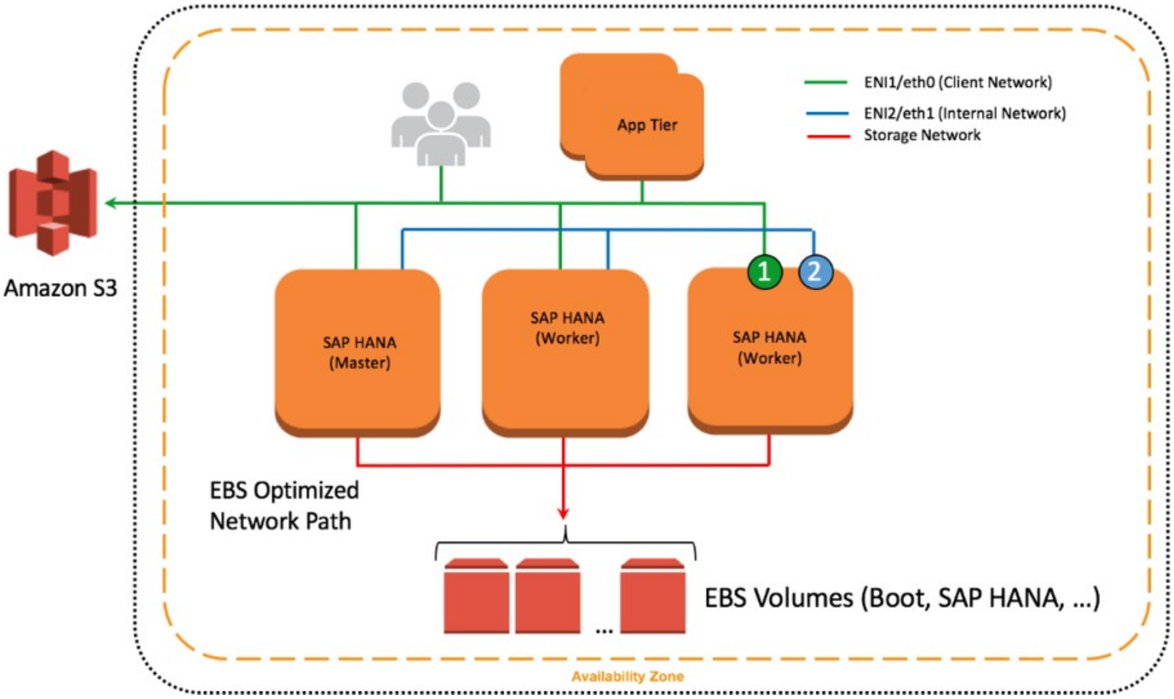


Figure 10: Network interfaces attached to SAP HANA nodes

Security Groups

A security group acts as a virtual firewall that controls the traffic for one or more instances. When you launch an instance, you associate one or more security groups with the instance. You add rules to each security group that allow traffic to or from its associated instances. You can modify the rules for a security group at any time. The new rules are automatically applied to all instances that are associated with the security group. To learn more about security groups, see the AWS documentation. In the following example, ENI-1 of each instance shown is a member of the same security group that controls inbound and outbound network traffic for the client network.

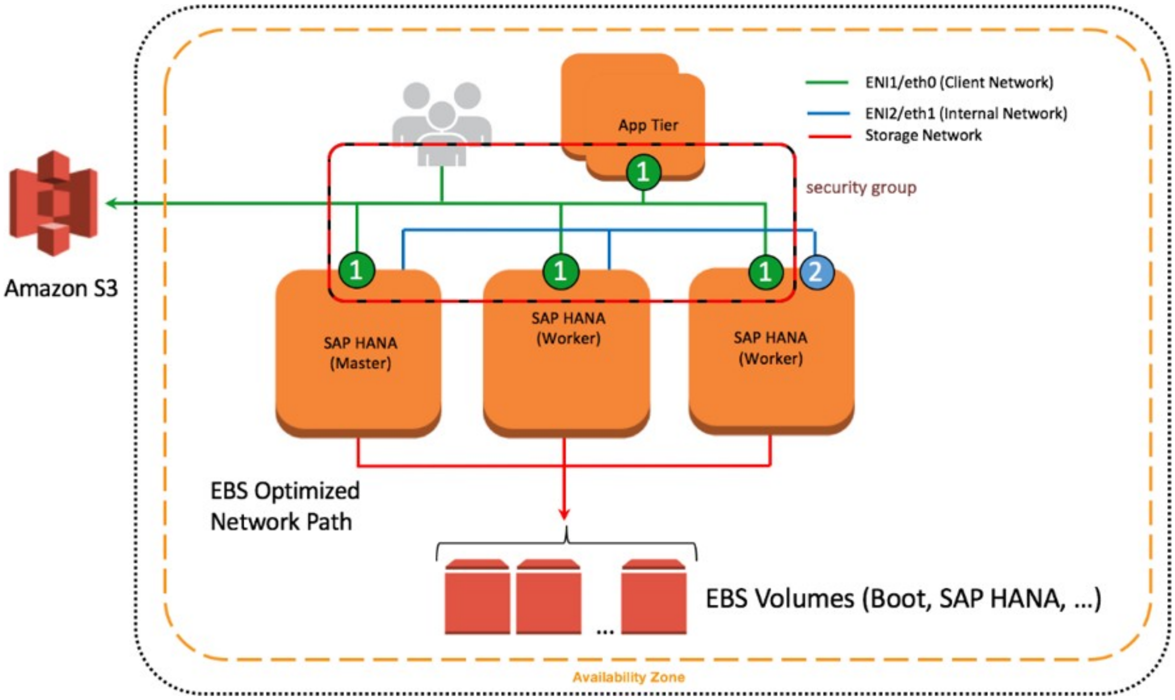


Figure 11: Network interfaces and security groups

Network Configuration for SAP HANA System Replication (HSR)

You can configure additional network interfaces and security groups to further isolate inter-node communication as well as SAP HSR network traffic. In Figure 10, ENI-2 is has its own security group (not shown) to secure client traffic from inter-node communication. ENI-3 is configured to secure SAP HSR traffic to another Availability Zone within the same Region. In this example, the target SAP HANA cluster would be configured with additional network interfaces similar to the source environment, and ENI-3 would share a common security group.

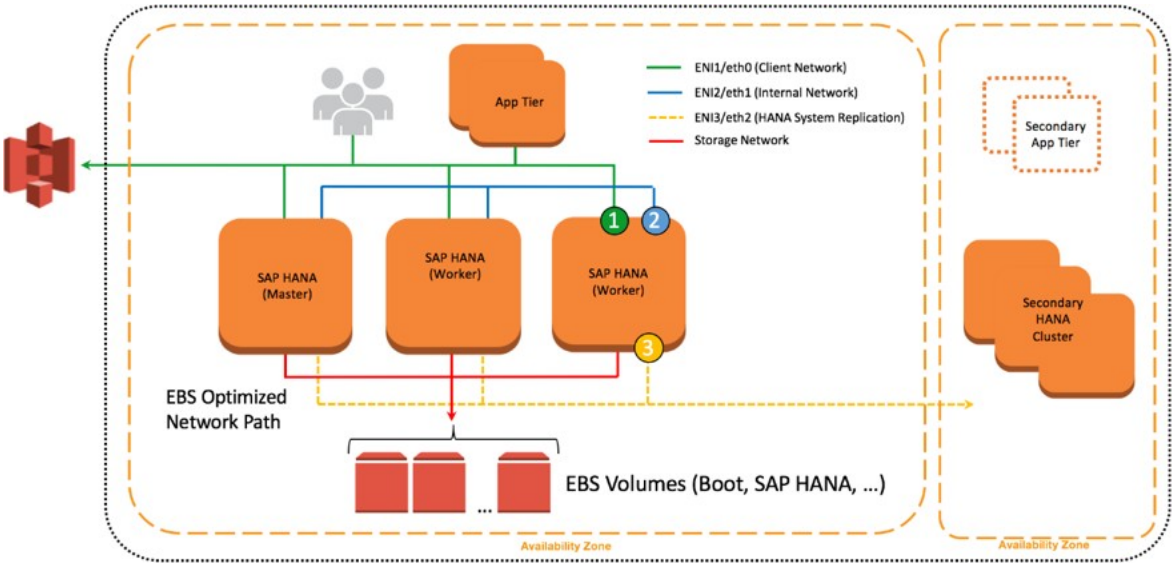


Figure 12: Further isolation with additional ENIs and security groups

Configuration Steps for Logical Network Separation

To configure your logical network for SAP HANA, follow these steps:

1. Create new security groups to allow for isolation of client, internal communication, and, if applicable, SAP HSR network traffic. See Ports and Connections in the SAP HANA documentation to learn about the list of ports used for different network zones. For more information about how to create and configure security groups, see the AWS documentation.
2. Use Secure Shell (SSH) to connect to your EC2 instance at the OS level. Follow the steps described in the appendix (p. 120) to configure the OS to properly recognize and name the Ethernet devices associated with the new network interfaces you will be creating.
3. Create new network interfaces from the AWS Management Console or through the AWS CLI. Make sure that the new network interfaces are created in the subnet where your SAP HANA instance is deployed. As you create each new network interface, associate it with the appropriate security group you created in step 1. For more information about how to create a new network interface, see the AWS documentation.
4. Attach the network interfaces you created to your EC2 instance where SAP HANA is installed. For more information about how to attach a network interface to an EC2 instance, see the AWS documentation.
5. Create virtual host names and map them to the IP addresses associated with client, internal, and replication network interfaces. Ensure that host name-to-IP-address resolution is working by creating entries in all applicable host files or in the Domain Name System (DNS). When complete, test that the virtual host names can be resolved from all SAP HANA nodes and clients.
6. For scale-out deployments, configure SAP HANA inter-service communication to let SAP HANA communicate over the internal network. To learn more about this step, see Configuring SAP HANA Inter-Service Communication in the SAP HANA documentation.
7. Configure SAP HANA hostname resolution to let SAP HANA communicate over the replication network for SAP HSR. To learn more about this step, see Configuring Hostname Resolution for SAP HANA System Replication in the SAP HANA documentation.

SAP Support Access

In some situations it may be necessary to allow an SAP support engineer to access your SAP HANA systems on AWS. The following information serves only as a supplement to the information contained in the “Getting Support” section of the SAP HANA Administration Guide.

A few steps are required to configure proper connectivity to SAP. These steps differ depending on whether you want to use an existing remote network connection to SAP, or you are setting up a new connection directly with SAP from systems on AWS.

Support Channel Setup with SAProuter on AWS

When setting up a direct support connection to SAP from AWS, consider the following steps:

1. For the SAProuter instance, create and configure a specific SAProuter security group, which only allows the required inbound and outbound access to the SAP support network. This should be limited to a specific IP address that SAP gives you to connect to, along with TCP port 3299. See the Amazon EC2 security group documentation for additional details about creating and configuring security groups.

2. Launch the instance that the SAProuter software will be installed on into a public subnet of the VPC and assign it an Elastic IP address.
3. Install the SAProuter software and create a saprouttab file that allows access from SAP to your SAP HANA system on AWS.
4. Set up the connection with SAP. For your internet connection, use **Secure Network Communication (SNC)**. For more information, see the SAP Remote Support – Help page.
5. Modify the existing SAP HANA security groups to trust the new SAProuter security group you have created.

> **Tip**
> For added security, shut down the EC2 instance that hosts the SAProuter service when it is not needed for support purposes

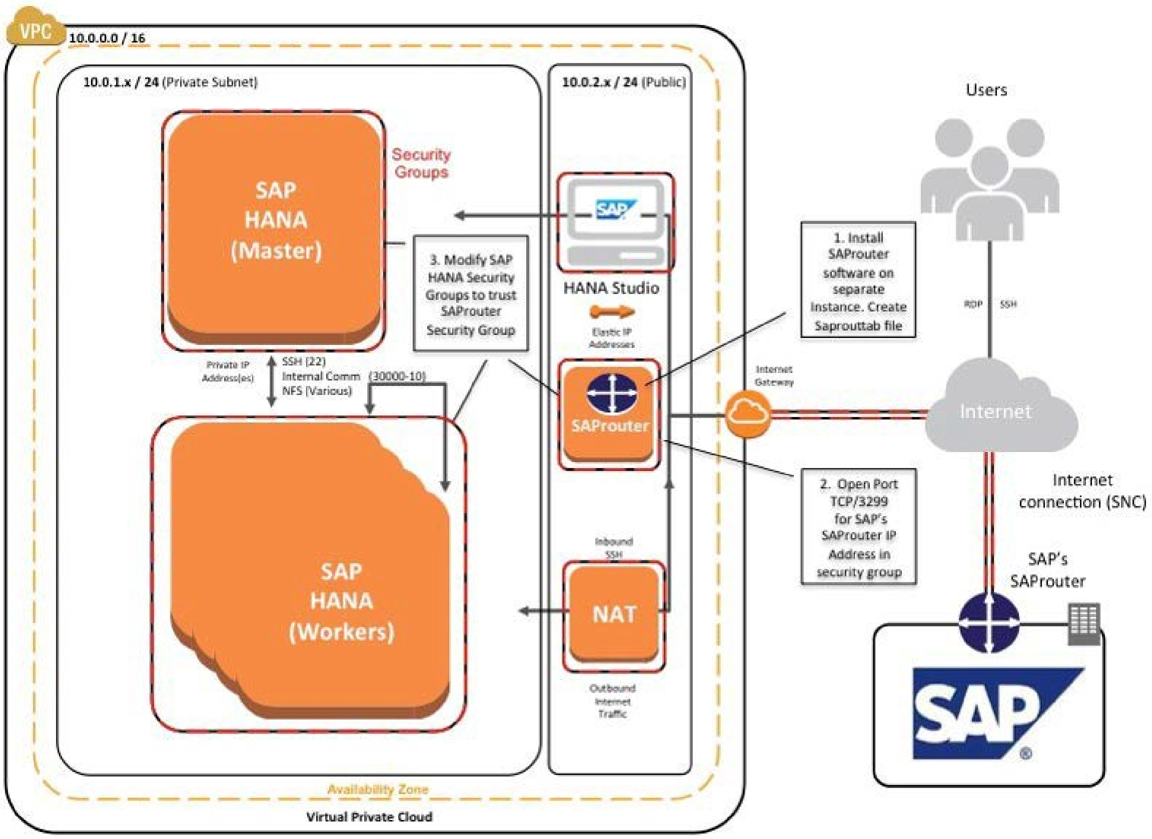


Figure 13: Support connectivity with SAProuter on AWS

Support Channel Setup with SAProuter on Premises

In many cases, you may already have a support connection configured between your data center and SAP. This can easily be extended to support SAP systems on AWS. This scenario assumes that connectivity between your data center and AWS has already been established, either by way of a secure VPN tunnel over the internet or by using AWS Direct Connect.

You can extend this connectivity as follows:

1. Ensure that the proper saprouttab entries exist to allow access from SAP to resources in the VPC.

2. Modify the SAP HANA security groups to allow access from the on- premises SAProuter IP address.
3. Ensure that the proper firewall ports are open on your gateway to allow traffic to pass over TCP port 3299.

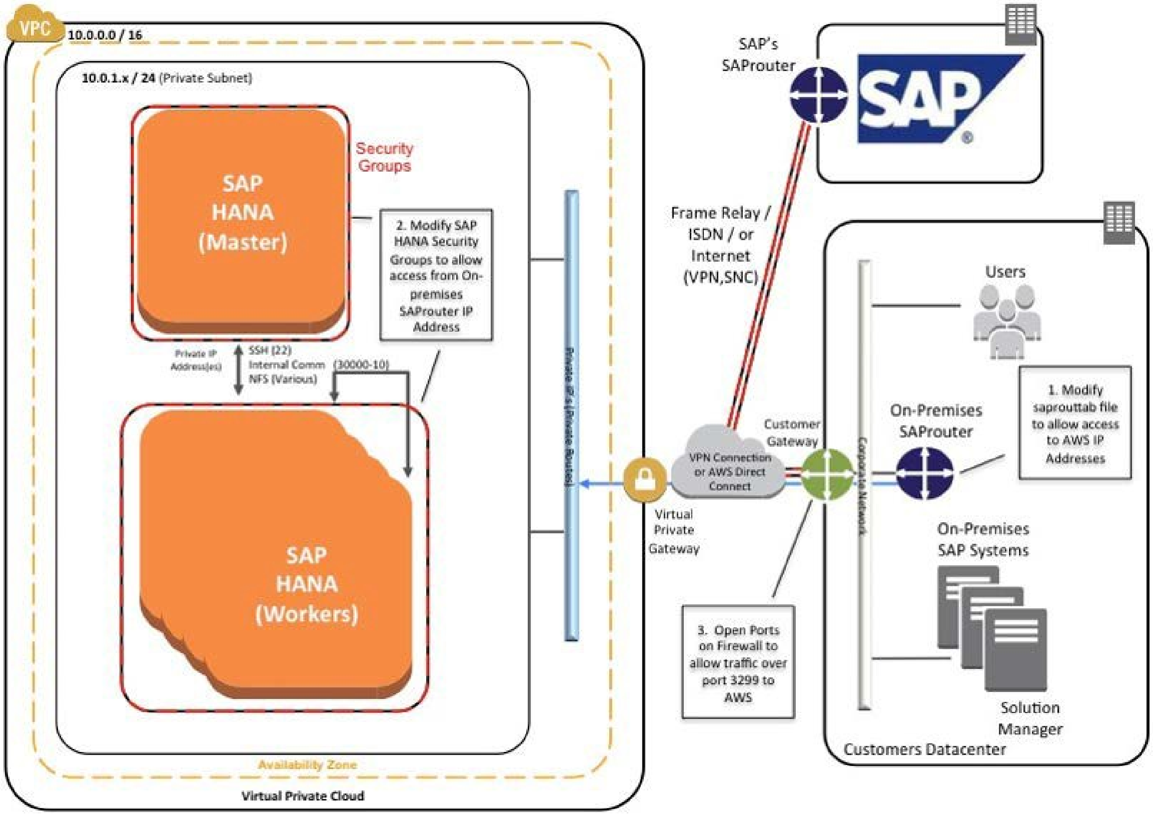

VPC
10.0.0.0 / 16
10.0.1.x / 24 (Private Subnet)
Security Groups
SAP HANA (Master)
2. Modify SAP HANA Security Groups to allow access from On-premises SAProuter IP Address
Private IP Address(es)
SSH (22)
Internal Comm (30000-10)
NFS (Various)
SAP HANA (Workers)
Private IP's (Private Routes)
Availability Zone
Virtual Private Cloud
SAP's SAProuter
SAP
Frame Relay / ISDN / or Internet (VPN,SNC)
VPN Connection or AWS Direct Connect
Customer Gateway
Virtual Private Gateway
3. Open Ports on Firewall to allow traffic over port 3299 to AWS
Corporate Network
Users
On-Premises SAProuter
1. Modify saprouttab file to allow access to AWS IP Addresses
On-Premises SAP Systems
Solution Manager
Customers Datacenter

Figure 14: Support connectivity with SAProuter on premises

Security

This section discusses additional security topics you may want to consider that are not covered in the SAP HANA Quick Start reference deployment guide.

Here are additional AWS security resources to help you achieve the level of security you require for your SAP HANA environment on AWS:

- AWS Cloud Security Center
- CIS AWS Foundation whitepaper
- AWS Cloud Security whitepaper
- AWS Cloud Security Best Practices whitepaper

OS Hardening

You may want to lock down the OS configuration further, for example, to avoid providing a DB administrator with root credentials when logging into an instance.

You can also refer to the following SAP notes:

- 1730999: *Configuration changes in HANA appliance*
- 1731000: *Unrecommended configuration changes*

Disabling HANA Services

HANA services such as HANA XS are optional and should be deactivated if they are not needed. For instructions, see SAP Note 1697613: *Remove XS Engine out of SAP HANA database*. In case of service deactivation, you should also remove the TCP ports from the SAP HANA AWS security groups for complete security.

API Call Logging

AWS CloudTrail is a web service that records AWS API calls for your account and delivers log files to you. The recorded information includes the identity of the API caller, the time of the API call, the source IP address of the API caller, the request parameters, and the response elements returned by the AWS service.

With CloudTrail, you can get a history of AWS API calls for your account, including API calls made via the AWS Management Console, AWS SDKs, command line tools, and higher-level AWS services (such as AWS CloudFormation). The AWS API call history produced by CloudTrail enables security analysis, resource change tracking, and compliance auditing.

Notifications on Access

You can use Amazon Simple Notification Service (Amazon SNS) or third-party applications to set up notifications on SSH login to your email address or mobile phone.

High Availability and Disaster Recovery

For details and best practices for high availability and disaster recovery of SAP HANA systems running on AWS, see High Availability and Disaster Recovery Options for SAP HANA on AWS.

Appendix: Configuring Linux to Recognize Ethernet Devices for Multiple Network Interfaces

Follow these steps to configure the Linux operating system to recognize and name the Ethernet devices associated with the new elastic network interfaces created for logical network separation, which were discussed earlier in this paper (p. 117).

1. Use SSH to connect to your SAP HANA host as `ec2-user`, and `sudo` to root.
2. Remove the existing `udev` rule; for example:

```
hanamaster:# rm -f /etc/udev/rules.d/70-persistent-net.rules
```

3. Create a new `udev` rule that writes rules based on MAC address rather than other device attributes. This will ensure that on reboot, `eth0` is still `eth0`, `eth1` is `eth1`, and so on. For example:

```
hanamaster:# cat <<EOF >/etc/udev/rules.d/75-persistent-net- generator.rules
```

```
# Copyright (C) 2012 Amazon.com, Inc. or its affiliates. # All Rights Reserved.
#
# Licensed under the Apache License, Version 2.0 (the "License").
# You may not use this file except in compliance with the License.
# A copy of the License is located at #
#     https://aws.amazon.com/apache2.0/ #
# or in the "license" file accompanying this file. This file is # distributed on an "AS
 IS" BASIS, WITHOUT WARRANTIES OR CONDITIONS
# OF ANY KIND, either express or implied. See the License for the
# specific language governing permissions and limitations under the
# License.
# these rules generate rules for persistent network device naming
SUBSYSTEM!="net", GOTO="persistent_net_generator_end" KERNEL!="eth*",
 GOTO="persistent_net_generator_end" ACTION!="add", GOTO="persistent_net_generator_end"
 NAME=="?*", GOTO="persistent_net_generator_end"

# do not create rule for eth0
ENV{INTERFACE}=="eth0", GOTO="persistent_net_generator_end" # read MAC address
ENV{MATCHADDR}="\$attr{address}" # do not use empty address
ENV{MATCHADDR}=="00:00:00:00:00:00",
GOTO="persistent_net_generator_end"
# discard any interface name not generated by our rules ENV{INTERFACE_NAME}=="?*",
 ENV{INTERFACE_NAME}=""
# default comment
ENV{COMMENT}="elastic network interface" # write rule IMPORT{program}="write_net_rules"
# rename interface if needed ENV{INTERFACE_NEW}=="?*", NAME="\$env{INTERFACE_NEW}"
LABEL="persistent_net_generator_end" EOF
```

4. Ensure proper interface properties. For example:

```
hanamaster:# cd /etc/sysconfig/network/

hanamaster:# cat <<EOF >/etc/sysconfig/network/ifcfg-ethN
BOOTPROTO='dhcp4'
MTU="9000"
REMOTE_IPADDR=''
STARTMODE='onboot'
LINK_REQUIRED=no
LINK_READY_WAIT=5
EOF
```

5. Ensure that you can accommodate up to seven more Ethernet devices or network interaces, and restart `wicked`. For example:

```
hanamaster:# for dev in eth{1..7} ; do
ln -s -f ifcfg-ethN /etc/sysconfig/network/ifcfg-${dev} done

hanamaster:# systemctl restart wicked
```

6. Create and attach a new network interface to the instance.
7. Reboot.
8. Modify `/etc/iproute2/rt_tables`.

   Important

   Repeat the following for each ENI that you attach to your instance.

   For example:

```
hanamaster:# cd /etc/iproute2
hanamaster:/etc/iproute2 # echo "2 eth1_rt" >> rt_tables
hanamaster:/etc/iproute2 # ip route add default via 172.16.1.122 dev eth1 table eth1_rt
```

```
hanamaster:/etc/iproute2 # ip rule
0: from all lookup local
32766: from all lookup main
32767: from all lookup default

hanamaster:/etc/iproute2 # ip rule add from <ENI IP Address>
lookup eth1_rt prio 1000

hanamaster:/etc/iproute2 # ip rule 0: from all lookup local
1000: from <ENI IP address> lookup eth1_rt
32766: from all lookup main
32767: from all lookup default
```

Document Revisions

Date	Change	Location
December 2017	Initial publication	–

SAP HANA Data Tiering on AWS Overview

SAP specialists, Amazon Web Services

Last updated (p. 133): July 2019

This guide is part of a content series that provides detailed information about hosting, configuring, and using SAP technologies in the Amazon Web Services Cloud. For the other guides in the series, ranging from overviews to advanced topics, see SAP on AWS Technical Documentation home page.

Overview

This guide provides an overview of data tiering for SAP customers and partners who are considering implementing or migrating SAP environments or systems to the Amazon Web Services Cloud.

This guide is for users who architect, design, deploy, and support SAP systems directly and IT professionals that support these same functions for their SAP systems.

Prerequisites

Specialized Knowledge

You should have previous experience installing, migrating, and operating SAP environments and systems.

Technical Requirements

To access the SAP notes referenced in this guide, you must have an SAP One Support Launchpad user account.

SAP Data Tiering

SAP data tiering is a data management strategy that's used to separate your data into different categories (hot, warm, and cold tiers) by various characteristics of the data. The most common characteristics used to assign the data to the correct categories are:

- frequency of access to the data
- requirement to update the data
- performance requirement and timely access to the data
- criticality of the data for operational business processes

Assigning your data to the correct category is a process that is specific to your business and IT requirements. Here are some ways to align these categories with your specific requirements.

Hot Tier: The hot tier is for storing data that is used (read, accessed or updated) in real time and that must be available in a performant and timely manner. This hot data is critical and valuable to the business for its operational and analytical processes.

Warm Tier: The warm tier is for data that is read less often than hot data, has less stringent performance requirements, but must still be updatable. The warm tier is integrated with the hot tier in the SAP HANA database. The benefit of this integration is a more transparent view of the data in the hot and warm data tiers. Applications accessing the data are unware that the data physically resides on different data tiers.

Cold Tier: The cold tier is for storing data that is infrequently accessed, does not require updates, can be accessed in a longer timeframe, and is not critical for daily operational or analytical processes.

The following table summarizes the data tiers and their characteristics.

Data tier characteristics

	Data access frequency	Performance requirement	Data criticality	Data updatability
Hot	High	High	High	Required
Warm	Medium	Medium	Medium	Required
Cold	Low	Low	Low	N/A

After you have assigned the data to your preferred tiers, you can map your SAP product to the data tiering solution that is supported by SAP on AWS. For more information, see SAP HANA on AWS: Supported Amazon EC2 products and SAP HANA on AWS: Dynamic Tiering.

For the hot tier, this guide does not cover SAP HANA on AWS specifically. See SAP HANA on AWS documentation for more information about running SAP HANA on AWS. For the warm and cold tier, you have the following technology options shown in the following table, depending on your SAP product:

Warm and cold tier options

	Native SAP HANA	SAP BW on HANA or SAP BW/4 HANA	SAP Business Suite on HANA or SAP S/4 HANA
Hot	Certified SAP HANA EC2 instances	Amazon EC2 instances certified for SAP HANA	Amazon EC2 instances certified for SAP HANA
Warm	SAP HANA dynamic tiering SAP HANA extension node Native Storage Extension	SAP HANA extension node	Data aging
Cold	Data Lifecycle Manager (DLM) with SAP Data Hub and Amazon S3 DLM with SAP HANA Spark Controller	SAP BW NLS with SAP IQ SAP BW NLS with Hadoop and Amazon S3 SAP BW/4 HANA Data Tiering Optimization	ILM Store with SAP IQ Data archiving and Amazon S3

	Native SAP HANA	SAP BW on HANA or SAP BW/4 HANA	SAP Business Suite on HANA or SAP S/4 HANA
		(DTO) with SAP Data Hub and Amazon S3	

Warm Data Tiering Options

The following sections discuss the warm data tiering options you have on AWS.

SAP HANA Dynamic Tiering

SAP HANA dynamic tiering is an optional add-on to the SAP HANA database to manage historical data that can be used for your native SAP HANA use case. SAP HANA dynamic tiering's purpose is to extend SAP HANA memory with a disk-centric columnar store (as opposed to SAP HANA's in-memory store) for managing less frequently accessed warm data. In this disk-centric solution, dynamic tiering service (esserver) runs on a separate dedicated server. Note that the SAP HANA dynamic tiering solution does not support all use cases. As noted in the solution table, SAP HANA dynamic tiering:

- can only be used for native SAP HANA use cases.
- provides online data storage in extended store, available for both queries and updates.
- is fully validated and supported on the AWS Cloud beginning with SAP HANA 2 SPS 2.
- is an integrated component of the SAP HANA database and cannot be operated separately from the SAP HANA database.
- allows you to store up to 5 times more data in the warm tier than in your hot tier.

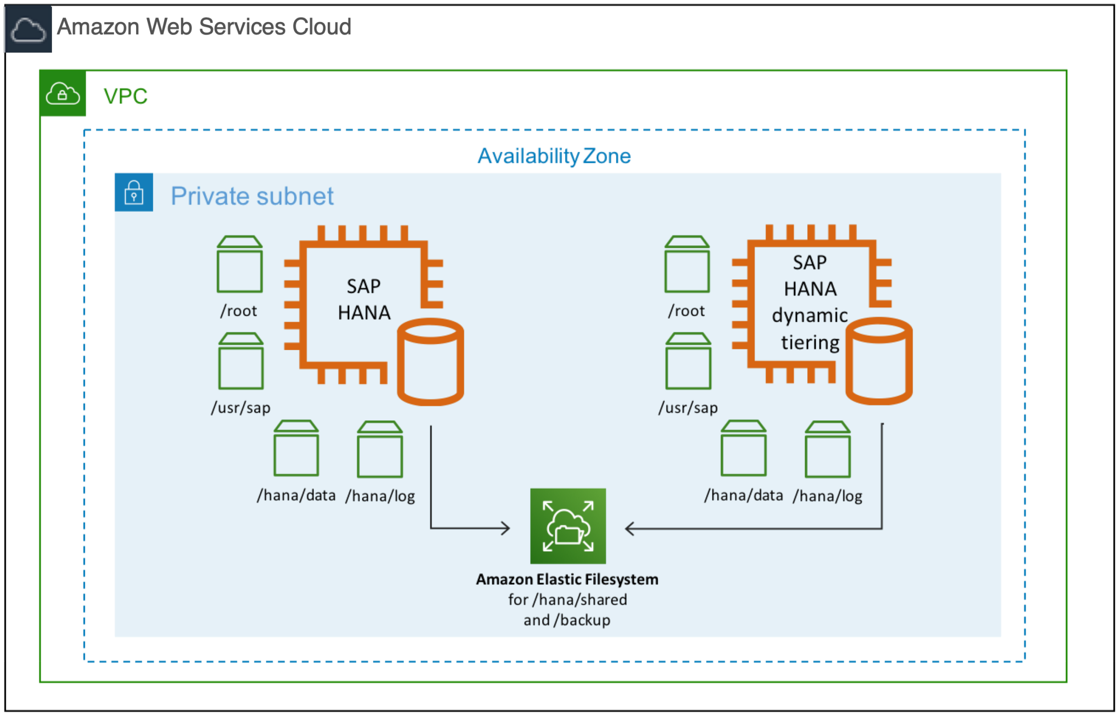


Figure 1: SAP HANA dynamic tiering on AWS (single-AZ)

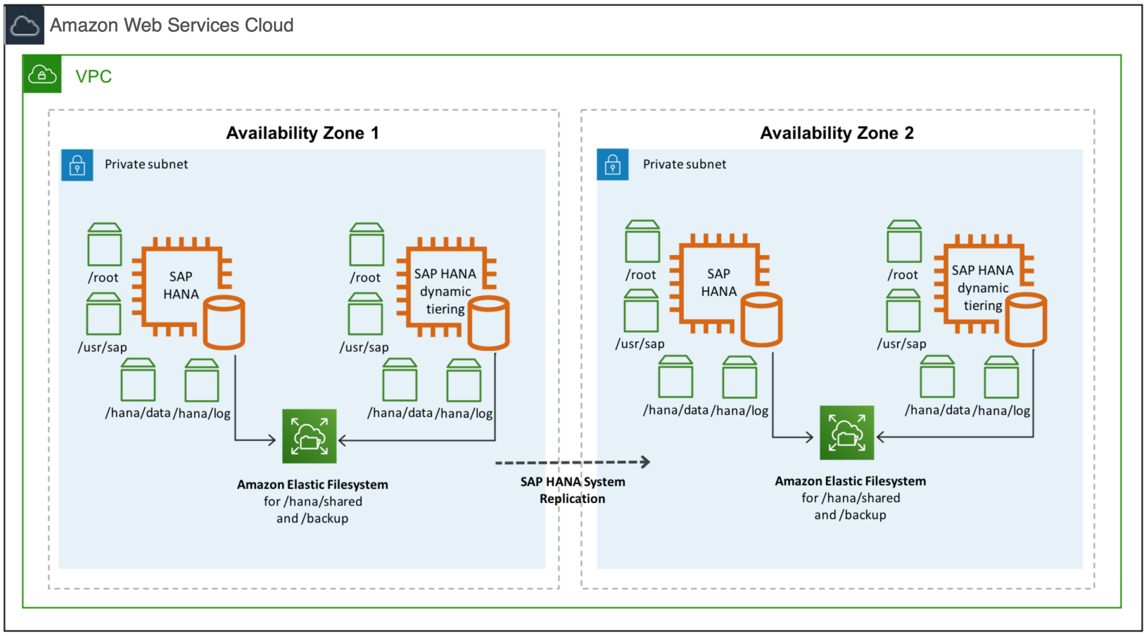


Figure 2: SAP HANA dynamic tiering on AWS (multi-AZ)

SAP HANA Extension Node

SAP HANA extension node is a special purpose SAP HANA worker node that is specifically set up and reserved for storing warm data. An important difference between SAP HANA dynamic tiering and SAP HANA extension node is that the extension node is a separate SAP HANA instance. It is not a separate process (esserver) like dynamic tiering. Because of this, the SAP HANA extension node offers the full feature set of the SAP HANA database. SAP HANA extension node allows you to store warm data for your SAP Business Warehouse (BW) or native SAP HANA use cases.

The total amount of data that can be stored on the SAP HANA extension node ranges from 1 to 2x of the total amount of memory of your extension node. For example, if your extension node had 2 TB of memory, you could potentially store up to 4 TB of warm data on your extension node.

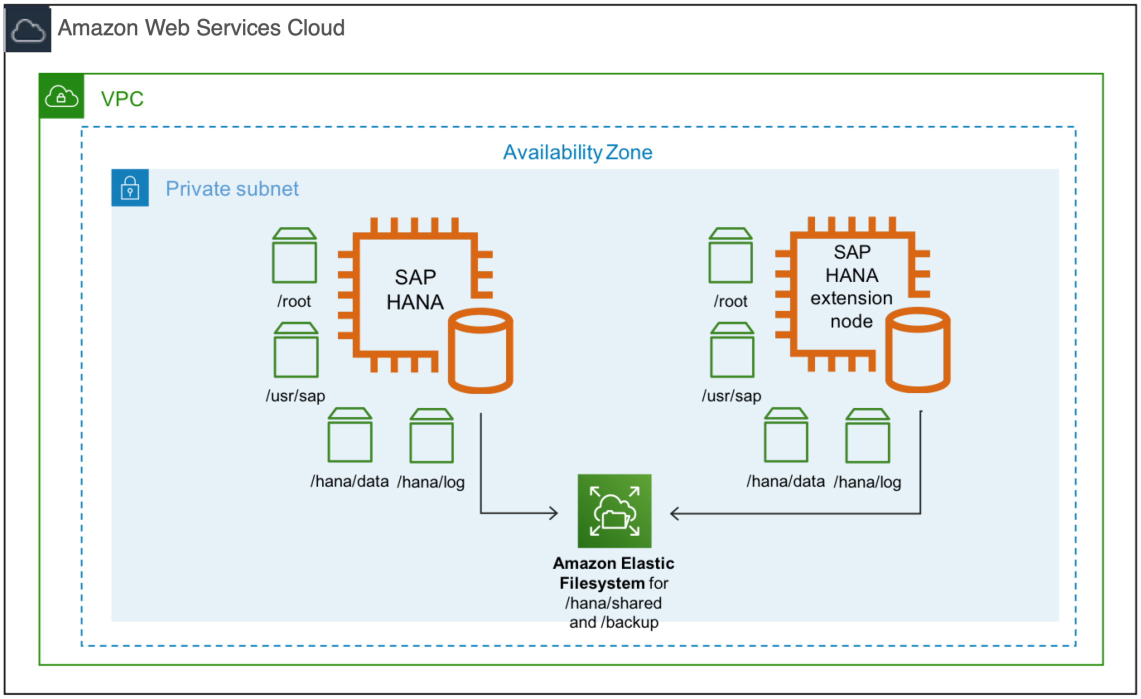


Figure 3: SAP HANA extension node on AWS

Data Aging

Data aging can be used for SAP products like SAP Business Suite on HANA (SoH) or SAP S/4HANA to move data from SAP HANA memory to the disk area. The disk area is additional disk space that is a part of the SAP HANA database. This helps free up more SAP HANA memory by storing older, less frequently accessed data in the disk area. When the data is read or updated, data aging uses the paged attribute property to selectively load the pages of a table into memory instead of loading the entire table into memory. This helps you conserve your memory space by only loading the required data (instead of the entire table) into memory. In addition, paged attributes are marked for a higher unload priority by SAP HANA and are paged out to disk first when SAP HANA needs to free up memory. To size your SAP HANA memory requirements for data aging, SAP recommends that you run the sizing report provided in the SAP Note 1872170 - ABAP on HANA sizing report (S/4HANA, Suite on HANA).

Cold Data Tiering Options

The following sections discuss cold data tiering options on AWS.

The Data Lifecycle Manager (DLM) tool, which is part of SAP HANA Data Warehousing Foundation, can be used to move data from SAP HANA memory to a cold storage location. For your native SAP HANA use case, you have two options.

DLM with SAP Data Hub

With this option, you can use the SAP Data Hub product to move data in and out of SAP HANA into your cold store location. On AWS, you are able to use native AWS services such as Amazon Simple Storage Service to store your cold data. Once your data is in Amazon S3, you can use Amazon S3 features such as S3 Intelligent-Tiering and Amazon S3 Lifecycle to optimize your costs. Once you have determined that you no longer need to access your cold data from SAP HANA, you can archive your data in Amazon S3 Glacier for long-term retention.

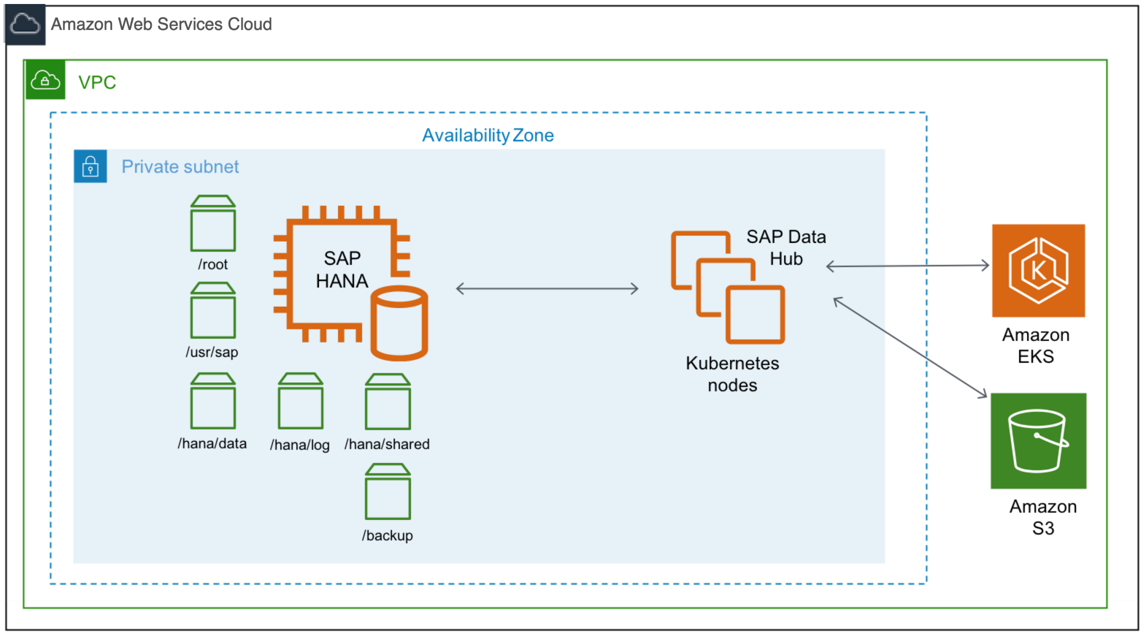


Figure 4: SAP Data Hub on Amazon EKS for cold tier

DLM with SAP HANA Spark Controller

With this option, you can use the SAP HANA Spark Controller to allow SAP HANA to access cold data through the Spark SQL SDA adapter. On AWS, you can use an AWS native service like Amazon EMR for the Hadoop cold tier storage location. To use Amazon EMR with SAP HANA, see DLM on Amazon Elastic Map Reduce documentation from SAP.

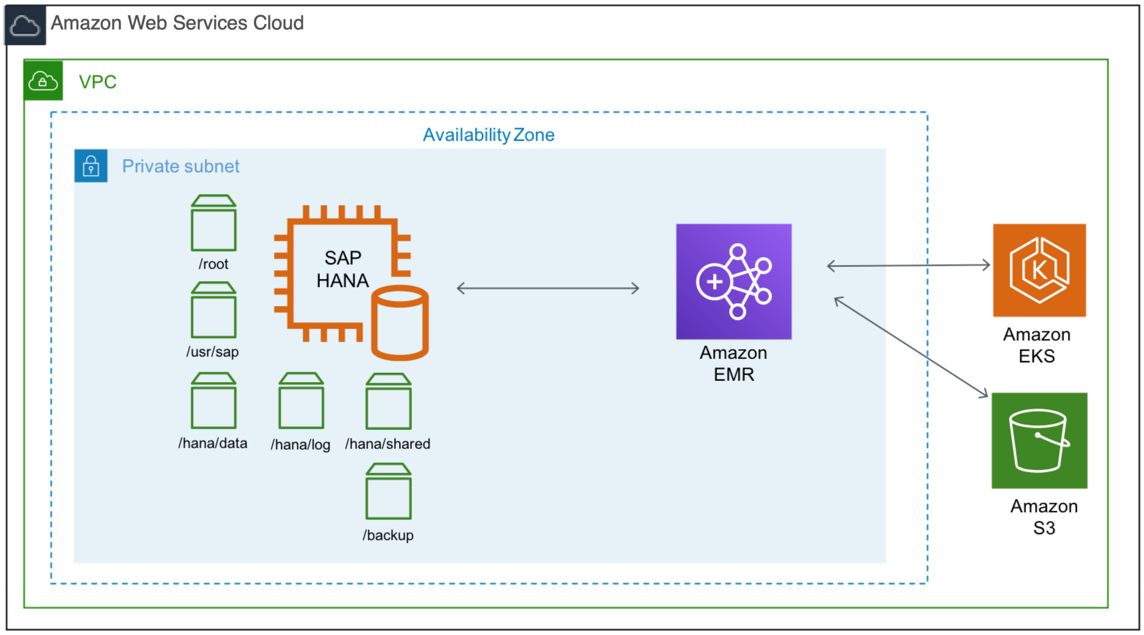


Figure 5: SAP HANA with Amazon EMR for cold tier

Cold Tier Options for SAP BW

For the SAP Business Warehouse (BW) on HANA or SAP BW/4 HANA use cases, you have additional options for cold tier storage.

SAP BW Near Line Storage (NLS) with SAP IQ

With this option, you can use SAP BW Near Line Storage (NLS) with SAP IQ or you can use Data Tiering Optimization (DTO) with SAP IQ to store your cold data. On AWS, you can run your SAP IQ server on Amazon Elastic Compute Cloud (Amazon EC2) instances for the cold tier storage.

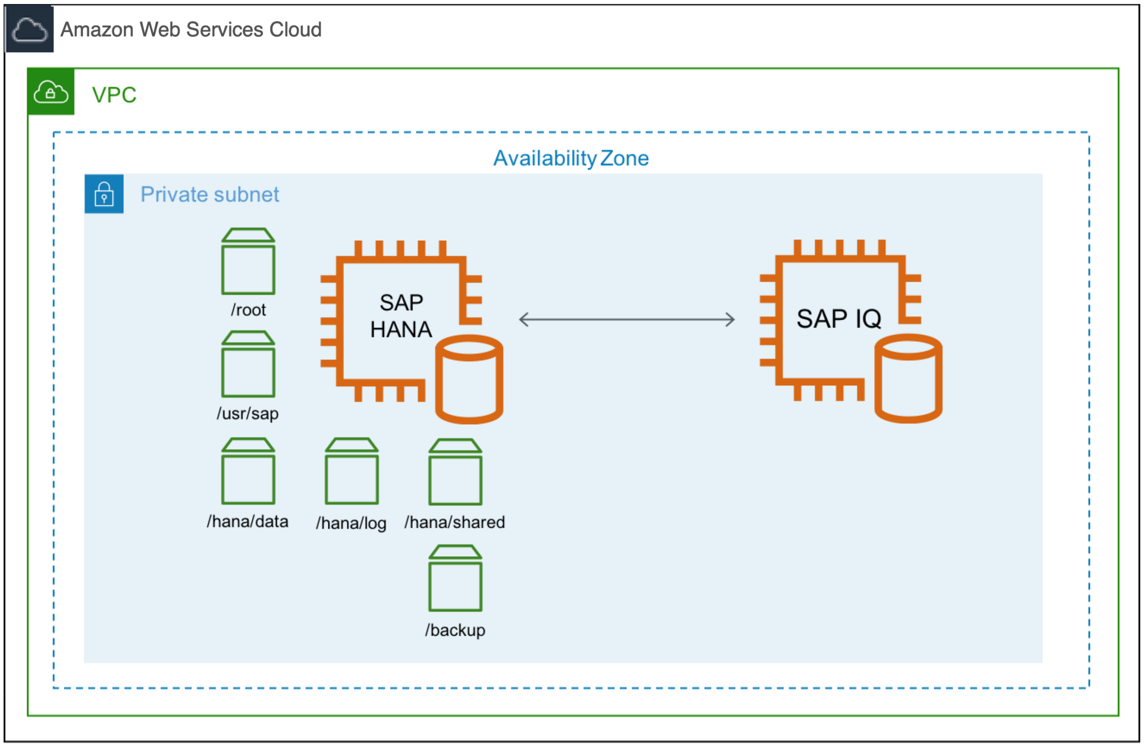


Figure 6: SAP BW NLS with SAP IQ for cold tier

SAP BW NLS with Hadoop

With this option, you can use SAP BW NLS with Apache Hadoop instead of SAP IQ, with this option you can persist your Hadoop data in Amazon S3 using a Hadoop third-party connector for Amazon S3. See Hadoop as a Near-Line Storage Solution documentation from SAP, SAP Note 2363218 – Hadoop NLS: Information, Recommendations and Limitations, and Cloud Data Access documentation from Hortonworks for details.

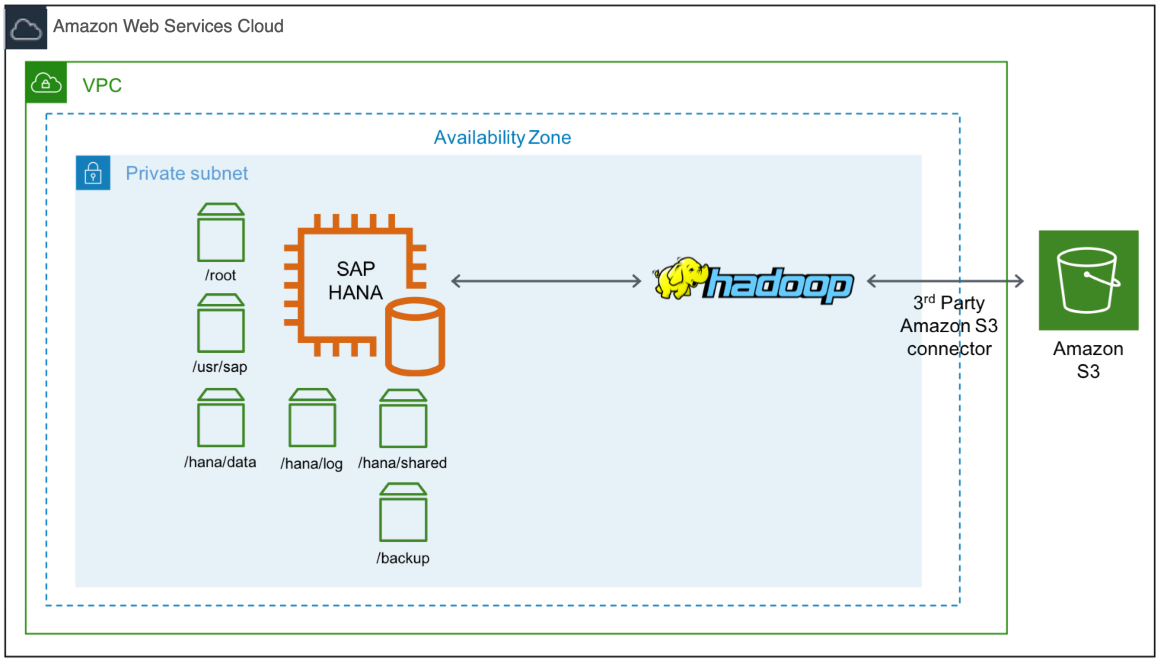


Figure 7: SAP BW NLS with Hadoop for cold tier

SAP BW/4HANA DTO with Data Hub

With this option, you can use DTO with SAP Data Hub to store your cold data in Amazon S3. This option only applies if you use SAP BW/4HANA.

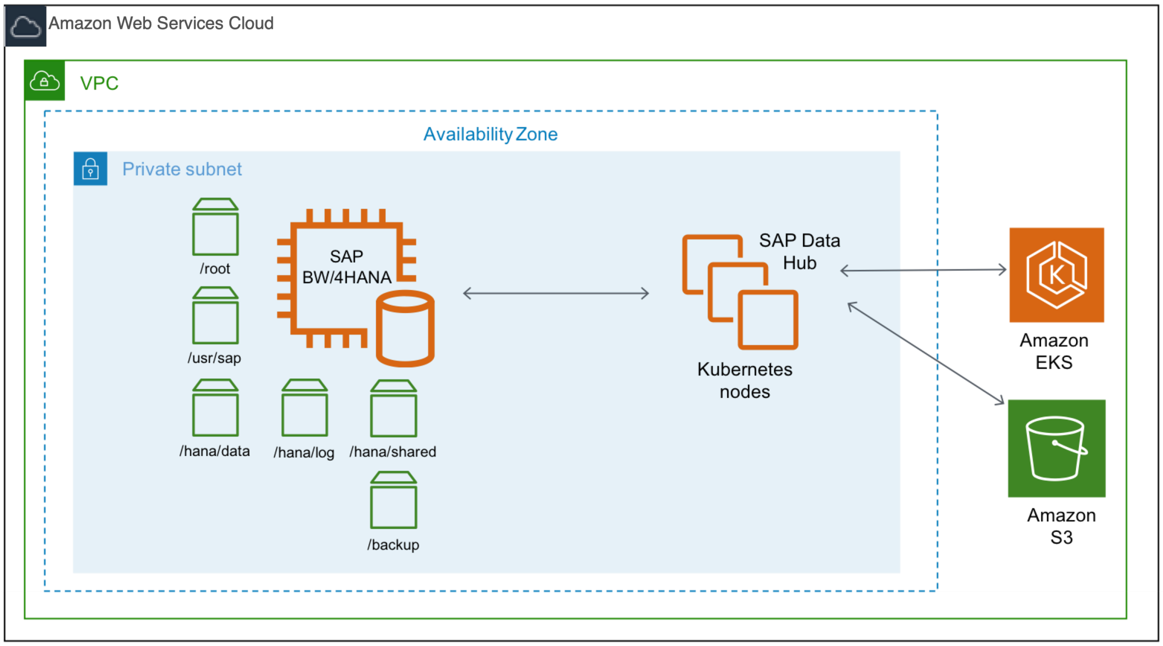


Figure 8: SAP Data Hub on Amazon EKS with BW4/HANA

Cold Tier Options for SAP S/4HANA or Suite on HANA

For S/4HANA or SOH, you can use SAP Information Life Cycle Management (ILM) for the cold data tiering. You have few options with ILM for cold tier. See ILM Store documentation from SAP for details.

SAP ILM with SAP IQ

With this option, you can use ILM with SAP IQ. Similar to the SAP BW NLS with SAP IQ scenario, you can run your SAP IQ server on AWS Amazon EC2 instances to store cold data.

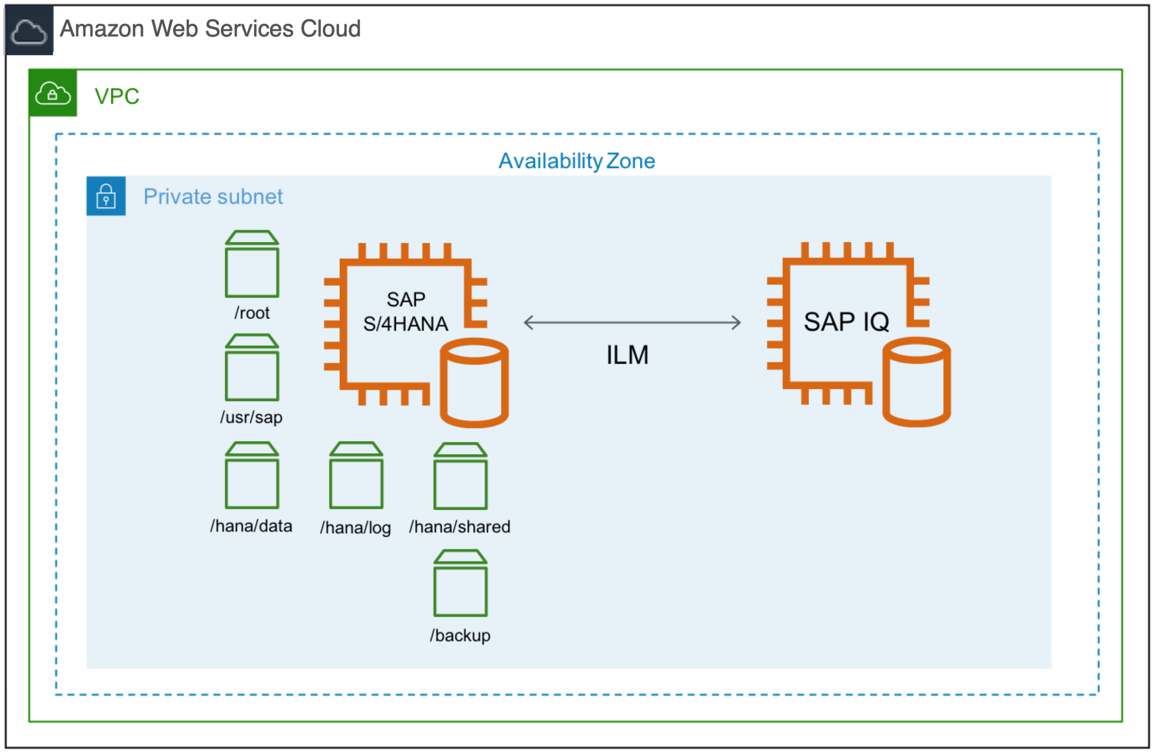


Figure 9: SAP ILM with SAP IQ for cold tier

SAP Archiving

With this option, you can use ILM or your standard data archiving process. You can use Amazon Elastic File System (Amazon EFS) to store your archive file in a highly available, scalable and durable manner. Similarly, for Windows based systems, you can use Amazon FSx to store your archive files. Amazon EFS and Amazon FSx can be mounted as your archive file system and you can archive your data from SAP to this file system through SAP transaction code SARA.

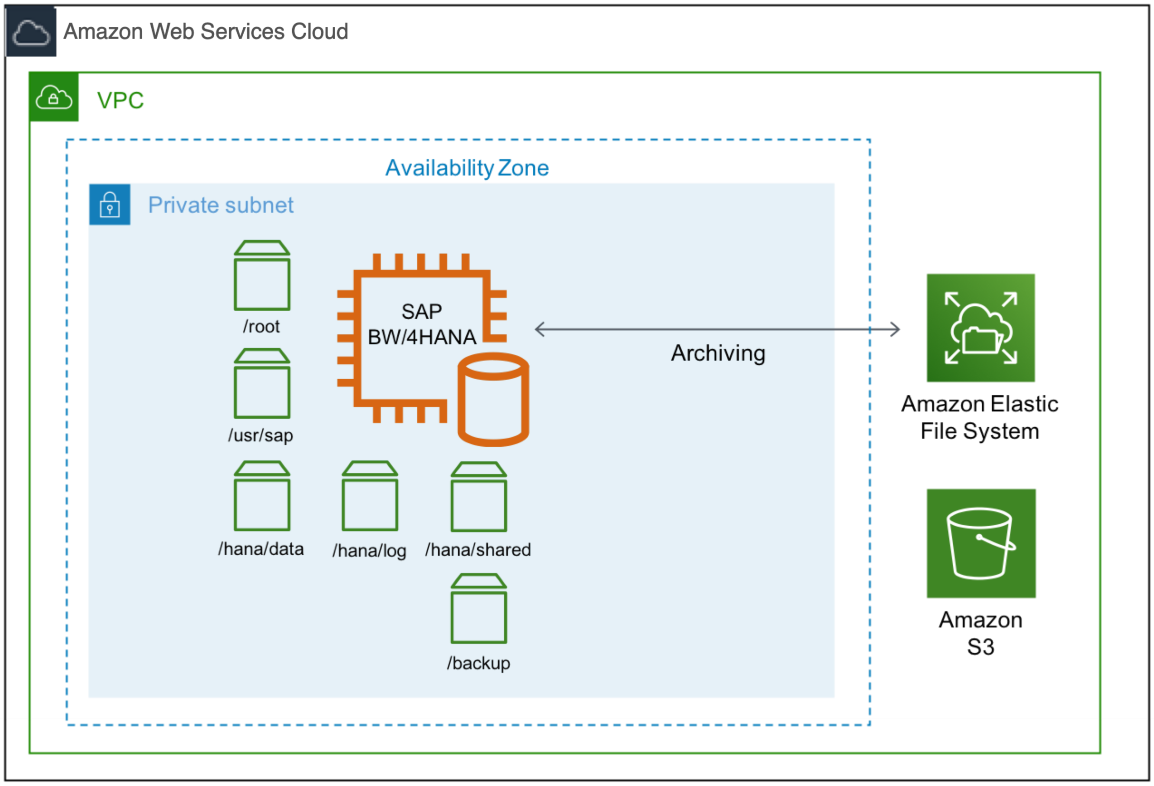


Figure 10: SAP archiving with Amazon EFS for cold tier

For archiving, another option is to use the Amazon Elastic Block Store (Amazon EBS) sc1 volume type as the underlying storage type for your archive file system. Amazon EBS sc1 volumes are inexpensive block storage and are designed for less frequently accessed workloads like data archiving. To increase durability and availability of your archived data, we recommend that you copy the data to Amazon S3 for backup and Amazon S3 Glacier for long term retention.

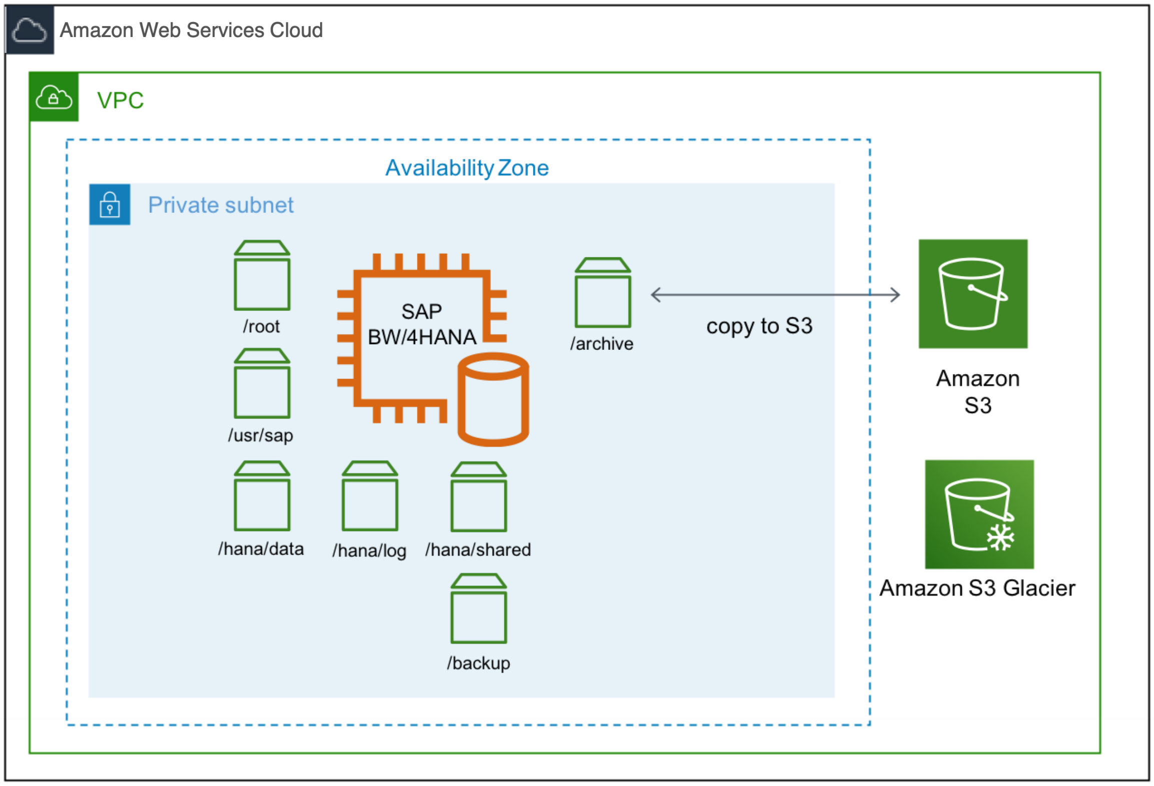


Figure 11: SAP archiving with Amazon EBS for cold tier

Additional Reading

SAP on AWS technical documentation

- SAP HANA on AWS Documentation
- SAP on AWS Technical Documentation

SAP documentation

- SAP Note 1872170 - ABAP on HANA sizing report (S/4HANA, Suite on HANA)
- SAP HANA Extension Nodes as a Warm Store
- SAP HANA Dynamic Tiering Architecture
- Extended Store Table Function Restrictions
- DLM on Amazon Elastic Map Reduce

Document Revisions

Date	Change
July 2019	Initial publication

SAP on AWS High Availability with Overlay IP Address Routing

SAP specialists, Amazon Web Services

Last updated (p. 146): June 2020

This guide is part of a content series that provides detailed information about hosting, configuring, and using SAP technologies in the Amazon Web Services Cloud. For the other guides in the series, ranging from overviews to advanced topics, see SAP on AWS Technical Documentation.

Overview

This guide provides SAP customers and partners instructions to set up a highly available SAP architecture that uses overlay IP addresses on Amazon Web Services. This guide includes two configuration approaches:

- AWS Transit Gateway serves as central hub to facilitate network connection to an overlay IP address.
- Elastic Load Balancing where a Network Load Balancer enables network access to an overlay IP address.

This guide is intended for users who have previous experience installing and operating highly available SAP environments and systems.

Prerequisites

Specialized Knowledge

Before you follow the configuration instructions in this guide, we recommend that you become familiar with the following AWS services. (If you are new to AWS, see Getting Started with AWS.)

- Amazon VPC
- AWS Transit Gateway
- Elastic Load Balancing

SAP on AWS High Availability Setup

SAP customers can fully realize the benefit of running mission-critical SAP workloads by building reliable, fault-tolerant, and highly available systems in the AWS Cloud depending on the operating system and database. AWS offers the use of multiple Availability Zones within an AWS Region to provide resiliency for the SAP applications.

As part of your SAP implementation, you create an Amazon Virtual Private Cloud (Amazon VPC) to logically isolate the network from other virtual networks in the AWS Cloud. Then, you use AWS network routing features to direct the traffic to any instance in the VPCs or between different subnets in a VPC. Amazon VPC setup includes assigning subnets to your SAP ASCS/ERS for NetWeaver and primary/secondary nodes for the SAP HANA database. Each of these configured subnets has a classless inter-domain routing (CIDR) IP assignment from the VPC which resides entirely within one Availability Zone. This CIDR IP assignment cannot span multiple zones or be reassigned to the secondary instance in a different AZ during a failover scenario.

For this reason, AWS allows you to configure Overlay IP (OIP) outside of your VPC CIDR block to access the active SAP instance. With IP overlay routing, you can allow the AWS network to use a non-overlapping RFC1918 private IP address that resides outside an VPC CIDR range and direct the SAP traffic to any instance setup across the Availability Zone within the VPC by changing the routing entry in AWS.

A SAP HANA database or SAP NetWeaver application that is protected by a cluster solution such as SUSE Linux Enterprise Server High Availability Extension (SLES HAE), RedHat Enterprise Linux HA Add-On(RHEL HA) or SIOS uses the overlay IP address assigned to ensure that the HA cluster is still accessible during the failover scenarios. Since the overlay IP address uses the IP address range outside the VPC CIDR range and Virtual Private Gateway connection, you can use AWS Transit Gateway as a central hub to facilitate the network connection to an overlay IP address from multiple locations including Amazon VPCs, other AWS Regions, and on-premises using AWS Direct Connect or AWS Client VPN.

If you do not have AWS Transit Gateway set up as a network transit hub or if AWS Transit Gateway is not available in your preferred AWS Region, you can use a Network Load Balancer to enable network access to an OIP.

Overlay IP Routing using AWS Transit Gateway

With Transit Gateway, you use route table rules which allow the overlay IP address to communicate to the SAP instance without having to configure any additional components, like a Network Load Balancer or Amazon Route 53. You can connect to the overlay IP from another VPC, another subnet (not sharing the same route table where overlay IP address is maintained), over a VPN connection, or via an AWS Direct Connect connection from a corporate network.

Note: If you do not use Amazon Route 53 or AWS Transit Gateway, see the Overlay IP Routing with Network Load Balancer (p. 140) section.

Architecture

AWS Transit Gateway acts as a hub that controls how traffic is routed among all the connected networks which act like spokes. Your Transit Gateway routes packets between source and destination attachments using Transit Gateway route tables. You can configure these route tables to propagate routes from the route tables for the attached VPCs and VPN connections. You can also add static routes to the Transit Gateway route tables. You can add the overlay IP address or address CIDR range as a static route in the transit gateway route table with a target as the VPC where the EC2 instances of SAP cluster are running. This way, all the network traffic directed towards overlay IP addresses is routed to this VPC. The following figure shows this scenario with connectivity from different VPC and corporate network.

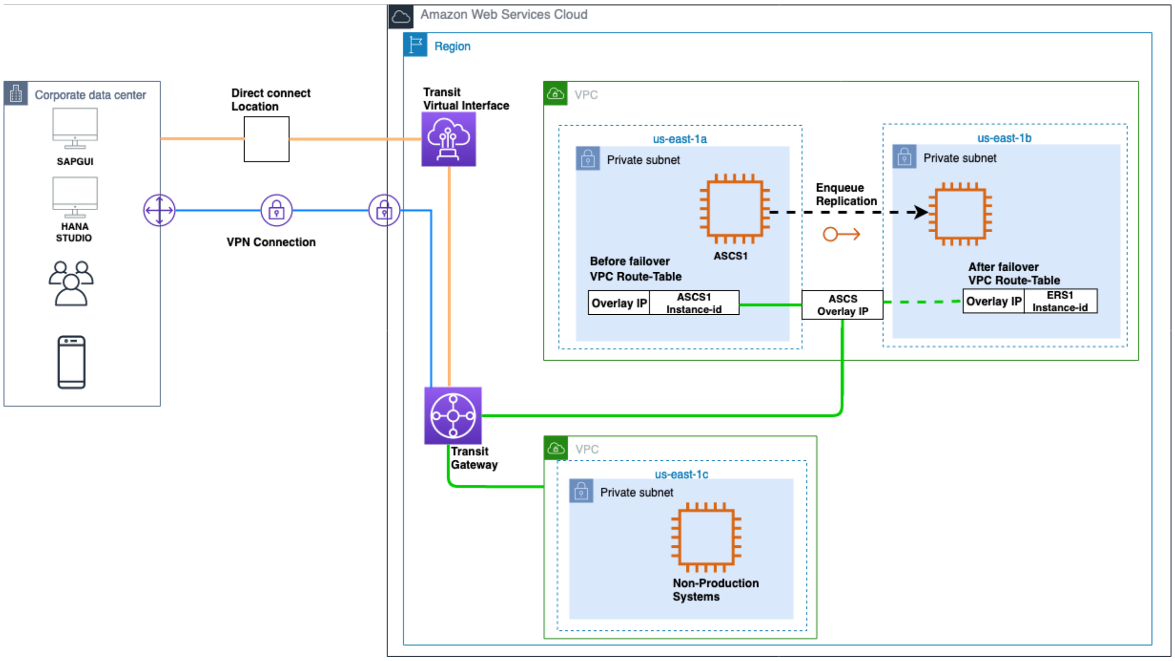


Figure 1: Overlay IP address setup with AWS Transit Gateway

Pricing for the AWS Transit Gateway:

AWS Transit Gateway pricing is based on the number of connections made to the Transit Gateway per hour and the amount of traffic that flows through AWS Transit Gateway. AWS uses commercially reasonable efforts to make each Transit Gateway available with a Monthly Uptime Percentage, during any monthly billing cycle, of at least 99.95%. See AWS Transit Gateway Service Level Agreement for more information.

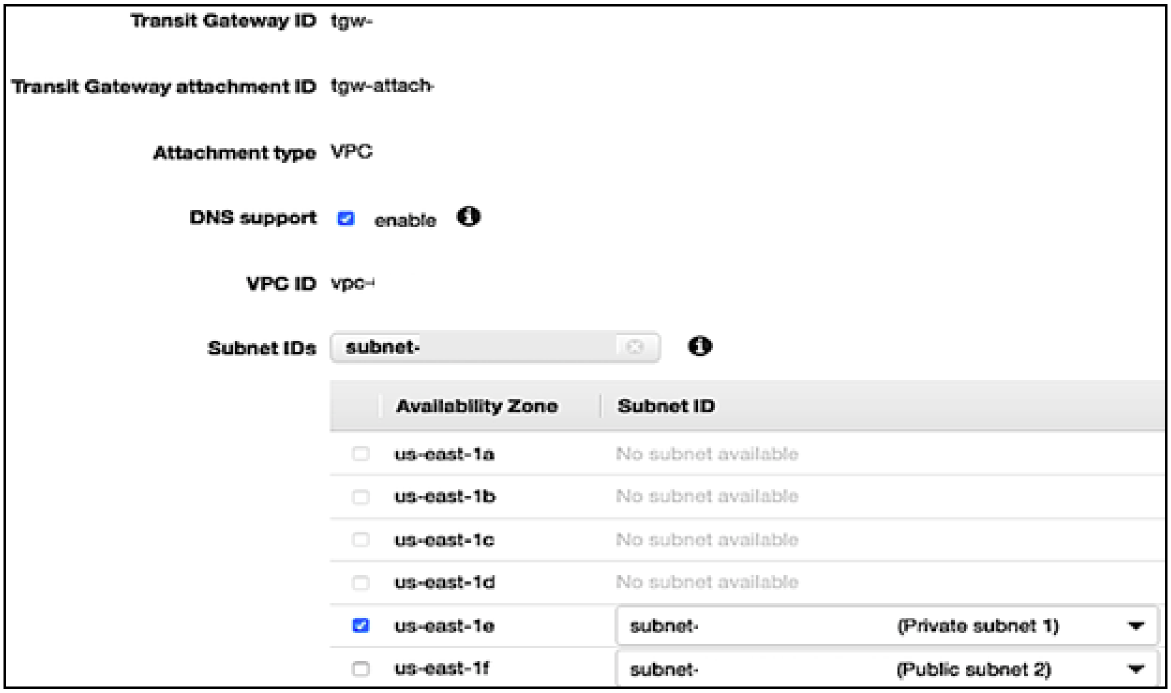
Configuration Steps for AWS Transit Gateway

This section includes high-level steps necessary to understand overlay IP address configuration for this scenario. See the AWS Transit Gateway documentation for detailed steps regarding AWS Transit Gateway configuration.

Step 1. Set up the Transit Gateway architecture

1. Create a Transit Gateway in your AWS account in the AWS Region where the SAP instance is deployed. For detailed steps, see Getting Started with Transit Gateways.
2. Attach VPCs where SAP instances are deployed (and any other VPCs as required) to the Transit Gateway. For detailed steps, see Transit Gateway Attachments to a VPC.

Note: For attachment, select only the subnet where the SAP instances are running with cluster and overlay IP configured. In the following figure, the private subnet of the SAP instance is selected for the Transit Gateway attachment.



Transit Gateway ID tgw-

Transit Gateway attachment ID tgw-attach-

Attachment type VPC

DNS support ☑ enable

VPC ID vpc-

Subnet IDs subnet-

	Availability Zone	Subnet ID
□	us-east-1a	No subnet available
□	us-east-1b	No subnet available
□	us-east-1c	No subnet available
□	us-east-1d	No subnet available
☑	us-east-1e	subnet- (Private subnet 1)
□	us-east-1f	subnet- (Public subnet 2)

Figure 2: Attaching Transit Gateway to private subnet

3. Do one of the following, depending on your connection:

- **VPN connection**. Attach a VPN to this Transit Gateway. For detailed steps, see Transit Gateway VPN Attachments.

  When you create a site-to-site VPN connection, you specify the static routes for the overlay IP address. For detailed steps, see VPN routing options.
- **AWS Direct Connect**. Attach a Direct Connect Gateway to this Transit Gateway. First, associate a Direct Connect Gateway with the Transit Gateway. Then, create a transit virtual interface for your AWS Direct Connect connection to the Direct Connect gateway. Here, you can advertise prefixes from on-premises to AWS and from AWS to on-premises. For detailed steps, see Transit Gateway Attachments to a Direct Connect Gateway.

  When you associate a Transit Gateway with a Direct Connect gateway, you specify the prefix lists to advertise the overlay IP address to the on-premises environment. For detailed steps, see Allowed prefixes interactions.

Note:AWS Direct Connect is recommended for business critical workloads. See Resilience in AWS Direct Connect to learn about resiliency at the network level.

Step 2. Configure routing for AWS and corporate networks.

The following table lists the IP addresses used in the example configuration. Make sure to use your valid private IP addresses for your implementation.

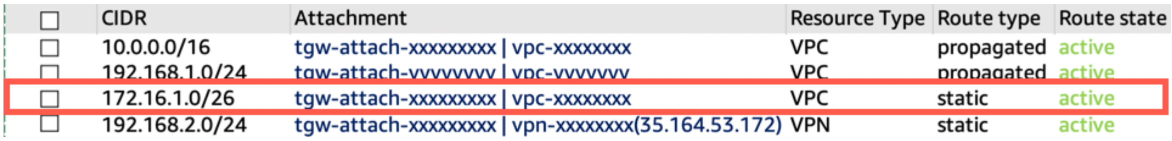
Description	IP Range/IP Address
VPC CIDR of production SAP systems	10.0.0.0/16

Description	IP Range/IP Address
(with HA cluster running with Overlay IP)	
VPC CIDR of non-production SAP systems (Instances in this VPC access the Production cluster overlay IP using AWS Transit Gateway)	192.168.1.0/24
Corporate network CIDR (Site-to-Site VPN is configured between corporate networks to AWS Transit Gateway)	192.168.2.0/24
Overlay IP address CIDR	172.16.1.0/26
Customer gateway IP address	34.216.94.150/32

> **Note**
> If you are using AWS Client VPN, you do not need to configure Transit Gateway. You can create additional entries in the routing table for overlay IP addresses. Route traffic to the subnets of the VPC of production SAP system where overlay IP addresses are configured.

When you create a Transit Gateway attachment to a VPC, the propagation route is created in the default Transit Gateway route table. In Figure 3, the first and second entry shows the propagated route created automatically for VPCs where SAP production and non-production systems are running through VPC attachment.

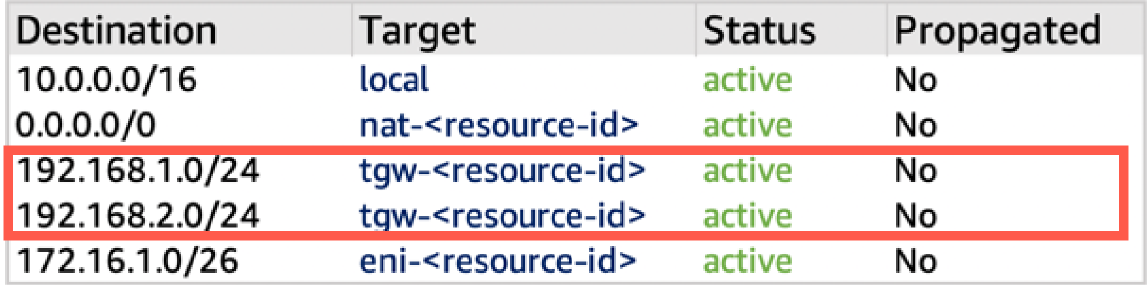
1. To route traffic from AWS Transit Gateway to the overlay IP address, create static routes in the **Transit Gateway route tables** to route overlay IP addresses to the VPC of production SAP system where the overlay IP addresses are configured. In Figure 3, the third entry shows that the static route created for the overlay IP range is attached. The target for this route is the SAP Production VPC.



□	CIDR	Attachment	Resource Type	Route type	Route state
□	10.0.0.0/16	tgw-attach-xxxxxxxxx | vpc-xxxxxxxx	VPC	propagated	active
□	192.168.1.0/24	tgw-attach-yyyyyyyy | vpc-yyyyyyyy	VPC	propagated	active
□	172.16.1.0/26	tgw-attach-xxxxxxxxx | vpc-xxxxxxxx	VPC	static	active
□	192.168.2.0/24	tgw-attach-xxxxxxxxx | vpn-xxxxxxxx(35.164.53.172)	VPN	static	active

Figure 3: Transit Gateway route table: Overlay IP static route with VPC of production SAP system target

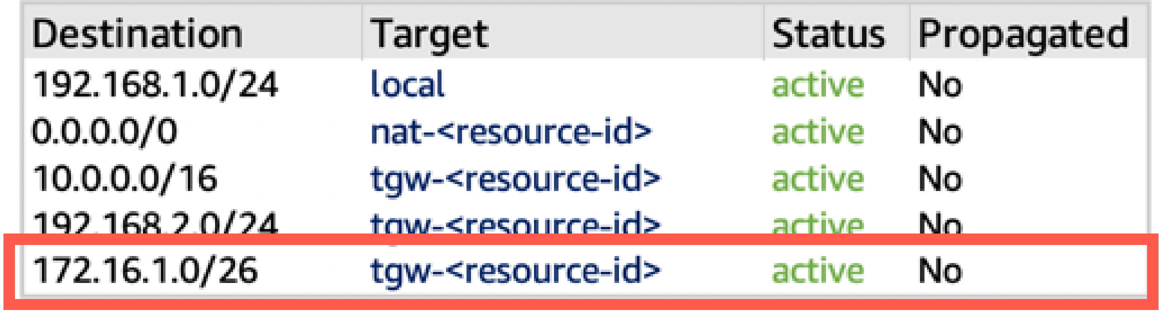
2. To route the outgoing traffic from VPCs where SAP instances are running to private IP addresses of another VPC where SAP instances are running attached to same Transit Gateway, create entries in the **route tables associated with these VPC subnets**. The target of these routes is AWS Transit Gateway. In the following VPC of production SAP system route table example, the non-production SAP VPC (third entry) and corporate network (fourth entry) are routed to the Transit Gateway.



Destination	Target	Status	Propagated
10.0.0.0/16	local	active	No
0.0.0.0/0	nat-<resource-id>	active	No
192.168.1.0/24	tgw-<resource-id>	active	No
192.168.2.0/24	tgw-<resource-id>	active	No
172.16.1.0/26	eni-<resource-id>	active	No

Figure 4: VPC of production SAP system route table: VPC of production SAP system and corporate network routed to AWS Transit Gateway

3. In the VPC of the non-production SAP system, to route the outgoing traffic from the overlay IP address, create entries in the route tables with Transit Gateway as the target. In the following VPC of non-production SAP system route table example, the destination is the overlay IP range and the target is Transit Gateway.



Destination	Target	Status	Propagated
192.168.1.0/24	local	active	No
0.0.0.0/0	nat-<resource-id>	active	No
10.0.0.0/16	tgw-<resource-id>	active	No
192.168.2.0/24	tgw-<resource-id>	active	No
172.16.1.0/26	tgw-<resource-id>	active	No

Figure 5: VPC of non-production SAP system route table: Outgoing traffic from overlay IP address routed to Transit Gateway

4. Configure routing from corporate devices to Amazon VPC IP addresses.

Step 3. Test the configuration.

Once the setup is complete, perform connectivity testing by making sure you can reach the SAP systems through overlay IP address. With this configuration, you can reach the overlay IP addresses from other VPCs and your corporate network just like any private IP address of the VPC. With the AWS Transit Gateway approach, no additional components are required for communication, such as Amazon Route 53 agent or Network Load Balancer.

Step 4. Update overlay IP address.

Step 4: Once the network connectivity is tested successfully, update the overlay IP address of the production or non-production SAP system in the message server parameter of your SAP Graphical User Interface (GUI) System Entry Properties along with other SAP connectivity properties for connection. You can use the corporate DNS or Amazon Route 53 to create a user friendly CNAME for the Overlay IP.

Overlay IP Routing with Network Load Balancer

If you do not use Amazon Route 53 or AWS Transit Gateway, you can use Network Load Balancer for accessing the overlay IP address externally. The Network Load Balancer functions at the fourth layer of the Open Systems Interconnection (OSI) model. It can handle millions of requests per second. After the load balancer receives a connection request, it selects a target from the Network Load Balancer target group to route network connection request to a destination address which can be an overlay IP address.

Architecture

The following figure shows the network access flow of ASCS or SAP HANA overlay IP from outside the VPC.

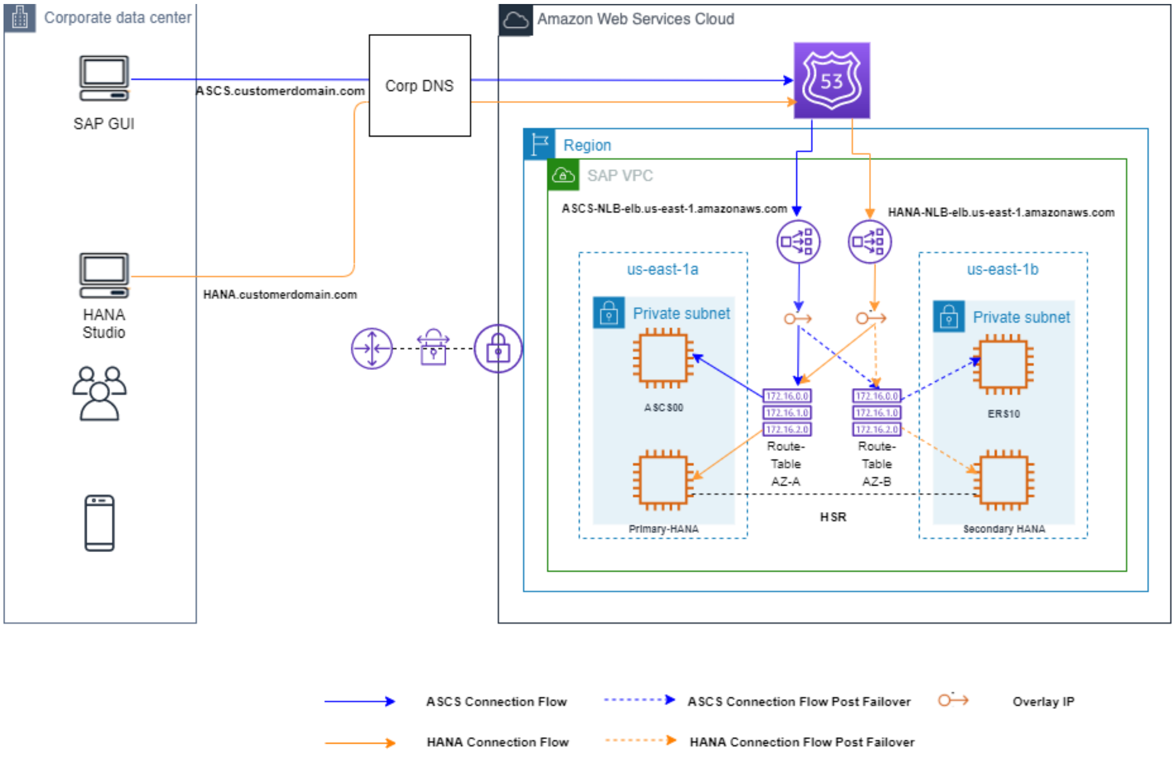


Figure 6: SAP High Availability with Overlay IP and Elastic Load Balancer

Pricing for Network Load Balancers:

With Network Load Balancers, you only pay for what you use. See Elastic Load Balancing pricing, for more information.

Configuration Steps for Network Load Balancer

Use the following instructions to set up the Network Load Balancer to access the overlay IP address. The following values are used for the example configuration.

Table 1: System Settings

System Setting	Value
Instance number for ASCS and SAP HANA	00

System Setting	Value
OIP for ASCS	192.168.0.20
OIP for HANA	192.168.1.99

Table 2: Listener Port Values

Listener Ports	Value
ASCS Message server port	36<instance number> (3600)
SAP HANA	SAP HANA Studio service connection (login required) SAP Note 1592925
SAPStartSrv/HTTP Port	5<instance number> (50013)
JDBC/SQL Port	3<instance number> (30015)

Step 1. Create the target group.

1. Open the Amazon EC2 console at https://console.aws.amazon.com/ec2/
2. On the navigation pane, under **LOAD BALANCING**, choose **Target Groups**.
3. Choose Create target group.
4. For **Name**, type an easily identified target group name for the sap-ascs instance. (For example, type sap-ascs for your ASCS overlay IP address).
5. For **Target type**, select **IP**.
6. For **Protocol**, choose **TCP**.
7. For **Port**, type 36<ASCS instance number>. For example: 3600, where 00 is the instance number.
8. For **Health checks**, keep the default health check settings, or change settings based on your requirements.
9. Choose **Create**.
10. Repeat steps 1 to 9 to create target group for JDBC/SQL port 3<instance number>15 and SAP HANA HTTP port 5<instance number>13 to access your SAP HANA instance with the respective overlay IP address.
11. Choose the **Targets** tab, then choose **Edit**.
12. Choose **Add** to register your targets.
13. Choose the **Network** drop-down and select **Other private IP address**. Then, enter the ASCS overlay IP address and choose **Add to list**.
14. Repeat steps 11 to 13 to register JDBC/SQL and HTTP ports with the respective overlay IP address.

Step 2. Create the Network Load Balancer for ASCS.

1. On the EC2 navigation pane, under **LOAD BALANCING**, choose **Load Balancers**.
2. Choose Create Load Balancer.
3. For Network Load Balancer, choose Create.
4. For **Name**, type a name for your load balancer. For example, sap-ha-nlb.
5. For **Scheme**, choose **internal**. An internal load balancer routes requests to targets using private IP addresses.

6. For **Listeners**, under Protocol, choose **TCP**. For **Port**, specify the ASCS port (36< SAP Instance number>. For example, use 3600 if your SAP instance number is 00.
7. For **Availability Zones**, select the VPC and subnets where the SAP instances with HA setup are deployed.
8. For **Tags**, choose **Add Tags** and for Key, type Name. For Value, type the name of the network load balancer, such as sap-ha-nlb.
9. Choose Next: Configure Security Settings.
10. Ignore the warning that appears and choose **Next: Configure Routing**. (In this scenario, the network load balancer is used as pass through without any SSL termination. For end-to-end encryption, use SNC from SAP GUI to SAP Instance.)
11. For **Target group**, choose **Existing target group** and select the **sap-ascs** target group created earlier.
12. Choose **Next: Register Targets**.
13. Choose **Next: Review**.
14. Choose **Create**.
15. Repeat the steps 1 to 14 to create another Network Load Balancer for SAP HANA setup with Network Load Balancer TCP protocol listener to JDBC/SQL port 3<instance number>15. Choose VPC and the subnets where the primary and secondary SAP HANA database is deployed and register the target JDBC/SQL target group.
16. Add an additional listener to the Network Load Balancer created in step 14 with SAP StartSrv/HTTP port 5<instance number>13 listener port and register the target StartSrv/HTTP port target group.

Step 3. Set up VPC routing table.

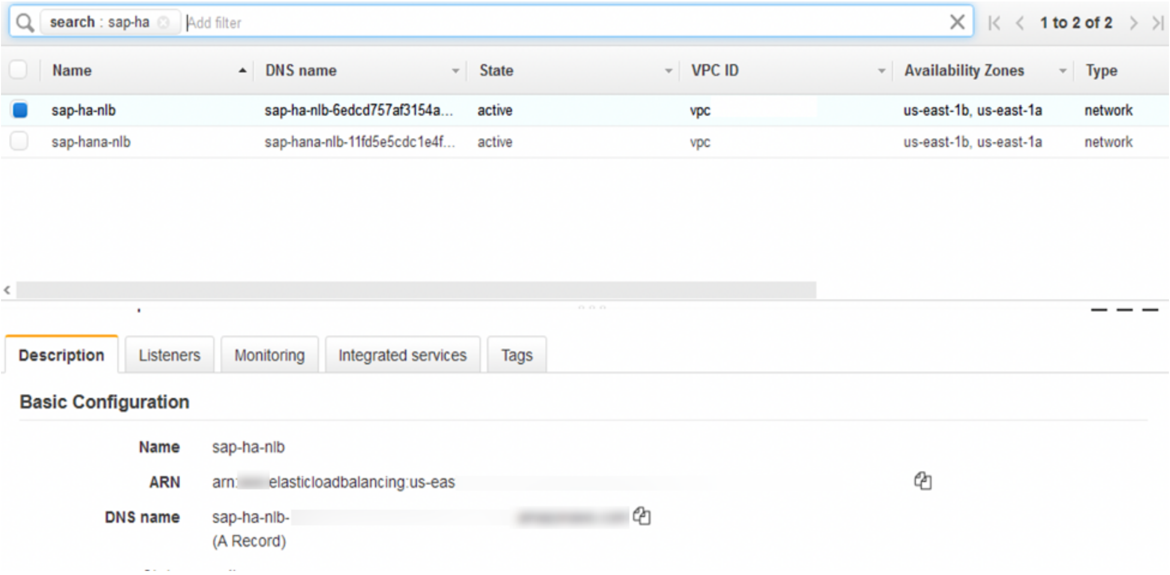
This step enables the connection to your SAP instance.

1. Open the Amazon VPC console at https://console.aws.amazon.com/vpc/
2. In the navigation pane, choose **Route Tables**, and select the Amazon VPC routing table where your SAP instance is deployed.
3. Choose **Actions**, **Edit routes**.
4. For **Destination**, specify your overlay IP address. For **Target**, specify the SAP instance Elastic Network Interface.
5. Choose Save routes.

This setup allows the static Network Load Balancer DNS to forward the traffic to your SAP instance network interface through the static overlay IP address. During failover scenarios, you can point to the you can point to the elastic network interface of the active SAP instance using manual steps or automatically using cluster management software.

Step 4. Connect using SAP GUI.

1. In the **Load Balancers** section of the EC2 console, make a note of the Network Load Balancer DNS name for the sap-ha-nlb.



	Name	DNS name	State	VPC ID	Availability Zones	Type
■	sap-ha-nlb	sap-ha-nlb-6edcd757af3154a...	active	vpc	us-east-1b, us-east-1a	network
□	sap-hana-nlb	sap-hana-nlb-11fd5e5cdc1e4f...	active	vpc	us-east-1b, us-east-1a	network

Basic Configuration

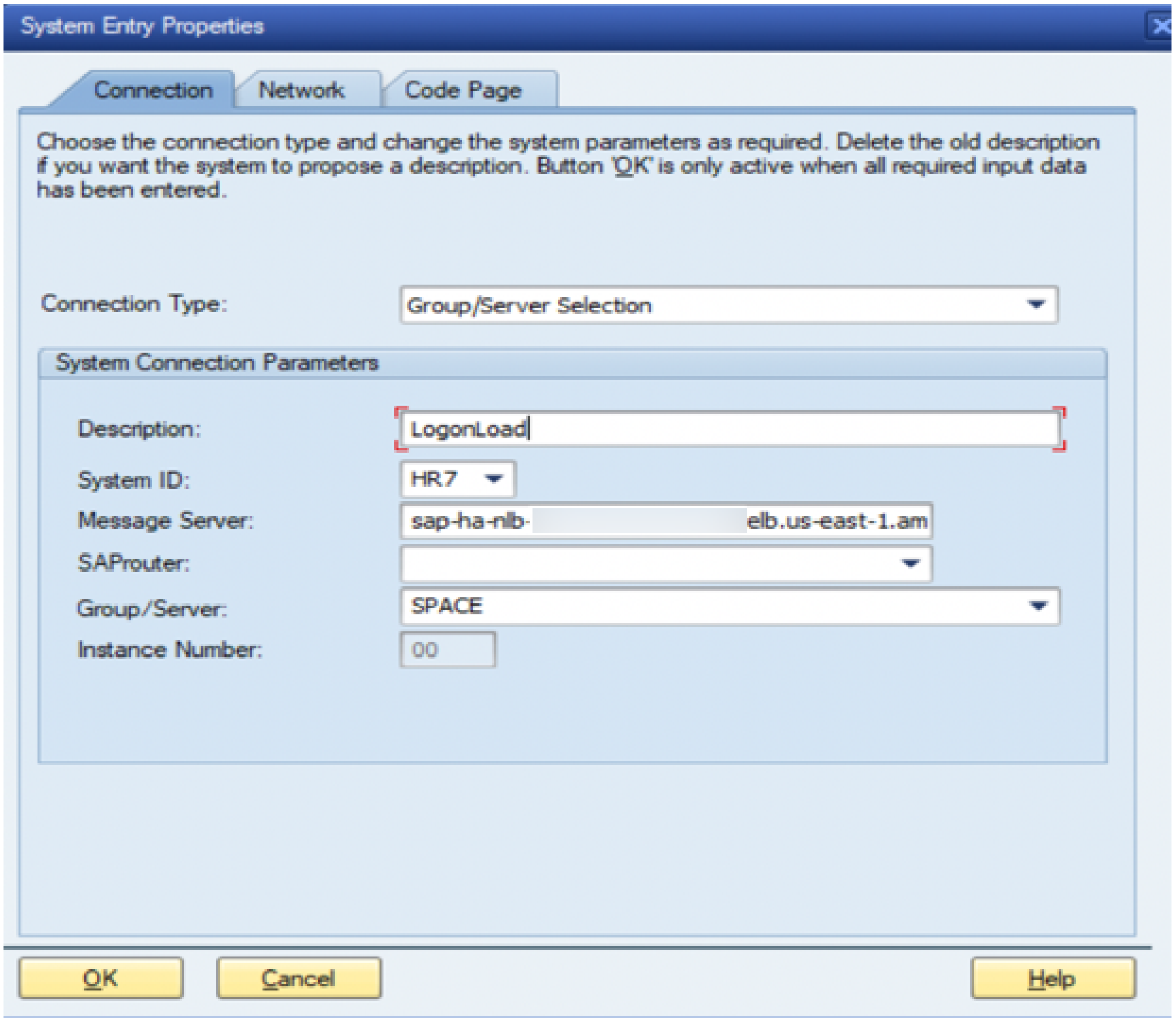
Name sap-ha-nlb

ARN arn:[redacted]elasticloadbalancing:us-eas[redacted]

DNS name sap-ha-nlb-[redacted]
(A Record)

Figure 7: sap-ha-nlb DNS name

2. Start SAP Logon.
3. Choose **New**, then **Next**.
4. In the System Entry Properties box, for Connection Type, choose Group/Server Selection.
5. For **Message Server**, type the Network Load Balancer DNS name, and choose **OK**.



Choose the connection type and change the system parameters as required. Delete the old description if you want the system to propose a description. Button 'OK' is only active when all required input data has been entered.

Connection Type: Group/Server Selection

Description: LogonLoad

System ID: HR7

Message Server: sap-ha-nlb-[redacted]elb.us-east-1.am

SAProuter:

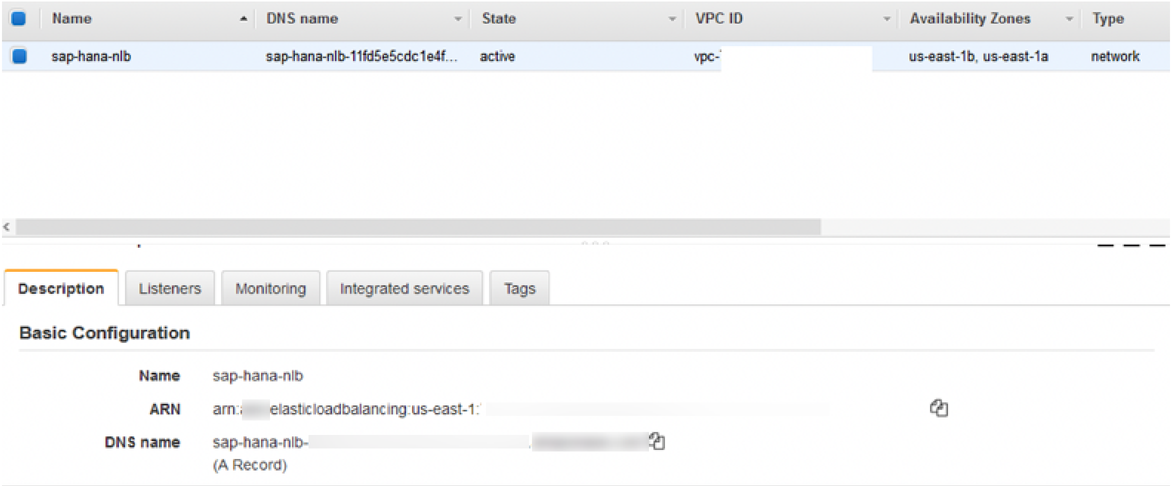
Group/Server: SPACE

Instance Number: 00

Figure 8: Configuring System Connection Parameters for SAP GUI

Step 5. Connect using SAP HANA Studio.

1. In the **Load Balancers** section of the EC2 console, make a note of the Network Load Balancer DNS name for the JBDC/SQL and SAPStartSrv/HTTP ports.



Name	DNS name	State	VPC ID	Availability Zones	Type
sap-hana-nlb	sap-hana-nlb-11fd5e5cdc1e4f...	active	vpc-[redacted]	us-east-1b, us-east-1a	network

Basic Configuration

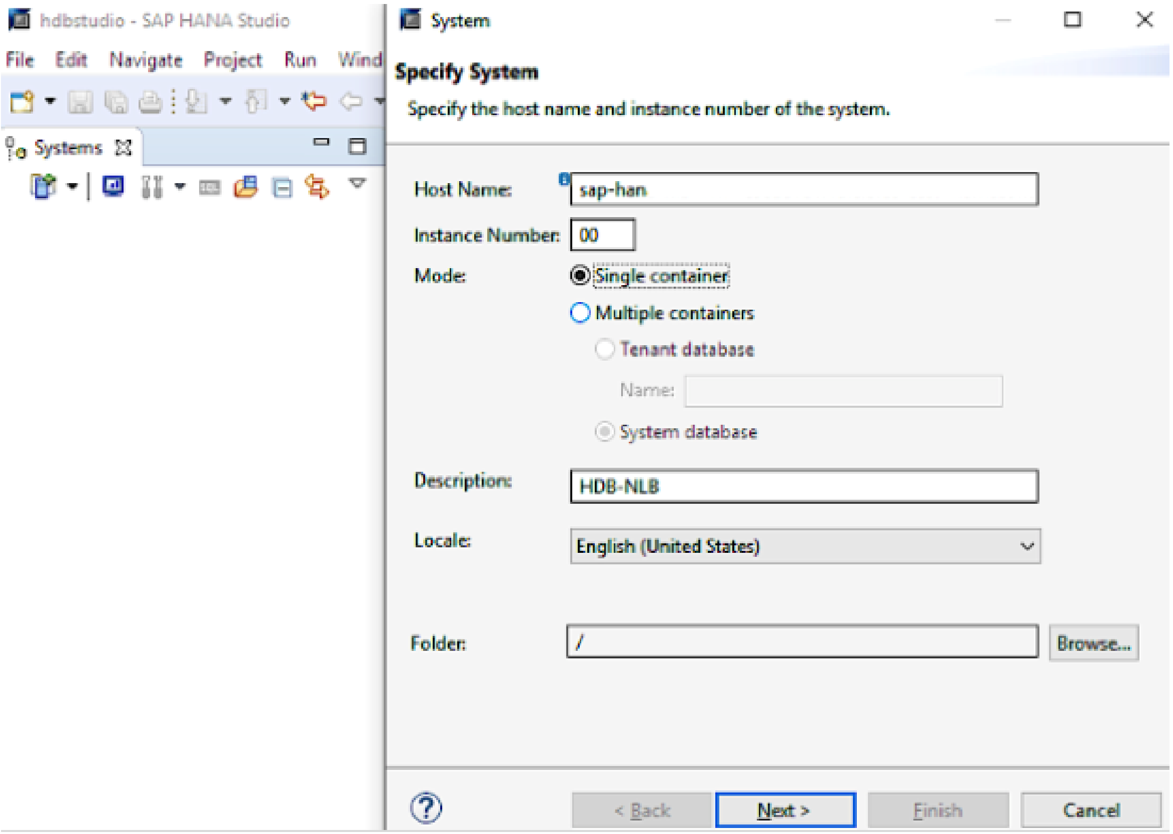
Name sap-hana-nlb

ARN arn:[redacted]elasticloadbalancing:us-east-1:[redacted]

DNS name sap-hana-nlb-[redacted]
(A Record)

Figure 9: DNS name of ports

2. In the Host Name parameter of SAP HANA Studio, use the Network Load Balancer DNS name and provide additional credentials to connect to the SAP HANA system.



hdbstudio - SAP HANA Studio
File Edit Navigate Project Run Wind
Systems
System

Specify System

Specify the host name and instance number of the system.

Host Name: sap-han

Instance Number: 00

Mode: ● Single container
○ Multiple containers
○ Tenant database
Name:
○ System database

Description: HDB-NLB

Locale: English (United States)

Folder: /

Browse...
< Back
Next >
Finish
Cancel

Figure 10: Updated Host Name in SAP HANA Studio

Additional Implementation Notes

- If other applications outside the VPC need to connect to the SAP system via the ASCS, create additional listeners with the ports on which these applications communicate.
- For customers using SAP Gateway Service (GW) and have designed HA for this service, create a target group for the GW service as well (33<instance-number>). Point the health check port for the GW target group to the message server port (36<instance-number>).
- You can use the corporate DNS or Amazon Route 53 to create a user friendly CNAME for the Network Load Balancer DNS name. If you use an alias for connecting to the SAP GUI on-premises, the alias can be created as the CNAME for the Network Load Balancer DNS name. With this approach, there are no changes required on your SAP GUI configuration post migration to AWS.

Additional Reading

SAP on AWS technical documentation

- SAP on AWS Technical Documentation
- AWS for SAP Solutions

SAP documentation

- SAP Hana Studio Service Connection SAP Note 1592925

Document Revisions

Date	Change
June 2020	Minor updates to add additional links and to make a diagram clearer.
March 2020	Initial publication

SAP HANA on AWS: High Availability Configuration Guide for SLES and RHEL

SAP specialists, Amazon Web Services

First publication: March 25, 2021

This guide is part of a content series that provides detailed information about hosting, configuring, and using SAP technologies in the Amazon Web Services Cloud. For the other guides in the series, ranging from overviews to advanced topics, see the SAP on AWS Technical Documentation home page.

This guide provides guidance about how to set up AWS resources and configure a high availability cluster on SUSE Linux Enterprise Server (SLES) and Red Hat Enterprise Linux (RHEL) operating systems to deploy a highly available configuration of SAP HANA on Amazon Elastic Compute Cloud (Amazon EC2) instances in an existing virtual private cloud (VPC).

Automated deployment of SAP HANA on AWS with high availability

AWS Launch Wizard and AWS Quick Start both provide reference deployment for SAP HANA to fast-track your SAP HANA deployment on AWS. Both AWS Launch Wizard and AWS Quick Start leverage AWS CloudFormation and scripts to quickly provision resources needed to deploy SAP HANA. They also encapsulate automated configuration of HANA System Replication (HSR) and SLES/RHEL high availability cluster with minimal manual intervention. Refer to the SAP HANA page on the AWS Quick Start deployment guide if you want to use the automated deployment:

- SAP HANA on the AWS Cloud: Quick Start Reference Deployment
- AWS Launch Wizard for SAP

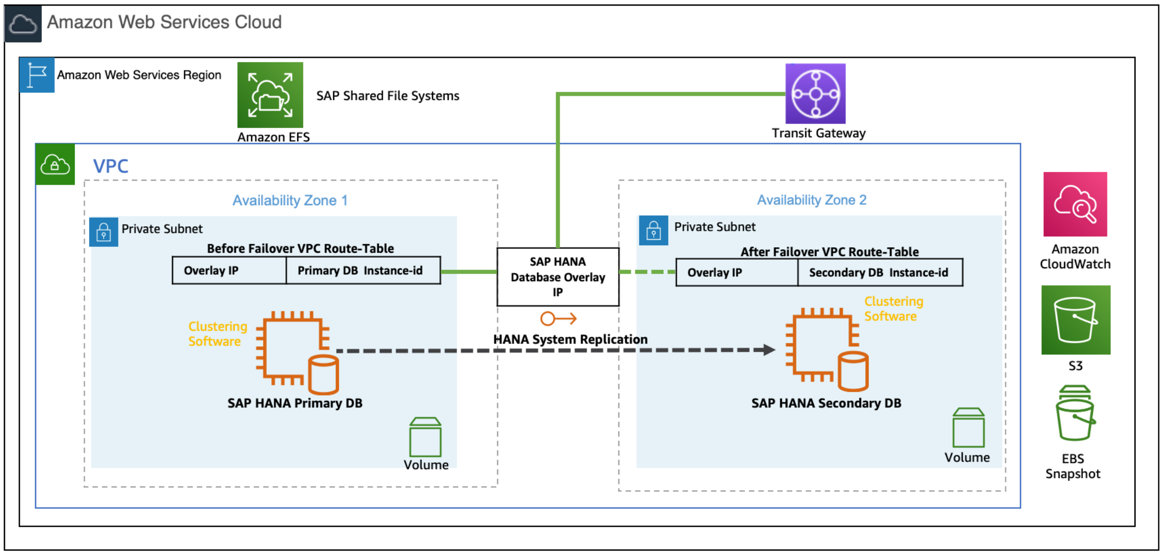
After you complete the deployment using either AWS Quick Start or Launch Wizard, you can follow the steps provided in these sections of the document to perform failover testing:

- Testing the cluster in SLES
- Testing the cluster in RHEL

Manual deployment of SAP HANA on AWS with high availability clusters

Architecture

This guide helps you configure high availability clusters on SLES or RHEL operating systems for your SAP HANA databases, deployed on Amazon EC2 instances in two different Availability Zones (AZs) within an AWS Region.



SAP HANA high availability cluster setup with Overlay IP

Operating System

You can deploy your SAP workload on SUSE Linux Enterprise Server (SLES) for SAP, Red Hat Enterprise Linux for SAP with High Availability and Update Services (RHEL for SAP with HA and US), or RHEL for SAP Solutions.

SLES for SAP and RHEL for SAP with HA and US are available in the AWS Marketplace with an hourly or an annual subscription model.

SLES

SLES for SAP provides additional benefits, including Extended Service Pack Overlap Support (ESPOS), configuration and tuning packages for SAP applications, and High Availability Extensions (HAE). See the SUSE SLES for SAP product page.AWS strongly recommends using SLES for SAP instead of SLES for all your SAP workloads.

If you plan to use Bring Your Own Subscription (BYOS) images provided by SUSE, ensure that you have the registration code required to register your instance with SUSE to access repositories for software updates.

RHEL

RHEL for SAP with HA and US provides access to Red Hat Pacemaker cluster software for High Availability, extended update support, and the libraries that are required to configure pacemaker cluster. For details, see the RHEL for SAP Offerings on AWS FAQ in the Red Hat knowledgebase.

If you plan to use the BYOS model with RHEL, either through the Red Hat Cloud Access program or another means, ensure that you have access to a RHEL for SAP Solutions subscription. For details, see Overview of the Red Hat Enterprise Linux for SAP Solutions subscription in the Red Hat knowledgebase.

The correct subscription is required to download the required packages for configuring the Pacemaker cluster.

AWS infrastructure, operating system setup and HANA installation

This guide mainly focuses on SAP HANA system replication setup and high availability cluster configuration steps on AWS. To set up AWS infrastructure, which is necessary to install primary and secondary SAP HANA databases, see the SAP HANA Environment Setup on AWS Guide and the following additional resources:

1. Amazon EC2 instances for SAP HANA
2. Storage recommendations for SAP HANA based on Amazon EC2 Instance Size
3. Deployment using AWS CLI and AWS Management Console
4. Operating system and storage configuration

After you have the AWS infrastructure ready, you will have to perform installations of primary and secondary SAP HANA databases as per the architecture diagram in the previous section. SAP HANA installation steps are detailed in SAP Installation Guides and Setup Manuals available on the SAP Help Portal.

Configure SAP HANA System Replication (HSR)

Following are the high-level steps to setup HSR:

1. Enable HANA system replication for the database on the primary cluster node.
2. Register the secondary SAP HANA database node with the primary cluster node and start the secondary SAP HANA database.
3. Verify the state of replication.

The following values are used to configure HSR and high availability cluster in this example:

- Primary database host name – `prihana`
- Secondary database host name – `sechana`
- Database system identifier (DBSID) – `HDB`
- Instance number – `00`
- Site name of primary node – `PRI`
- Site name of secondary node – `SEC`

Enabling system replication in primary node

As `<sid>adm` user enables the system replication at the primary node:

```
hdbadm@prihana> hdbnsutil -sr_enable --name=PRI
```

Register the secondary node with the primary node

The SAP HANA database instance on the secondary cluster node must be stopped before registering the database instance for system replication.

After the database instance is stopped, you can register the instance using `hdbnsutil`. On the secondary node, the mode should be either “SYNC“ or “SYNCMEM“.

In the following example, the replication mode used is SYNC.

As a <sid>adm user, stop the secondary SAP HANA database, register the secondary node, and start the SAP HANA database:

```
hdbadm@sechana> HDB stop
hdbadm@sechana> hdbnsutil -sr_register --name=SEC \
--remoteHost=prihana --remoteInstance=00 \
--replicationMode=sync --operationMode=logreplay
hdbadm@sechana> HDB start
```

Verifying the state of system replication

You can use the hdbnsutil tool to check the system replication mode and site name:

```
hdbadm@prihana> hdbnsutil -sr_state
checking for active or inactive nameserver ...
System Replication State
~~~~~~~~~~~~~~~~~~~~~~~~
mode: primary site id: 1
site name: PRI
Host Mappings:
~~~~~~~~~~~~~~
done.
```

```
hdbadm@sechana> hdbnsutil -sr_state
checking for active or inactive nameserver ...
System Replication State
~~~~~~~~~~~~~~~~~~~~~~~~
mode: sync
site id: 2
site name: SEC
active primary site: 1
~~~~~~~~~~~~~~
```

You can view the replication state of the whole SAP HANA landscape using the following command as a <sid>adm user on the primary node:

```
hdbadm@prihana> HDBSettings.sh systemReplicationStatus.py --sapcontrol=1
...
site/2/SITE_NAME=SEC
site/2/SOURCE_SITE_ID=1
site/2/REPLICATION_MODE=SYNC
site/2/REPLICATION_STATUS=ACTIVE
site/1/REPLICATION_MODE=PRIMARY
site/1/SITE_NAME=PRI
local_site_id=1
...
```

Configuring system replication operation mode

When your SAP HANA database is connected as an SAPHanaSR target, you can find an entry in the global.ini which represents the operation mode.

To have your secondary site as a hot standby system, the operation mode configured must be 'logreplay'.

For more details regarding all operation modes, see How To Perform System Replication for SAP HANA.

Ensure the operation_mode parameter is set to your desired operation mode in the global.ini configuration file on both the primary and secondary nodes.

The path for the `global.ini` is `/hana/shared/global/hdb/custom/config/`.

```
operation_mode = logreplay
```

Configuring the SAP HANA HA/DR provider hook

The following section is applicable if your SAP HANA database version is 2.0 and above. You can skip this section if your SAP HANA database is below version 2.0.

SAP HANA provides "hooks" that allows SAP HANA to send out notifications for certain events. A hook is used to improve the detection of when a takeover is required. Both SLES and RHEL provide such a hook in their respective resource packages which allows SAP HANA to report to the cluster immediately if the secondary gets out of sync. These hooks must be configured on both nodes – primary and secondary. To integrate the HA/DR hook script with SAP HANA, you must stop the database and update the `global.ini` configuration file.

Implementing the Python hook `SAPHanaSR` in RHEL

As a `<sid>adm` user, stop the SAP HANA databases on both nodes, either with HDB or using `sapcontrol`, before proceeding further with changes.

```
sapcontrol -nr NN -function StopSystem
```

As a root user, copy the hook from the `SAPHanaSR` package into a read/writable directory.

```
# mkdir -p /hana/shared/myHooks
# cp /usr/share/SAPHanaSR/srHook/SAPHanaSR.py /hana/shared/myHooks
# chown -R hdbadm:sapsys /hana/shared/myHooks
```

Update the `global.ini` file **on each node** to enable use of the hook script by both SAP HANA instances. Ensure that you make a copy/backup of `global.ini` before updating the file.

See the following example for updating the global.ini at location (`/hana/shared/HDB/global/hdb/custom/config/global.ini`):

```
[ha_dr_provider_SAPHanaSR]
provider = SAPHanaSR
path = /hana/shared/myHooks
execution_order = 1

[trace]
ha_dr_saphanasr = info
```

The current version of the `SAPHanaSR` python hook uses the command `sudo` to allow the `<sid>adm` user to access the cluster attributes. To enable this, update the file `/etc/sudoers` as a root user with entries as shown in the following example:

```
# SAPHanaSR-ScaleUp entries for writing srHook cluster attribute
Cmnd_Alias SOK_SITEA = /usr/sbin/crm_attribute -n hana_HDB_site_srHook_PRI -v SOK -t
 crm_config -s SAPHanaSR
Cmnd_Alias SFAIL_SITEA = /usr/sbin/crm_attribute -n hana_HDB_site_srHook_PRI -v SFAIL -t
 crm_config -s SAPHanaSR
Cmnd_Alias SOK_SITEB = /usr/sbin/crm_attribute -n hana_HDB_site_srHook_SEC -v SOK -t
 crm_config -s SAPHanaSR
Cmnd_Alias SFAIL_SITEB = /usr/sbin/crm_attribute -n hana_HDB_site_srHook_SEC -v SFAIL -t
 crm_config -s SAPHanaSR
hdbadm ALL=(ALL) NOPASSWD: SOK_SITEA, SFAIL_SITEA, SOK_SITEB, SFAIL_SITEB
```

Note
When using the above example for your HANA system, replace `hdbam` with `<sid>adm`.

Implementing Python hook `SAPHanaSR` in SLES

Use the hook from the `SAPHanaSR` package. Optionally, you can copy it to your preferred directory; for example, `/hana/share/myHooks`. The hook must be available on all SAP HANA cluster nodes.

Stop the SAP HANA database, either with HDB or using sapcontrol, before proceeding further with changes.

```
sapcontrol -nr <instance_number> -function StopSystem
```

Update the global.ini file located at the `/hana/shared/<SID>/global/hdb/custom/config/` directory on each node to enable the use of the hook script by both SAP HANA instances. Ensure that you make a copy/backup of `global.ini`before updating the file.

```
[ha_dr_provider_SAPHanaSR]
provider = SAPHanaSR
path = /usr/share/SAPHanaSR
execution_order = 1

[trace]
ha_dr_saphanasr = info
```

The current version of the `SAPHanaSR` python hook uses the command sudo to allow the `<sid>adm` to access the cluster attributes. To enable this, edit and update the file `/etc/sudoers` as a root user with entries as shown in the following example:

```
# SAPHanaSR-ScaleUp entries for writing srHook cluster attribute
Cmnd_Alias SOK_SITEA = /usr/sbin/crm_attribute -n
hana_HDB_site_srHook_PRI -v SOK -t crm_config -s SAPHanaSR
Cmnd_Alias SFAIL_SITEA = /usr/sbin/crm_attribute -n
hana_HDB_site_srHook_PRI -v SFAIL -t crm_config -s SAPHanaSR
Cmnd_Alias SOK_SITEB = /usr/sbin/crm_attribute -n
hana_HDB_site_srHook_SEC -v SOK -t crm_config -s SAPHanaSR
Cmnd_Alias SFAIL_SITEB = /usr/sbin/crm_attribute -n
hana_HDB_site_srHook_SEC -v SFAIL -t crm_config -s SAPHanaSR hdbadm
ALL=(ALL) NOPASSWD: SOK_SITEA, SFAIL_SITEA, SOK_SITEB, SFAIL_SITEB
```

Cluster configuration prerequisites

Disable the source/destination check

Each EC2 instance performs source/destination checks by default. This means that the instance must be the source or destination of any traffic it sends or receives. For cluster instances, source/destination check must be disabled on both EC2 instances which are supposed to receive traffic from the Overlay IP address. You can use the AWS CLI or AWS Management Console to disable source/destination check. For details, see the ec2 modify-instance-attribute documentation.

AWS roles and policies

The SAP HANA database EC2 instances will run the SLES or RHEL cluster software and its agents. Because SLES and RHEL clustering software and its agents need to access AWS resources to perform failover activities, they need specific AWS IAM privileges.

Create a new IAM role and associate it to the two EC2 instances which are part of the cluster. Attach the following IAM policies to this IAM role.

Create the `STONITH` policy

Both instances of the cluster need the privilege to start and stop the other nodes within the cluster. Create a policy as shown in the following example and attach it to the IAM role which is assigned to both cluster instances.

```
{
    "Version": "2012-10-17",
    "Statement": [
        {
            "Effect": "Allow",
            "Action": [
                "ec2:DescribeInstances",
                "ec2:DescribeInstanceAttribute",
                "ec2:DescribeTags"
            ],
            "Resource": "*"
        },
        {
            "Effect": "Allow",
            "Action": [
                "ec2:ModifyInstanceAttribute",
                "ec2:RebootInstances",
                "ec2:StartInstances",
                "ec2:StopInstances"
            ],
            "Resource": [
                "arn:aws:ec2:<Region-name>:<account-id>:instance/<instance-id>",
                "arn:aws:ec2: <Region-name>:<account-id>:instance/<instance-id>"
            ]
        }
    ]
}
```

Replace region name, `account-id`, and instance identifier with the appropriate values.

Create an overlay IP agent policy

Amazon VPC setup includes assigning subnets to your primary/secondary nodes for the SAP HANA database. Each of these configured subnets has a classless inter-domain routing (CIDR) IP assignment from the VPC which resides entirely within one Availability Zone. This CIDR IP assignment cannot span multiple zones or be reassigned to the secondary instance in a different AZ during a failover scenario. For this reason,AWS enables you to configure Overlay IP (OIP) outside of your VPC CIDR block to access the active SAP instance. With IP overlay routing, you can allow the AWS network to use a non-overlapping RFC1918 private IP address that resides outside an VPC CIDR range and direct the SAP traffic to any instance setup across the Availability Zone within the VPC by changing the routing entry in AWS using SLES/RHEL Overlay IP agent.

For the SLES/RHEL Overlay IP agent to change a routing entry in AWS routing tables, create the following policy and attach to the IAM role which is assigned to both cluster instances:

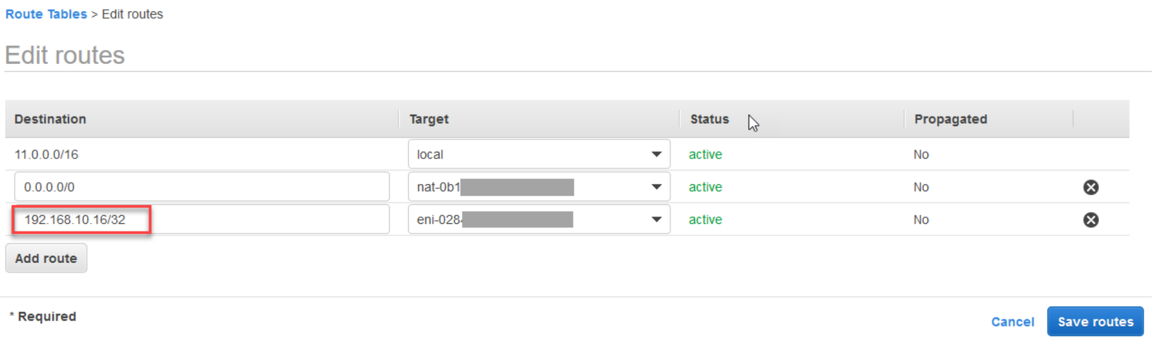
```
{
    "Version": "2012-10-17",
    "Statement": [
        {
            "Effect": "Allow",
            "Action": "ec2:ReplaceRoute",
            "Resource": [
"arn:aws:ec2:<Region>:<account-id>:route-table/<route table identifier 1>",
"arn:aws:ec2:<Region>:<account-id>:route-table/<route table identifier 2>”
]
        },
        {
            "Effect": "Allow",
            "Action": "ec2:DescribeRouteTables",
            "Resource": "*"
        }
    ]
}
```

Replace region name, account-id, and route table identifiers with appropriate values.

Update routing tables

Add a routing entry to the routing tables which are assigned to the subnets of your primary and secondary EC2 instances. This IP address is the virtual IP (overlay IP) address of the SAP HANA cluster which needs to be outside the CIDR range of the VPC. To modify or add a route to a route table using the console:

1. Open the Amazon VPC console at https://console.aws.amazon.com/vpc/ (signin required).
2. In the navigation pane, choose **Route Tables**, and select the route table.
3. Choose **Actions** > **Edit routes**.
4. Scroll to the end of the list and click **Add another route**.
5. Add the overlay IP address in the **Destination** section and select **Elastic Network Interface (ENI) name** for one of your existing instances.
6. Save your changes by clicking **Save routes**.



Route Tables > Edit routes

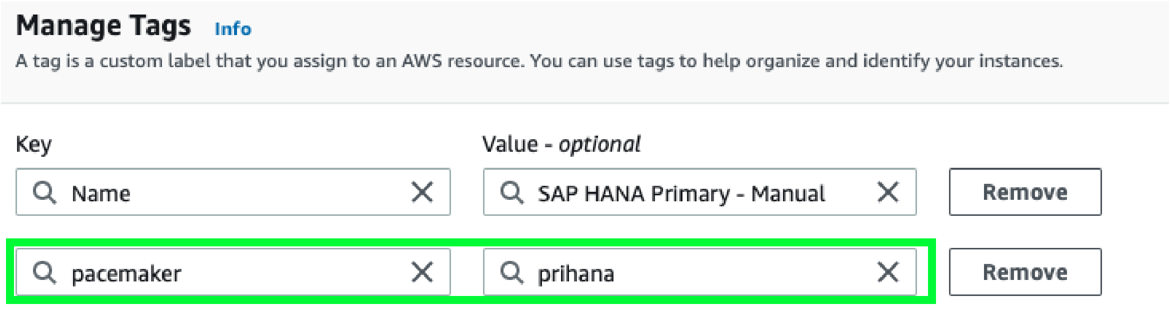
Edit routes

Destination	Target	Status	Propagated
11.0.0.0/16	local	active	No
0.0.0.0/0	nat-0b1[redacted]	active	No
192.168.10.16/32	eni-028[redacted]	active	No

Overlay-IP address entry in route table

Tagging the EC2 instances (required only for SLES)

In SLES, AWS EC2 STONITH agents use AWS resource tags to identify the EC2 instances. Create a tag for the primary and secondary EC2 instances through the console or the AWS CLI. In the following example the user has chosen pacemaker and the hostname, which is shown in the command uname.

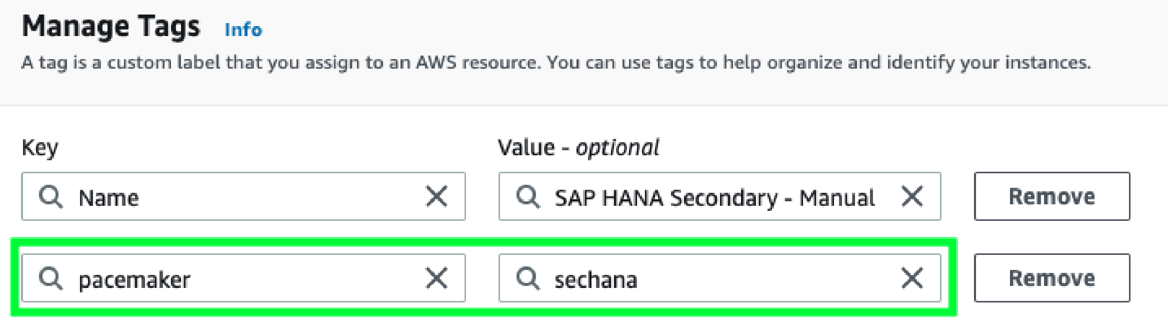


Manage Tags Info

A tag is a custom label that you assign to an AWS resource. You can use tags to help organize and identify your instances.

Key	Value - *optional*
Name	SAP HANA Primary - Manual
pacemaker	prihana

Tagging the primary database EC2 instance



Manage Tags

A tag is a custom label that you assign to an AWS resource. You can use tags to help organize and identify your instances.

Key	Value - *optional*
Name	SAP HANA Secondary - Manual
pacemaker	sechana

Tagging the secondary database EC2 instance

HA cluster configuration on SLES

These instructions are applicable for SUSE Linux Enterprise Server for SAP Applications 12 and SUSE Linux Enterprise Server for SAP Applications 15.

Cluster installation

SLES for SAP Images sold by AWS through AWS Marketplace comes with pre-installed SUSE HAE packages. Ensure you have the latest version of the following packages. If needed, update them using the `zypper` command. If you are using BYOS images, ensure that the following packages are installed:

- `corosync`
- `crmsh`
- `fence-agents`
- `ha-cluster-bootstrap`
- `pacemaker`
- `patterns-ha-ha_sles`
- `resource-agents`
- `cluster-glue`

Cluster configuration

System logging

SUSE recommends using the rsyslogd daemon for logging in the SUSE cluster. Install the `rsyslog` package as a root user on all cluster nodes. `logd` is a subsystem to log additional information coming from the `STONITH` agent:

```
prihana:~ # zypper install rsyslog
prihana:~ # systemctl enable logd
prihana:~ # systemctl start logd
```

Corosync configuration

The cluster service (Pacemaker) should be in a stopped state when performing cluster configuration. Check the status and stop the Pacemaker service if it is running.

- This is the command to check the Pacemaker status:

```
prihana:~ # systemctl status pacemaker
```

- This is the command to stop Pacemaker:

```
prihana:~ # systemctl stop pacemaker
```

Create encryption keys

Run the following command to create a secret key which is used to encrypt all the cluster communication:

```
prihana:~ # corosync-keygen
```

A new key file called “`authkey`” is created at location `/etc/corosync/`. Copy this file to the same location on the second cluster node with the same permissions and ownership.

Create the Corosync configuration file

All cluster nodes are required to have a local configuration file “`/etc/corosync/corosync.conf`”, as shown in the following example.

```
prihana:/etc/corosync # cat corosync.conf
# Please read the corosync.conf.5 manual page
totem {
        version: 2
        token: 30000
        consensus: 36000
        token_retransmits_before_loss_const: 6
        crypto_cipher: none
        crypto_hash: none
        clear_node_high_bit: yes
        rrp_mode: passive

        interface {
                ringnumber: 0
                bindnetaddr: 11.0.1.132
                mcastport: 5405
                ttl: 1
        }
        transport: udpu
}
logging {
        fileline: off
        to_logfile: yes
        to_syslog: yes
        logfile: /var/log/cluster/corosync.log
        debug: off
        timestamp: on
        logger_subsys {
                subsys: QUORUM
                debug: off
        }
}
nodelist {
        node {
                ring0_addr: 11.0.1.132
                ring1_addr: 11.0.1.75
                nodeid: 1
        }
        node {
                ring0_addr: 11.0.2.139
                ring1_addr: 11.0.2.35
                nodeid: 2
        }
}

        quorum {
        # Enable and configure quorum subsystem (default: off)
        # see also corosync.conf.5 and votequorum.5
        provider: corosync_votequorum
        expected_votes: 2
        two_node: 1
}
```

Replace the values for the following variables with those for your environment:

- `bindnetaddr` — IP address of the node where the file is being configured.
- `ring0_addr` — Primary IP address of cluster node 1.
- `ring1_addr` — Secondary IP address of cluster node 1.
- `ring0_addr` — Primary IP address of cluster node 2.
- `ring1_addr` — Secondary IP address of cluster node 2.

Also update the value of for `crypto_cipher` and `crypto_hash` as per your encryption requirements.

Update the `hacluster` password

Change the password of the user `haclustser` on both the nodes as shown in the following example:

```
prihana:~ # passwd hacluster
```

```
sechana:~ # passwd hacluster
```

Start the cluster

Start the cluster on both the primary and secondary nodes and check the status.

- This is the command to check the Pacemaker status:

  ```
  prihana:~ # systemctl status pacemaker
  ```

- This is the command to start Pacemaker:

  ```
  prihana:~ # systemctl start pacemaker
  ```

After the cluster service (Pacemaker) is started, check the cluster status with the `crm_mon` command as shown in the following example. You will see both nodes online and a full list of resources.

```
prihana:~ # crm_mon -r
Stack: corosync
Current DC: prihana (version 1.1.18+20180430.b12c320f5-3.24.1-b12c320f5) - partition with
 quorum
Last updated: Wed Nov 11 16:20:40 2020
Last change: Wed Nov 11 16:20:21 2020 by root via crm_attribute on sechana

2 nodes configured
```

```
0 resources configured

Online: [ prihana sechana ]

Full list of resources:

No resources
```

You can find the ring status and the associated IP address of the cluster with the `corosync-cfgtool` command as shown in the following example:

```
prihana:~ # corosync-cfgtool -s
Printing ring status.
Local node ID 1
RING ID 0
        id      = 11.0.1.132
        status  = ring 0 active with no faults
RING ID 1
        id      = 11.0.1.75
        status  = ring 1 active with no faults
```

Cluster resources

This section describes how to configure the bootstrap, `STONITH`, resources, and constraints using the `crm` command. You can use the command “`crm`” to add objects.

Cluster the bootstrap

Create a file called “`crm-bs.txt`” with the following cluster bootstrap options:

```
prihana:~ # cat crm-bs.txt
property $id="cib-bootstrap-options" \
   stonith-enabled="true" \
   stonith-action="off" \
   stonith-timeout="600s"
rsc_defaults $id="rsc-options" \
   resource-stickiness="1000" \
   migration-threshold="5000"
op_defaults $id="op-options" \
   timeout="600"
```

Setting the `stonith-action` parameter value to “off” forces the agents to shut down the instance during failover. This is desirable to avoid split brain scenarios.

Add the cluster bootstrap configuration to the cluster with the following command:

```
prihana:~ # crm configure load update crm-bs.txt
```

`STONITH` device

Create a file called “`aws-stonith.txt`” with the following `STONITH` options:

```
prihana:~ # cat aws-stonith.txt
primitive res_AWS_STONITH stonith:external/ec2 \
        op start interval=0 timeout=180 \
        op stop interval=0 timeout=180 \
        op monitor interval=120 timeout=60 \
        meta target-role=Started \
        params tag=pacemaker profile=cluster pcmk_delay_max=15
```

Ensure the value parameter “`tag`” matches the tag key you created for your EC2 instance in the “Prerequisites” section. In this example, “`pacemaker`” is used for the parameter tag. The name of the profile “`cluster`” needs to be matched with the configured AWS profile.

Add the `STONITH` configuration file to the cluster with the following command:

```
prihana:~ # crm configure load update aws-stonith.txt
```

Move the IP resource

Create a file called “`aws-move-ip.txt`” with the following cluster bootstrap options to move IP resources during failover:

```
prihana:~ # cat aws-move-ip.txt
primitive res_AWS_IP ocf:suse:aws-vpc-move-ip \
params ip=<overlay ip address> routing_table=<route table identifier 1>,
<route table identifier 2>  interface=eth0 profile=cluster \
op start interval=0 timeout=180 \
op stop interval=0 timeout=180 \
op monitor interval=60 timeout=60
```

Replace the value for parameters `ip` and `routing_table` with your overlay IP address and route table names.

Add the `move` IP configuration file to the cluster with the following command:

```
prihana:~ # crm configure load update aws-move-ip.txt
```

SAPHanaTopology

Create a file called “`crm-saphanatop.txt`” with the following cluster bootstrap options for SAP HANA topology information:

```
prihana:~ # cat crm-saphanatop.txt
primitive rsc_SAPHanaTopology_HDB_HDB00 ocf:suse:SAPHanaTopology \
        op monitor interval="10" timeout="600" \
        op start interval="0" timeout="600" \
        op stop interval="0" timeout="300" \
        params SID="HDB" InstanceNumber="00"
clone cln_SAPHanaTopology_HDB_HDB00 rsc_SAPHanaTopology_HDB_HDB00 \
        meta clone-node-max="1" interleave="true"
```

Update the value of parameters `SID` and `InstanceNumber` with your SAP HANA system information. In addition, update the SID and Instance number referred in the `rsc_SAPHanaTopology_<SID>HDB<Instance Number>` and `ln_SAPHanaTopology_<SID>_HDB<Instance Number>c` configurations. Tune the timeout parameters (`start`, `stop`, and `monitor`) for your environment.

Add the SAP HANA topology configuration file to the cluster with the following command:

```
prihana:~ # crm configure load update crm-saphanatop.txt
```

SAPHana

Create a file called “`crm-saphana.txt`” with the following cluster bootstrap options for SAP HANA:

```
prihana:~ # cat crm-saphana.txt
primitive rsc_SAPHana_HDB_HDB00 ocf:suse:SAPHana \
        op start interval="0" timeout="3600" \
        op stop interval="0" timeout="3600" \
        op promote interval="0" timeout="3600" \
        op monitor interval="60" role="Master" timeout="700" \
        op monitor interval="61" role="Slave" timeout="700" \
        params SID="HDB" InstanceNumber="10" PREFER_SITE_TAKEOVER="true" \
        DUPLICATE_PRIMARY_TIMEOUT="7200" AUTOMATED_REGISTER="true"
ms msl_SAPHana_HDB_HDB00 rsc_SAPHana_HDB_HDB00 \
        meta clone-max="2" clone-node-max="1" interleave="true"
```

Update the value of parameters `SID` and `InstanceNumber` with your SAP HANA system information. In addition, update the SID and Instance number referred in the `rsc_SAPHana_<SID>HDB<Instance Number>` and `msl_SAPHana<SID>_HDB<Instance Number>` configuration.

> **Note**
> You can find the detailed information about all the parameters with the command “`man ocf_suse_SAPHana`”

Add the SAP HANA configuration file to the cluster with the following command:

```
prihana:~ # crm configure load update crm-saphana.txt
```

Constraints

Define two constraints, one for the Overlay IP address which helps with routing client traffic to active database host and the second one for the start order between the `SAPHANA` and `SAPHANATopology` resource agents.

Create a file called “`crm-cs.txt`” with following cluster bootstrap options for constraints:

```
prihana:~ # cat crm-cs.txt
colocation col_IP_Primary 2000: res_AWS_IP:Started msl_SAPHana_HDB_HDB00:Master
order ord_SAPHana 2000: cln_SAPHanaTopology_HDB_HDB00 msl_SAPHana_HDB_HDB00
```

Update the `SID` and `Instance` number referred in `cln_SAPHanaTopology_<SID>_HDB<Instance Number>` and `msl_SAPHana_<SID>_HDB<Instance Number>` configuration.

Add the constraints configuration file to the cluster with the following command:

```
prihana:~ # crm configure load update crm-cs.txt
```

Cluster status

After the cluster is configured, you should see two online nodes, and six resources. You can check it with the following command:

```
prihana:~ # crm status
Stack: corosync
Current DC: prihana (version 1.1.18+20180430.b12c320f5-3.24.1-b12c320f5) - partition with
 quorum
Last updated: Thu Nov 12 11:37:20 2020
Last change: Thu Nov 12 11:37:11 2020 by hacluster via crmd on sechana

2 nodes configured
6 resources configured

Online: [ prihana sechana ]

Full list of resources:
 res_AWS_STONITH        (stonith:external/ec2): Started prihana
 res_AWS_IP     (ocf::suse:aws-vpc-move-ip):    Started prihana
 Clone Set: cln_SAPHanaTopology_HDB_HDB00 [rsc_SAPHanaTopology_HDB_HDB00]
     Started: [ prihana sechana ]
 Master/Slave Set: msl_SAPHana_HDB_HDB00 [rsc_SAPHana_HDB_HDB00]
     Masters: [ prihana ]
     Slaves: [ sechana ]
```

You can check the status of the replication by executing the `crm_mon` command as shown in the following example. Ensure that the state of the replication in the secondary node is `"SOK"`.

```
prihana:~ # crm_mon -A1
Stack: corosync
Current DC: prihana (version 1.1.18+20180430.b12c320f5-3.24.1-b12c320f5) - partition with
 quorum
Last updated: Thu Nov 12 11:38:25 2020
Last change: Thu Nov 12 11:37:33 2020 by root via crm_attribute on prihana

2 nodes configured
6 resources configured

Online: [ prihana sechana ]

Active resources:

 res_AWS_STONITH        (stonith:external/ec2): Started prihana
 res_AWS_IP     (ocf::suse:aws-vpc-move-ip):    Started prihana
 Clone Set: cln_SAPHanaTopology_HDB_HDB00 [rsc_SAPHanaTopology_HDB_HDB00]
     Started: [ prihana sechana ]
 Master/Slave Set: msl_SAPHana_HDB_HDB00 [rsc_SAPHana_HDB_HDB00]
     Masters: [ prihana ]
     Slaves: [ sechana ]

Node Attributes:
* Node prihana:
    + hana_hdb_clone_state              : PROMOTED
    + hana_hdb_op_mode                  : logreplay
    + hana_hdb_remoteHost               : sechana
    + hana_hdb_roles                    : 4:P:master1:master:worker:master
    + hana_hdb_site                     : PRI
    + hana_hdb_srmode                   : sync
    + hana_hdb_sync_state               : PRIM
    + hana_hdb_version                  : 2.00.030.00.1522209842
    + hana_hdb_vhost                    : prihana
    + lpa_hdb_lpt                       : 1605181053
    + master-rsc_SAPHana_HDB_HDB00      : 150
* Node sechana:
    + hana_hdb_clone_state              : DEMOTED
    + hana_hdb_op_mode                  : logreplay
    + hana_hdb_remoteHost               : prihana
    + hana_hdb_roles                    : 4:S:master1:master:worker:master
    + hana_hdb_site                     : SEC
    + hana_hdb_srmode                   : sync
    + hana_hdb_sync_state               : SOK
    + hana_hdb_version                  : 2.00.030.00.1522209842
    + hana_hdb_vhost                    : sechana
    + lpa_hdb_lpt                       : 30
    + master-rsc_SAPHana_HDB_HDB00      : 100
```

Testing the cluster

After the cluster setup is complete, perform the following tests to validate cluster setup. Run these tests in sequence.

Test 1: Stop SAP HANA database on the primary node

Description — Stop the primary SAP HANA database during normal cluster operation.

Run node — Primary SAP HANA database node

Run steps:

- Stop the primary SAP HANA database gracefully as `<sid>adm`.

```
prihana:~ # su - hdbadm
hdbadm@prihana:/usr/sap/HDB/HDB00> HDB stop
hdbdaemon will wait maximal 300 seconds for NewDB services finishing.
Stopping instance using: /usr/sap/HDB/SYS/exe/hdb/sapcontrol -prot
NI_HTTP -nr 00 -function Stop 400

12.11.2020 11:39:19
Stop
OK
Waiting for stopped instance using: /usr/sap/HDB/SYS/exe/hdb/sapcontrol
-prot NI_HTTP -nr 00 -function WaitforStopped 600 2

12.11.2020 11:39:51
WaitforStopped
OK
hdbdaemon is stopped.
```

Expected result:

- The cluster detects stopped primary SAP HANA database (on node 1) and promotes secondary SAP HANA database (on node 2) to take over as primary.

```
prihana:~ # crm status
Stack: corosync
Current DC: prihana (version 1.1.18+20180430.b12c320f5-3.24.1-b12c320f5) -
partition with quorum
Last updated: Thu Nov 12 11:41:31 2020
Last change: Thu Nov 12 11:41:30 2020 by root via crm_attribute on sechana

2 nodes configured
6 resources configured

Online: [ prihana sechana ]

Full list of resources:

 res_AWS_STONITH        (stonith:external/ec2): Started prihana
 res_AWS_IP     (ocf::suse:aws-vpc-move-ip):    Started sechana
 Clone Set: cln_SAPHanaTopology_HDB_HDB00 [rsc_SAPHanaTopology_HDB_HDB00]
     Started: [ prihana sechana ]
 Master/Slave Set: msl_SAPHana_HDB_HDB00 [rsc_SAPHana_HDB_HDB00]
     Masters: [ sechana ]
     Slaves: [ prihana ]

Failed Actions:
* rsc_SAPHana_HDB_HDB00_monitor_60000 on prihana 'master (failed)' (9):
call=30, status=complete, exitreason='',
    last-rc-change='Thu Nov 12 11:40:42 2020', queued=0ms, exec=0ms
```

- The overlay IP address is migrated to the new primary (on node 2).

```
sechana:~ # ip addr show
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen
 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
2: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 9000 qdisc mq state UP group default qlen
 1000
    link/ether 0e:ef:dd:3c:bf:1b brd ff:ff:ff:ff:ff:ff
    inet 11.0.2.139/24 brd 11.0.2.255 scope global eth0
       valid_lft forever preferred_lft forever
    inet 11.0.2.35/32 scope global eth0:1
       valid_lft forever preferred_lft forever
    inet 192.168.10.16/32 scope global eth0
       valid_lft forever preferred_lft forever
    inet6 fe80::cef:ddff:fe3c:bf1b/64 scope link
       valid_lft forever preferred_lft forever
```

- With the `AUTOMATIC_REGISTER` parameter set to "`true`", the cluster restarts the failed SAP HANA database and automatically registers it against the new primary.

Recovery procedure:

- Clean up the cluster “`failed actions`” on node 1 as root.

```
prihana:~ # crm resource cleanup rsc_SAPHana_HDB_HDB00 prihana
Cleaned up rsc_SAPHana_HDB_HDB00:0 on prihana
Cleaned up rsc_SAPHana_HDB_HDB00:1 on prihana
Waiting for 1 replies from the CRMd. OK
```

- After you run the `crm` command to clean up the resource, “`failed actions`” messages should disappear from the cluster status.

```
prihana:~ # crm status
Stack: corosync
Current DC: prihana (version 1.1.18+20180430.b12c320f5-3.24.1-b12c320f5) - partition with
 quorum
Last updated: Thu Nov 12 11:44:05 2020
Last change: Thu Nov 12 11:43:39 2020 by hacluster via crmd on prihana

2 nodes configured
6 resources configured

Online: [ prihana sechana ]

Full list of resources:

 res_AWS_STONITH        (stonith:external/ec2): Started prihana
 res_AWS_IP     (ocf::suse:aws-vpc-move-ip):    Started sechana
 Clone Set: cln_SAPHanaTopology_HDB_HDB00 [rsc_SAPHanaTopology_HDB_HDB00]
     Started: [ prihana sechana ]
 Master/Slave Set: msl_SAPHana_HDB_HDB00 [rsc_SAPHana_HDB_HDB00]
     Masters: [ sechana ]
     Slaves: [ prihana ]
```

Test 2: Stop SAP HANA database on the secondary node

Description — Stop the primary SAP HANA database (on Node 2) during normal cluster operation.

Run node — Primary SAP HANA database node (on Node 2)

Run steps:

- Stop the SAP HANA database gracefully as `<sid>adm` on node 2.

```
sechana:~ # su - hdbadm
hdbadm@sechana:/usr/sap/HDB/HDB00> HDB stop
hdbdaemon will wait maximal 300 seconds for NewDB services finishing.
Stopping instance using: /usr/sap/HDB/SYS/exe/hdb/sapcontrol -prot
NI_HTTP -nr 00 -function Stop 400

12.11.2020 11:45:21
Stop
OK
Waiting for stopped instance using: /usr/sap/HDB/SYS/exe/hdb/sapcontrol
-prot NI_HTTP -nr 00 -function WaitforStopped 600 2


12.11.2020 11:45:53
WaitforStopped
OK
hdbdaemon is stopped.
```

Expected result:

- The cluster detects stopped primary SAP HANA database (on node 2) and promotes the secondary SAP HANA database (on node 1) to take over as primary.

```
sechana:~ # crm status
Stack: corosync
Current DC: prihana (version 1.1.18+20180430.b12c320f5-3.24.1-b12c320f5)
- partition with quorum
Last updated: Thu Nov 12 11:47:38 2020
Last change: Thu Nov 12 11:47:33 2020 by root via crm_attribute on prihana

2 nodes configured
6 resources configured

Online: [ prihana sechana ]

Full list of resources:

 res_AWS_STONITH        (stonith:external/ec2): Started prihana
 res_AWS_IP     (ocf::suse:aws-vpc-move-ip):    Started prihana
 Clone Set: cln_SAPHanaTopology_HDB_HDB00 [rsc_SAPHanaTopology_HDB_HDB00]
     Started: [ prihana sechana ]
 Master/Slave Set: msl_SAPHana_HDB_HDB00 [rsc_SAPHana_HDB_HDB00]
     Masters: [ prihana ]
     Slaves: [ sechana ]

Failed Actions:
* rsc_SAPHana_HDB_HDB00_monitor_60000 on sechana 'master (failed)' (9):
call=46, status=complete, exitreason='',
    last-rc-change='Thu Nov 12 11:46:45 2020', queued=0ms, exec=0ms
```

- The overlay IP address is migrated to the new primary (on node 1).

```
prihana:~ # ip addr show
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen
 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
2: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 9000 qdisc mq state UP group default qlen
 1000
    link/ether 0a:38:1c:ce:b4:3d brd ff:ff:ff:ff:ff:ff
    inet 11.0.1.132/24 brd 11.0.1.255 scope global eth0
       valid_lft forever preferred_lft forever
    inet 11.0.1.75/32 scope global eth0:1
       valid_lft forever preferred_lft forever
    inet 192.168.10.16/32 scope global eth0
       valid_lft forever preferred_lft forever
    inet6 fe80::838:1cff:fece:b43d/64 scope link
       valid_lft forever preferred_lft forever
```

- With the `AUTOMATIC_REGISTER` parameter set to "`true`", the cluster restarts the failed SAP HANA database and automatically registers it against the new primary.

Recovery procedure:

- After you run the `crm` command to clean up the resource, "`failed actions`" messages should disappear from the cluster status.

```
sechana:~ # crm resource cleanup rsc_SAPHana_HDB_HDB00 sechana
Cleaned up rsc_SAPHana_HDB_HDB00:0 on sechana
Cleaned up rsc_SAPHana_HDB_HDB00:1 on sechana
Waiting for 1 replies from the CRMd. OK
```

- After resource cleanup, the cluster “`failed actions`” are cleaned up.

```
sechana:~ # crm status
Stack: corosync
Current DC: prihana (version 1.1.18+20180430.b12c320f5-3.24.1-b12c320f5) - partition with
 quorum
Last updated: Thu Nov 12 11:50:05 2020
Last change: Thu Nov 12 11:49:39 2020 by root via crm_attribute on prihana

2 nodes configured
6 resources configured

Online: [ prihana sechana ]

Full list of resources:

 res_AWS_STONITH        (stonith:external/ec2): Started prihana
 res_AWS_IP     (ocf::suse:aws-vpc-move-ip):    Started prihana
 Clone Set: cln_SAPHanaTopology_HDB_HDB00 [rsc_SAPHanaTopology_HDB_HDB00]
     Started: [ prihana sechana ]
 Master/Slave Set: msl_SAPHana_HDB_HDB00 [rsc_SAPHana_HDB_HDB00]
     Masters: [ prihana ]
     Slaves: [ sechana ]
```

Test 3: Crash primary SAP HANA database on node 1

Description: Simulate a complete breakdown of the primary database system.

Run node: Primary SAP HANA database node

Run steps:

- Stop the primary database system using the following command as `<sid>adm`.

```
prihana:~ # sudo su - hdbadm
hdbadm@prihana:/usr/sap/HDB/HDB00> HDB kill -9
hdbenv.sh: Hostname prihana defined in $SAP_RETRIEVAL_PATH=/usr/sap/
HDB/HDB00/prihana differs from host name defined on command line.
hdbenv.sh: Error: Instance not found for host -9
killing HDB processes:
kill -9 6011 /usr/sap/HDB/HDB00/prihana/trace/hdb.sapHDB_HDB00 -d -nw -f
/usr/sap/HDB/HDB00/prihana/daemon.ini pf=/usr/sap/HDB/SYS/profile/HDB_HDB00_prihana
kill -9 6027 hdbnameserver
kill -9 6137 hdbcompileserver
kill -9 6139 hdbpreprocessor
kill -9 6484 hdbindexserver -port 30003
kill -9 6494 hdbxsengine -port 30007
kill -9 7068 hdbwebdispatcher
kill orphan HDB processes:
kill -9 6027 [hdbnameserver] <defunct>
kill -9 6484 [hdbindexserver] <defunct>
```

Expected result:

- The cluster detects the stopped primary SAP HANA database (on node 1) and promotes the secondary SAP HANA database (on node 2) to take over as primary.

```
prihana:~ # crm status
Stack: corosync
Current DC: prihana (version 1.1.18+20180430.b12c320f5-3.24.1-b12c320f5) -
partition with quorum
Last updated: Thu Nov 12 11:53:21 2020
Last change: Thu Nov 12 11:53:19 2020 by root via crm_attribute on sechana

2 nodes configured
6 resources configured

Online: [ prihana sechana ]

Full list of resources:

 res_AWS_STONITH        (stonith:external/ec2): Started prihana
 res_AWS_IP     (ocf::suse:aws-vpc-move-ip):    Started sechana
 Clone Set: cln_SAPHanaTopology_HDB_HDB00 [rsc_SAPHanaTopology_HDB_HDB00]
     Started: [ prihana sechana ]
 Master/Slave Set: msl_SAPHana_HDB_HDB00 [rsc_SAPHana_HDB_HDB00]
     Masters: [ sechana ]
     Slaves: [ prihana ]

Failed Actions:
* rsc_SAPHana_HDB_HDB00_monitor_60000 on prihana 'master (failed)' (9): call=50,
status=complete, exitreason='',
    last-rc-change='Thu Nov 12 11:51:45 2020', queued=0ms, exec=0ms
```

- The overlay IP address is migrated to the new primary (on node 2).
- With the `AUTOMATIC_REGISTER` parameter set to "`true`", the cluster restarts the failed SAP HANA database and automatically registers it against the new primary.

Recovery procedure:

- Clean up the cluster “`failed actions`” on node 1 as root.

```
prihana:~ # crm resource cleanup rsc_SAPHana_HDB_HDB00 prihana
Cleaned up rsc_SAPHana_HDB_HDB00:0 on prihana
Cleaned up rsc_SAPHana_HDB_HDB00:1 on prihana
Waiting for 1 replies from the CRMd. OK
```

- After resource cleanup, the cluster “`failed actions`” are cleaned up.

Test 4: Crash primary database on node 2

Description — Simulate a complete breakdown of the primary database system.

Run node — Primary SAP HANA database node (on node 2).

Run steps:

- Stop the primary database (on node 2) system using the following command as `<sid>adm`.

```
sechana:~ # su - hdbadm
hdbadm@sechana:/usr/sap/HDB/HDB00> HDB kill -9
hdbenv.sh: Hostname sechana defined in $SAP_RETRIEVAL_PATH=/usr/sap/
HDB/HDB00/sechana differs from host name defined on command line.
hdbenv.sh: Error: Instance not found for host -9
killing HDB processes:
kill -9 30751 /usr/sap/HDB/HDB00/sechana/trace/hdb.sapHDB_HDB00 -d
-nw -f /usr/sap/HDB/HDB00/sechana/daemon.ini pf=/usr/sap/HDB/SYS/profile/
HDB_HDB00_sechana
kill -9 30899 hdbnameserver
kill -9 31166 hdbcompileserver
kill -9 31168 hdbpreprocessor
kill -9 31209 hdbindexserver -port 30003
kill -9 31211 hdbxsengine -port 30007
kill -9 31721 hdbwebdispatcher
kill orphan HDB processes:
kill -9 30899 [hdbnameserver] <defunct>
kill -9 31209 [hdbindexserver] <defunct>
```

Expected result:

- The cluster detects stopped primary SAP HANA database (on node 2) and promotes the secondary SAP HANA database (on node 1) to take over as primary.

```
sechana:~ # crm status
Stack: corosync
Current DC: prihana (version 1.1.18+20180430.b12c320f5-3.24.1-b12c320f5)
- partition with quorum
Last updated: Thu Nov 12 12:04:01 2020
Last change: Thu Nov 12 12:03:53 2020 by root via crm_attribute on prihana

2 nodes configured
```

```
6 resources configured

Online: [ prihana sechana ]

Full list of resources:

 res_AWS_STONITH        (stonith:external/ec2): Started prihana
 res_AWS_IP     (ocf::suse:aws-vpc-move-ip):    Started prihana
 Clone Set: cln_SAPHanaTopology_HDB_HDB00 [rsc_SAPHanaTopology_HDB_HDB00]
     Started: [ prihana sechana ]
 Master/Slave Set: msl_SAPHana_HDB_HDB00 [rsc_SAPHana_HDB_HDB00]
     Masters: [ prihana ]
     Slaves: [ sechana ]

Failed Actions:
* rsc_SAPHana_HDB_HDB00_monitor_60000 on sechana 'master (failed)' (9):
call=66, status=complete, exitreason='',
    last-rc-change='Thu Nov 12 11:58:53 2020', queued=0ms, exec=0ms
```

- The overlay IP address is migrated to the new primary (on node 1).
- With the `AUTOMATIC_REGISTER` parameter set to "`true`", the cluster restarts the failed SAP HANA database and automatically registers it against the new primary.

Recovery procedure:

- Clean up the cluster “`failed actions`” on node 2 as root.

```
sechana:~ # crm resource cleanup rsc_SAPHana_HDB_HDB00 sechana
Cleaned up rsc_SAPHana_HDB_HDB00:0 on sechana
Cleaned up rsc_SAPHana_HDB_HDB00:1 on sechana
Waiting for 1 replies from the CRMd. OK
```

- After resource cleanup, the cluster “`failed actions`” are cleaned up.

Test 5: Reboot SAP HANA node1

Description: Simulate a crash of the primary site node running the primary SAP HANA database.

Run node: Primary SAP HANA database node

Run steps:

- Crash the primary database system using the following command as root:

```
prihana:~ # crm status
Stack: corosync
Current DC: prihana (version 1.1.18+20180430.b12c320f5-3.24.1-b12c320f5) - partition with
 quorum
Last updated: Thu Nov 12 12:09:44 2020
Last change: Thu Nov 12 12:09:11 2020 by root via crm_attribute on prihana

2 nodes configured
6 resources configured

Online: [ prihana sechana ]

Full list of resources:

 res_AWS_STONITH        (stonith:external/ec2): Started prihana
 res_AWS_IP     (ocf::suse:aws-vpc-move-ip):    Started prihana
 Clone Set: cln_SAPHanaTopology_HDB_HDB00 [rsc_SAPHanaTopology_HDB_HDB00]
```

```
     Started: [ prihana sechana ]
 Master/Slave Set: msl_SAPHana_HDB_HDB00 [rsc_SAPHana_HDB_HDB00]
     Masters: [ prihana ]
     Slaves: [ sechana ]

prihana:~ # echo 'b' > /proc/sysrq-trigger
```

> **Note**
> To simulate a system crash, you must first ensure that `/proc/sys/kernel/sysrq` is set to 1.

Expected result:

- The cluster detects failed node (node 1), declares it “`UNCLEAN`” and sets the secondary node (node 2) to status “`partition WITHOUT quorum`”.
- The cluster fences node 1 and promotes the secondary SAP HANA database (on node 2) to take over as primary.

```
sechana:~ # crm status
Stack: corosync
Current DC: prihana (version 1.1.18+20180430.b12c320f5-3.24.1-b12c320f5) - partition with
 quorum
Last updated: Thu Nov 12 12:15:51 2020
Last change: Thu Nov 12 12:15:31 2020 by root via crm_attribute on sechana

2 nodes configured
6 resources configured

Online: [ sechana ]
OFFLINE: [ prihana ]

Full list of resources:

 res_AWS_STONITH        (stonith:external/ec2): Started sechana
 res_AWS_IP     (ocf::suse:aws-vpc-move-ip):    Started sechana
 Clone Set: cln_SAPHanaTopology_HDB_HDB00 [rsc_SAPHanaTopology_HDB_HDB00]
     Started: [ sechana ]
     Stopped: [ prihana ]
 Master/Slave Set: msl_SAPHana_HDB_HDB00 [rsc_SAPHana_HDB_HDB00]
     Masters: [ sechana ]
     Stopped: [ prihana ]
```

- The overlay IP address is migrated to the new primary (on node 2).
- With the `AUTOMATIC_REGISTER` parameter set to "`true`", the cluster restarts the failed SAP HANA database and automatically registers it against the new primary.

Recovery procedure:

- Start node 1 (EC2 instance) with the AWS Management Console or AWS CLI tools and start Pacemaker (if it’s not enabled by default).

Test 6: Reboot SAP HANA node 2

Description — Simulate a crash of the primary site node (on node 2) running the primary SAP HANA database.

Run node — Primary SAP HANA database node (on node 2)

Run steps:

- Crash the primary database system (on node 2) using the following command as root:

```
sechana:~ # crm status
Stack: corosync
Current DC: sechana (version 1.1.18+20180430.b12c320f5-3.24.1-b12c320f5) - partition with
 quorum
Last updated: Thu Nov 12 12:16:57 2020
Last change: Thu Nov 12 12:16:41 2020 by root via crm_attribute on sechana

2 nodes configured
6 resources configured

Online: [ prihana sechana ]

Full list of resources:

 res_AWS_STONITH        (stonith:external/ec2): Started prihana
 res_AWS_IP     (ocf::suse:aws-vpc-move-ip):    Started sechana
 Clone Set: cln_SAPHanaTopology_HDB_HDB00 [rsc_SAPHanaTopology_HDB_HDB00]
     Started: [ prihana sechana ]
 Master/Slave Set: msl_SAPHana_HDB_HDB00 [rsc_SAPHana_HDB_HDB00]
     Masters: [ sechana ]
     Slaves: [ prihana ]

sechana:~ # echo 'b' > /proc/sysrq-trigger
```

> **Note**
> To simulate a system crash, you must first ensure that `/proc/sys/kernel/sysrq` is set to `1`.

Expected result:

- The cluster detects failed node (node 2), declares it "`UNCLEAN`", and sets the secondary node (node 1) to status "`partition WITHOUT quorum`".
- The cluster fences node 2 and promotes the secondary SAP HANA database (on node 1) to take over as primary.

```
prihana:~ # crm status
Stack: corosync
Current DC: prihana (version 1.1.18+20180430.b12c320f5-3.24.1-b12c320f5) - partition with
 quorum
Last updated: Thu Nov 12 12:28:51 2020
Last change: Thu Nov 12 12:28:31 2020 by root via crm_attribute on prihana

2 nodes configured
6 resources configured

Online: [ prihana ]
OFFLINE: [ sechana ]

Full list of resources:

 res_AWS_STONITH        (stonith:external/ec2): Started prihana
 res_AWS_IP     (ocf::suse:aws-vpc-move-ip):    Started prihana
 Clone Set: cln_SAPHanaTopology_HDB_HDB00 [rsc_SAPHanaTopology_HDB_HDB00]
     Started: [ prihana ]
     Stopped: [ sechana ]
 Master/Slave Set: msl_SAPHana_HDB_HDB00 [rsc_SAPHana_HDB_HDB00]
     Masters: [ prihana ]
     Stopped: [ sechana ]
```

- The overlay IP address is migrated to the new primary (on node 1).

- With the AUTOMATIC_REGISTER parameter set to "true", the cluster restarts the failed SAP HANA database and automatically registers it against the new primary.

Recovery procedure:

- Start node 2 (EC2 instance) with AWS Management Console or AWS CLI tools and start Pacemaker (if it's not enabled by default).

Test 7: Simulating a cluster network failure

Description — Simulate a network failure to test the cluster behavior in case of a split brain.

Run node — Can be run on any node. In this test case, this is done on node B.

Run steps:

- Drop all the traffic coming from and going to node A with the following command:

```
iptables -A INPUT -s <<Primary IP address of Node A>> -j DROP; iptables
-A OUTPUT -d <<Primary IP address of Node A>> -j DROP

sechana:~ # crm status
Stack: corosync
Current DC: prihana (version 1.1.18+20180430.b12c320f5-3.24.1-b12c320f5)
- partition with quorum
Last updated: Fri Jan 22 02:16:28 2021
Last change: Fri Jan 22 02:16:27 2021 by root via crm_attribute on sechana
2 nodes configured
6 resources configured
Online: [ prihana sechana ]
Full list of resources:
 res_AWS_STONITH        (stonith:external/ec2): Started prihana
 res_AWS_IP     (ocf::suse:aws-vpc-move-ip):    Started sechana
 Clone Set: cln_SAPHanaTopology_HDB_HDB00 [rsc_SAPHanaTopology_HDB_HDB00]
     Started: [ prihana sechana ]
 Master/Slave Set: msl_SAPHana_HDB_HDB00 [rsc_SAPHana_HDB_HDB00]
     Masters: [ prihana ]
     Slaves: [ sechana ]
sechana:~ # iptables -A INPUT -s 11.0.1.132 -j DROP; iptables -A OUTPUT -d 11.0.1.132 -j
 DROP
```

Expected result:

- The cluster detects network failure and fence node 1. It promotes the secondary SAP HANA database (on node 2) to take over as primary without going to a split brain situation.

```
sechana:~ # crm status
Stack: corosync
Current DC: prihana (version 1.1.18+20180430.b12c320f5-3.24.1-b12c320f5)
- partition with quorum
Last updated: Fri Jan 22 17:08:09 2021
Last change: Fri Jan 22 17:07:46 2021 by root via crm_attribute on sechana

2 nodes configured
6 resources configured

Online: [ prihana sechana ]

Full list of resources:
 res_AWS_STONITH        (stonith:external/ec2): Started prihana
 res_AWS_IP     (ocf::suse:aws-vpc-move-ip):    Started sechana
 Clone Set: cln_SAPHanaTopology_HDB_HDB00 [rsc_SAPHanaTopology_HDB_HDB00]
     rsc_SAPHanaTopology_HDB_HDB00      (ocf::suse:SAPHanaTopology):
Started prihana (Monitoring)
     Started: [ sechana ]
 Master/Slave Set: msl_SAPHana_HDB_HDB00 [rsc_SAPHana_HDB_HDB00]
     Masters: [ sechana ]
     Stopped: [ prihana ]

Failed Actions:
* rsc_SAPHanaTopology_HDB_HDB00_monitor_10000 on prihana 'unknown error'
(1): call=317, status=Timed Out, exitreason='',
    last-rc-change='Fri Jan 22 16:58:19 2021', queued=0ms, exec=300001ms
* rsc_SAPHana_HDB_HDB00_start_0 on prihana 'unknown error' (1): call=28, status=Timed
 Out,
exitreason='',
    last-rc-change='Fri Jan 22 02:40:38 2021', queued=0ms, exec=3600001ms
```

Recovery procedure:

- Clean up the cluster “`failed actions`”.

Administration and troubleshooting

Monitor the status of the cluster

You can check the status of the cluster with the following commands:

```
prihana:~ # crm status
Stack: corosync
Current DC: prihana (version 1.1.18+20180430.b12c320f5-3.24.1-b12c320f5) - partition with
 quorum
Last updated: Thu Nov 12 12:35:56 2020
Last change: Thu Nov 12 12:34:57 2020 by root via crm_attribute on prihana

2 nodes configured
6 resources configured

Online: [ prihana sechana ]

Full list of resources:

 res_AWS_STONITH        (stonith:external/ec2): Started prihana
 res_AWS_IP     (ocf::suse:aws-vpc-move-ip):    Started prihana
 Clone Set: cln_SAPHanaTopology_HDB_HDB00 [rsc_SAPHanaTopology_HDB_HDB00]
     Started: [ prihana sechana ]
 Master/Slave Set: msl_SAPHana_HDB_HDB00 [rsc_SAPHana_HDB_HDB00]
     Masters: [ prihana ]
     Slaves: [ sechana ]
```

```
prihana:~ # crm_mon -1
Stack: corosync
Current DC: prihana (version 1.1.18+20180430.b12c320f5-3.24.1-b12c320f5) - partition with
 quorum
Last updated: Thu Nov 12 12:36:24 2020
Last change: Thu Nov 12 12:36:01 2020 by root via crm_attribute on prihana

2 nodes configured
6 resources configured
```

```
Online: [ prihana sechana ]

Active resources:

 res_AWS_STONITH        (stonith:external/ec2): Started prihana
 res_AWS_IP     (ocf::suse:aws-vpc-move-ip):    Started prihana
 Clone Set: cln_SAPHanaTopology_HDB_HDB00 [rsc_SAPHanaTopology_HDB_HDB00]
     Started: [ prihana sechana ]
 Master/Slave Set: msl_SAPHana_HDB_HDB00 [rsc_SAPHana_HDB_HDB00]
     Masters: [ prihana ]
     Slaves: [ sechana ]
```

Check the status of replication with the following command:

```
prihana:~ # crm_mon -A1
Stack: corosync
Current DC: prihana (version 1.1.18+20180430.b12c320f5-3.24.1-b12c320f5) - partition with
 quorum
Last updated: Thu Nov 12 12:37:28 2020
Last change: Thu Nov 12 12:37:04 2020 by root via crm_attribute on prihana

2 nodes configured
6 resources configured

Online: [ prihana sechana ]

Active resources:

 res_AWS_STONITH        (stonith:external/ec2): Started prihana
 res_AWS_IP     (ocf::suse:aws-vpc-move-ip):    Started prihana
 Clone Set: cln_SAPHanaTopology_HDB_HDB00 [rsc_SAPHanaTopology_HDB_HDB00]
     Started: [ prihana sechana ]
 Master/Slave Set: msl_SAPHana_HDB_HDB00 [rsc_SAPHana_HDB_HDB00]
     Masters: [ prihana ]
     Slaves: [ sechana ]

Node Attributes:
* Node prihana:
    + hana_hdb_clone_state              : PROMOTED
    + hana_hdb_op_mode                  : logreplay
    + hana_hdb_remoteHost               : sechana
    + hana_hdb_roles                    : 4:P:master1:master:worker:master
    + hana_hdb_site                     : PRI
    + hana_hdb_srmode                   : sync
    + hana_hdb_sync_state               : PRIM
    + hana_hdb_version                  : 2.00.030.00.1522209842
    + hana_hdb_vhost                    : prihana
    + lpa_hdb_lpt                       : 1605184624
    + master-rsc_SAPHana_HDB_HDB00      : 150
* Node sechana:
    + hana_hdb_clone_state              : DEMOTED
    + hana_hdb_op_mode                  : logreplay
    + hana_hdb_remoteHost               : prihana
    + hana_hdb_roles                    : 4:S:master1:master:worker:master
    + hana_hdb_site                     : SEC
    + hana_hdb_srmode                   : sync
    + hana_hdb_sync_state               : SOK
    + hana_hdb_version                  : 2.00.030.00.1522209842
    + hana_hdb_vhost                    : sechana
    + lpa_hdb_lpt                       : 30
    + master-rsc_SAPHana_HDB_HDB00      : 100
```

Cluster administration

To manually migrate the cluster resources from one node to another, run the following command:

```
prihana:~ # crm resource move rsc_SAPHana_HDB_HDB00 sechana
INFO: Move constraint created for rsc_SAPHana_HDB_HDB00 to sechana
```

Check the status of the migration using the command "`crm_mon -r`".

```
prihana:~ # crm_mon -r
Stack: corosync
Current DC: prihana (version 1.1.18+20180430.b12c320f5-3.24.1-b12c320f5) - partition with
 quorum
Last updated: Thu Nov 12 12:39:00 2020
Last change: Thu Nov 12 12:38:47 2020 by root via crm_attribute on prihana

2 nodes configured
6 resources configured

Online: [ prihana sechana ]

Full list of resources:

res_AWS_STONITH (stonith:external/ec2): Started prihana
res_AWS_IP      (ocf::suse:aws-vpc-move-ip):    Started sechana
 Clone Set: cln_SAPHanaTopology_HDB_HDB00 [rsc_SAPHanaTopology_HDB_HDB00]
     Started: [ prihana sechana ]
 Master/Slave Set: msl_SAPHana_HDB_HDB00 [rsc_SAPHana_HDB_HDB00]
     rsc_SAPHana_HDB_HDB00      (ocf::suse:SAPHana):    Promoting sechana
     Slaves: [ prihana ]
```

After the resource is migrated, you can check the status of the cluster. Clean up the failed actions as shown in next section.

```
prihana:~ # crm status
Stack: corosync
Current DC: prihana (version 1.1.18+20180430.b12c320f5-3.24.1-b12c320f5) - partition with
 quorum
Last updated: Thu Nov 12 12:41:07 2020
Last change: Thu Nov 12 12:40:44 2020 by root via crm_attribute on prihana

2 nodes configured
6 resources configured

Online: [ prihana sechana ]

Full list of resources:

 res_AWS_STONITH        (stonith:external/ec2): Started prihana
 res_AWS_IP     (ocf::suse:aws-vpc-move-ip):    Started sechana
 Clone Set: cln_SAPHanaTopology_HDB_HDB00 [rsc_SAPHanaTopology_HDB_HDB00]
     Started: [ prihana sechana ]
 Master/Slave Set: msl_SAPHana_HDB_HDB00 [rsc_SAPHana_HDB_HDB00]
     Masters: [ sechana ]
     Slaves: [ prihana ]

Failed Actions:
* rsc_SAPHana_HDB_HDB00_monitor_61000 on prihana 'not running' (7): call=35,
status=complete, exitreason='',
    last-rc-change='Thu Nov 12 12:39:49 2020', queued=0ms, exec=0ms
```

Resource cleanup activities

- You can run the command "`crm resource cleanup rsc_SAPHana_<SID>_HDB<Instance Number> <hostname>`" to clean up any failed actions, as shown in the following example:

```
prihana:~ # crm status
Stack: corosync
Current DC: prihana (version 1.1.18+20180430.b12c320f5-3.24.1-b12c320f5) - partition with
 quorum
Last updated: Thu Nov 12 12:41:07 2020
Last change: Thu Nov 12 12:40:44 2020 by root via crm_attribute on prihana

2 nodes configured
6 resources configured

Online: [ prihana sechana ]

Full list of resources:

 res_AWS_STONITH        (stonith:external/ec2): Started prihana
 res_AWS_IP     (ocf::suse:aws-vpc-move-ip):    Started sechana
 Clone Set: cln_SAPHanaTopology_HDB_HDB00 [rsc_SAPHanaTopology_HDB_HDB00]
     Started: [ prihana sechana ]
 Master/Slave Set: msl_SAPHana_HDB_HDB00 [rsc_SAPHana_HDB_HDB00]
     Masters: [ sechana ]
     Slaves: [ prihana ]

Failed Actions:
* rsc_SAPHana_HDB_HDB00_monitor_61000 on prihana 'not running' (7): call=35,
  status=complete, exitreason='',
    last-rc-change='Thu Nov 12 12:39:49 2020', queued=0ms, exec=0ms

prihana:~ # crm resource cleanup rsc_SAPHana_HDB_HDB00 prihana
Cleaned up rsc_SAPHana_HDB_HDB00:0 on prihana
Cleaned up rsc_SAPHana_HDB_HDB00:1 on prihana
Waiting for 1 replies from the CRMd. OK
prihana:~ #
```

- When you manually migrate resources from one node to another, there will be constraints in the `crm` configuration. You can find the constraints with the command "`crm configure show`" as shown in the following example:

```
prihana:~ # crm configure show
node 1: prihana \
        attributes lpa_hdb_lpt=30 hana_hdb_vhost=prihana hana_hdb_site=PRI
hana_hdb_srmode=sync hana_hdb_remoteHost=sechana hana_hdb_op_mode=logreplay
node 2: sechana \
        attributes lpa_hdb_lpt=1605184953 hana_hdb_vhost=sechana hana_hdb_site=SEC
hana_hdb_srmode=sync hana_hdb_remoteHost=prihana hana_hdb_op_mode=logreplay
primitive res_AWS_IP ocf:suse:aws-vpc-move-ip \
        params ip=192.168.10.16 routing_table=rtb-06ca3aca4c58bd17d interface=eth0
profile=cluster \
        op start interval=0 timeout=180 \
        op stop interval=0 timeout=180 \
        op monitor interval=60 timeout=60 \
        meta target-role=Started
primitive res_AWS_STONITH stonith:external/ec2 \
        op start interval=0 timeout=180 \
        op stop interval=0 timeout=180 \
        op monitor interval=120 timeout=60 \
        meta target-role=Started \
        params tag=pacemaker profile=cluster
```

```
primitive rsc_SAPHanaTopology_HDB_HDB00 ocf:suse:SAPHanaTopology \
        operations $id=rsc_sap2_HDB_HDB00-operations \
        op monitor interval=10 timeout=600 \
        op start interval=0 timeout=600 \
        op stop interval=0 timeout=300 \
        params SID=HDB InstanceNumber=00
primitive rsc_SAPHana_HDB_HDB00 ocf:suse:SAPHana \
        operations $id=rsc_sap_HDB_HDB00-operations \
        op start interval=0 timeout=3600 \
        op stop interval=0 timeout=3600 \
        op promote interval=0 timeout=3600 \
        op monitor interval=60 role=Master timeout=700 \
        op monitor interval=61 role=Slave timeout=700 \
        params SID=HDB InstanceNumber=00 PREFER_SITE_TAKEOVER=true DUPLICATE_PRIMARY_
TIMEOUT=7200 AUTOMATED_REGISTER=true HANA_CALL_TIMEOUT=600
ms msl_SAPHana_HDB_HDB00 rsc_SAPHana_HDB_HDB00 \
        meta clone-max=2 clone-node-max=1 interleave=true
clone cln_SAPHanaTopology_HDB_HDB00 rsc_SAPHanaTopology_HDB_HDB00 \
        meta clone-node-max=1 interleave=true
location cli-prefer-rsc_SAPHana_HDB_HDB00 rsc_SAPHana_HDB_HDB00 role=Started inf: sechana
colocation col_IP_Primary 2000: res_AWS_IP:Started msl_SAPHana_HDB_HDB00:Master
order ord_SAPHana 2000: cln_SAPHanaTopology_HDB_HDB00 msl_SAPHana_HDB_HDB00
property SAPHanaSR: \
        hana_hdb_site_srHook_SEC=PRIM \
        hana_hdb_site_srHook_PRI=SOK
property cib-bootstrap-options: \
        stonith-enabled=true \
        stonith-action=off \
        stonith-timeout=600s \
        have-watchdog=false \
        dc-version="1.1.18+20180430.b12c320f5-3.24.1-b12c320f5" \
        cluster-infrastructure=corosync \
        last-lrm-refresh=1605184909
rsc_defaults rsc-options: \
        resource-stickiness=1000 \
        migration-threshold=5000
op_defaults op-options: \
        timeout=600
```

You must clean up these location constraints before you perform any further cluster actions with following command:

```
prihana:~ # crm resource clear rsc_SAPHana_HDB_HDB00
INFO: Removed migration constraints for rsc_SAPHana_HDB_HDB00
```

Checking the logs

Start your troubleshooting by checking logs at `/var/log/messages`. For additional details, you can check cluster and Pacemaker logs.

- **Cluster logs** — Cluster logs are updated in the `corosync.log` file located under `/var/log/cluster` folder.
- **Pacemaker logs** — Pacemaker logs are updated in the `pacemaker.log` file located in the `/var/log/pacemaker` folder.

Sample working configuration

The example of a working configuration:

```
prihana:~ # crm configure show
node 1: prihana \
        attributes lpa_hdb_lpt=30 hana_hdb_vhost=prihana hana_hdb_site=PRI
hana_hdb_srmode=sync hana_hdb_remoteHost=sechana hana_hdb_op_mode=logreplay
node 2: sechana \
        attributes lpa_hdb_lpt=1605185144 hana_hdb_vhost=sechana hana_hdb_site=SEC
hana_hdb_srmode=sync hana_hdb_remoteHost=prihana hana_hdb_op_mode=logreplay
primitive res_AWS_IP ocf:suse:aws-vpc-move-ip \
        params ip=192.168.10.16 routing_table=rtb-06ca3aca4c58bd17d interface=eth0
        profile=cluster \
        op start interval=0 timeout=180 \
        op stop interval=0 timeout=180 \
        op monitor interval=60 timeout=60 \
        meta target-role=Started
primitive res_AWS_STONITH stonith:external/ec2 \
        op start interval=0 timeout=180 \
        op stop interval=0 timeout=180 \
        op monitor interval=120 timeout=60 \
        meta target-role=Started \
        params tag=pacemaker profile=cluster
primitive rsc_SAPHanaTopology_HDB_HDB00 ocf:suse:SAPHanaTopology \
        operations $id=rsc_sap2_HDB_HDB00-operations \
        op monitor interval=10 timeout=600 \
        op start interval=0 timeout=600 \
        op stop interval=0 timeout=300 \
        params SID=HDB InstanceNumber=00
primitive rsc_SAPHana_HDB_HDB00 ocf:suse:SAPHana \
        operations $id=rsc_sap_HDB_HDB00-operations \
        op start interval=0 timeout=3600 \
        op stop interval=0 timeout=3600 \
        op promote interval=0 timeout=3600 \
        op monitor interval=60 role=Master timeout=700 \
        op monitor interval=61 role=Slave timeout=700 \
        params SID=HDB InstanceNumber=00 PREFER_SITE_TAKEOVER=true
        DUPLICATE_PRIMARY_TIMEOUT=7200 AUTOMATED_REGISTER=true
ms msl_SAPHana_HDB_HDB00 rsc_SAPHana_HDB_HDB00 \
        meta clone-max=2 clone-node-max=1 interleave=true
clone cln_SAPHanaTopology_HDB_HDB00 rsc_SAPHanaTopology_HDB_HDB00 \
        meta clone-node-max=1 interleave=true
colocation col_IP_Primary 2000: res_AWS_IP:Started msl_SAPHana_HDB_HDB00:Master
order ord_SAPHana 2000: cln_SAPHanaTopology_HDB_HDB00 msl_SAPHana_HDB_HDB00
property SAPHanaSR: \
        hana_hdb_site_srHook_SEC=PRIM \
        hana_hdb_site_srHook_PRI=SOK
property cib-bootstrap-options: \
        stonith-enabled=true \
        stonith-action=off \
        stonith-timeout=600s \
        have-watchdog=false \
        dc-version="1.1.18+20180430.b12c320f5-3.24.1-b12c320f5" \
        cluster-infrastructure=corosync \
        last-lrm-refresh=1605184909
rsc_defaults rsc-options: \
        resource-stickiness=1000 \
        migration-threshold=5000
op_defaults op-options: \
        timeout=600
```

`Corosync` configuration file:

```
prihana:~ # cat /etc/corosync/corosync.conf
# Please read the corosync.conf.5 manual page
totem {
        version: 2
        token: 30000
        consensus: 36000
        token_retransmits_before_loss_const: 6
        crypto_cipher: none
        crypto_hash: none
        clear_node_high_bit: yes
        rrp_mode: passive

        interface {
                ringnumber: 0
                bindnetaddr: 11.0.1.132
                mcastport: 5405
                ttl: 1
        }
        transport: udpu
}
logging {
        fileline: off
        to_logfile: yes
        to_syslog: yes
        logfile: /var/log/cluster/corosync.log
        debug: off
        timestamp: on
        logger_subsys {
                subsys: QUORUM
                debug: off
        }
}
nodelist {
        node {
                ring0_addr: 11.0.1.132
                ring1_addr: 11.0.1.75
                nodeid: 1
        }
        node {
                ring0_addr: 11.0.2.139
                ring1_addr: 11.0.2.35
                nodeid: 2
        }
}

        quorum {
        # Enable and configure quorum subsystem (default: off)
        # see also corosync.conf.5 and votequorum.5
        provider: corosync_votequorum
        expected_votes: 2
        two_node: 1
}
```

HA cluster configuration on RHEL

The following instructions are applicable to Red Hat Enterprise Linux for SAP with version 7.x and 8.x. You will see different instructions (where applicable) in the following sections.

Cluster installation

Prerequisite – The system must be subscribed to the required subscription; in this case, RHEL for SAP Solutions.

> **Note**
> If you are using a BYOS image, ensure your system is configured with RHEL for SAP and Pacemaker repositories to install the required packages.

```
yum install -y pcs pacemaker fence-agents-aws
yum install -y resource-agents
yum install -y resource-agents-sap-hana
```

Cluster configuration

Update user `hacluster` password

Change the password of the user `haclustser` on both the nodes, as shown in the following example:

```
[root@prihana ~]# passwd hacluster
[root@sechana ~]# passwd hacluster
```

Start and enable the `pcs` services

The following commands start and enable the `pcs` service on both the nodes:

```
[root@prihana ~]# systemctl start pcsd.service
[root@prihana ~]# systemctl enable pcsd.service
```

Authenticate pcs with user hacluster

The following command authenticates `pcs` to the `pcs` daemon on the nodes in the cluster. The user name for the `pcs` administration must be `hacluster` on both the nodes with the same password.

RHEL 7.x

```
[root@prihana ~]# pcs cluster auth prihana sechana
Username: hacluster
Password:
sechana: Authorized
prihana: Authorized
[root@prihana ~]#
```

RHEL 8.x

```
[root@<host1> ~]# pcs host auth prihana sechana
Username: hacluster
Password:
sechana: Authorized
prihana: Authorized
[root@<host1> ~]#
```

Set up the cluster

The following command configures the cluster configuration file and syncs the configuration on both the nodes.

```
pcs cluster setup -name rhelhanaha prihana sechana

[rooteprihana~]pcs cluster setup --name rhelhanaha prihana sechana
Destroying cluster on nodes: prihana, sechana...
sechana: Stopping Cluster (pacemaker)...
prihana: Stopping Cluster (pacemaker)...
sechana: Successfully destroyed cluster
prihana: Successfully destroyed cluster
Sending 'pacemaker_remote authkey' to iprihana', 'sechana' prihana:
```

```
successful distribution of the file 'pacemaker remote authkey'
sechana: successful distribution of the file 'pacemaker_remote authkey'
Sending cluster config files to the nodes...
prihana: Succeeded
sechana: Succeeded
Synchronizing pcsd certificates on nodes prihana, sechana... saphdbdbe2: Success
prihana: Success
Restarting pcsd on the nodes in order to reload the certificates... sechana: Success
prihana: Success
```

Enable and start the cluster

The following commands enable and start the cluster:

```
pcs cluster enable -all

root@prihana etc]# pcs cluster enable --all
prihana: Cluster Enabled
sechana: Cluster Enabled
```

```
pcs cluster start -all

[root@prihana etc]# pcs cluster start --all
prihana: Starting Cluster (corosync)...
sechana: Starting Cluster (corosync)...
sechana: Starting Cluster (pacemaker)...
prihana: Starting Cluster (pacemaker)...
[rooteprihana etc]# I
```

Cluster resources

This section describes how to create the cluster resources.

STONITH

The following command creates the STONITH resource. This is to protect your data from being corrupted by rogue nodes or concurrent access in an event of split brain or dual primary situations.

```
pcs stonith create <resource-name> fence_aws region=<aws-region>
pcmk_host_map="<primary-hostname>:<primary-instance-id>;<secondary-
hostname>:<secondary-instance-id>" power_timeout=600
pcmk_reboot_timeout=600 pcmk_reboot_retries=4 op start timeout=300
op monitor timeout=60 pcmk_delay_max=15
```

```
[root@prihana —1#] pcs stonith create clusterfence fence_aws
region=us-east-1 pcmk_host_map=" prihana: 1-0dfS622xxxxxxxxx;
sechana: i-Ob2e372xxxxxxxx power_timeout=240
pcmk_reboot_timeout=480 pcm reboot retries=4 op start timeout=300
op monitor timeout=60 pcmk_delay_max=15
```

The default pcmk action is reboot. If you want to have the instance remain in a stopped state until it has been investigated and then manually started again, add pcmk_reboot_action=off. Any high-memory instances or metal instance running on a dedicated host won't support reboot and will require pcmk_reboot_action=off. To do this, update the previously created STONITH resource as:

```
pcs stonith update clusterfence fence_aws region=us-east-1
pcmk_host_map="prihana:i-0df8622xxxxxxxxxxx;sechana:i-
0b2e372xxxxxxxxxxx" power_timeout=600 pcmk_reboot_timeout=600
pcmk_reboot_retries=4 op start timeout=300 op monitor timeout=60
```

```
pcmk_reboot_action=off
```

SAPHanaTopology

The SAPHanaTopology resource gathers the status and configuration of SAP HANA System Replication on each node. Configure the following attributes for SAPHanaTopology.

Run the following command to create the SAPHANATopology resource:

```
pcs resource create SAPHanaTopology_HDB_00 SAPHanaTopology SID=HDB
InstanceNumber=00 op start timeout=600 op stop timeout=300 op
monitor interval=10 timeout=600 clone clone-max=2 clone-node-max=1
interleave=true
```

SAPHana

The SAPHana resource is responsible for starting, stopping, and relocating the SAP HANA database. This resource must be run as a primary/secondary cluster resource. To create this resource, run the following command:

RHEL 7.x

```
[root@prihana~] pcs resource create SAPHana_HDB_00 SAPHana SID=HDB
InstanceNumber=00 PREFER_SITE_TAKEOVER=true
DUPLICATE_PRIMARY_TIMEOUT=7200 AUTOMATED_REGISTER=true op start
timeout=3600 op stop timeout=3600 op monitor interval=61
role="Slave" timeout=700 op monitor interval=59 role="Master"
timeout=700 op promote timeout=3600 op demote timeout=3600 master
notify=true clone-max=2 clone-node-max=1 interleave=true
```

RHEL 8.x

```
[root@prihana~] pcs resource create SAPHana_HDB_00 SAPHana SID=HDB
InstanceNumber=00 PREFER_SITE_TAKEOVER=true
DUPLICATE_PRIMARY_TIMEOUT=7200 AUTOMATED_REGISTER=true op start
timeout=3600 op stop timeout=3600 op monitor interval=61
role="Slave" timeout=700 op monitor interval=59 role="Master"
timeout=700 op promote timeout=3600 op demote timeout=3600
promotable meta notify=true clone-max=2 clone-node-max=1
interleave=true
```

> **Note**
> If the AUTOMATED_REGISTER parameter is set to true, the secondary instance will automatically register after startup, and start the replication.

Overlay IP

Add the Overlay IP (OIP) address to the primary node using the following command:

```
ip address add <overlay IP address> dev eth0
root@prihana ~]# ip address add xxx.xxx.xxx.xxx/32 dev eth0
```

To route the traffic to your primary SAP HANA database with Overlay IP, you must update the route table and map the Overlay IP address to the primary SAP HANA database instance-id.

```
aws ec2 create-route --route-table-id rtb-xxxxxxxx --destination-
cidr-block OIP --instance-id i-xxxxxxxx
```

```
[root@prihana ~]# aws ec2 create-route --route-table-id rtb-
```

```
xxxxxxxxxx --destination-cidr-block xxx.xxx.xxx.xxx/32 --instance-
id i-xxxxxxxxxxxx
{
    "Return": true
}
[root@prihana ~]#
```

```
pcs resource create hana-oip aws-vpc-move-ip ip=192.168.0.1
interface=eth0 routing_table=rtb-dbexxxxx
```

If you are using different route tables for subnet in each Availability Zone where you are deploying the SAP HANA instances, you need to update the OIP in the route table associated with both the subnets. To create the resource in such scenario, you can use the previous command and mention both the route table IDs separated by a comma. See the following example:

```
pcs resource create hana-oip aws-vpc-move-ip ip=192.168.0.1
interface=eth0 routing_table=rtb-xxxxxxx, rtb-yyyyyyyy
```

Constraints

Define two constraints, one for the Overlay IP address which helps with routing client traffic to active database host and the second one for the start order between the `SAPHANA` and `SAPHanaTopology` resource agents.

Constraint: start `SAPHanaTopology` before `SAPHana`

Following command will create the constraint that mandates the start order of these resources.

RHEL 7.x

```
pcs constraint order SAPHanaTopology_HDB_00-clone then
SAPHana_HDB_00-master symmetrical=false

[root@prihana ~]# pcs constraint order SAPHanaTopology_HDB_00-clone
then SAPHana_HDB_00-master symmetrical=false
Adding SAPHanaTopology_HDB_00-clone SAPHana_HDB_00-master (kind:
Mandatory) (Options: first-action=start then-action=start
symmetrical=false)
[root@prihana ~]#
```

RHEL 8.x

```
pcs constraint order SAPHanaTopology_HDB_00-clone then
SAPHana_HDB_00-clone symmetrical=false
```

- **`symmetrical=false`** — This attribute defines that it is just the start order of resources and they don't need to be stopped in reverse order.
- **`interleave = true`** — This attribute allows parallel start of these resources on nodes. This allows the `SAPHana` resource to start on any node as soon as the `SAPHanaTopology` resource is running on any one node.

Use the following command for creating the constraint:

```
[root@prihana ~]# pcs constraint order SAPHanaTopology_HDB_00-clone
then SAPHana_HDB_00-clone symmetrical=false
Adding SAPHanaTopology_HDB_00-clone SAPHana_HDB_00-clone (kind:
Mandatory) (Options: first-action=start then-action=start
symmetrical=false)
```

Both resources (`SAPHana` and `SAPHanaTopology`) have the attribute `interleave=true` that allows parallel start of these resources on nodes.

Constraint co-locate the `aws-vpc-move-ip` resource with the primary `SAPHana` resource

The following command will co-locate the `aws-vpc-move-ip` resource with the `SAPHana` resource when promoted as primary.

RHEL 7.x

```
pcs constraint colocation add hana-oip with master SAPHana_HDB_00-master 2000
```

```
[root@prihana ~]# pcs constraint
Location Constraints:
Ordering Constraints:
  start SAPHanaTopology_HDB_00-clone then start SAPHana_HDB_00-master (kind:Mandatory)
  (non-symmetrical)
Colocation Constraints:
  hana-oip with SAPHana_HDB_00-master (score:2000) (rsc-role:Started) (with-rsc-
role:Master)
Ticket Constraints:
[root@prihana ~]#
```

RHEL 8.x

```
pcs constraint colocation add hana-oip with master SAPHana_HDB_00-clone 2000
```

```
[root@prihana ~]# pcs constraint
Location Constraints:
Ordering Constraints:
  start SAPHanaTopology_HDB_00-clone then start SAPHana_HDB_00-clone (kind:Mandatory)
(non-symmetrical)
Colocation Constraints:
  hana-oip with SAPHana_HDB_00-clone (score:2000) (rsc-role:Started) (with-rsc-role:Master)
Ticket Constraints:
[root@prihana ~]#
```

You can use the following command to check the final status of the cluster:

```
[root@prihana ~]# pcs status
Cluster name: rhelhanaha
Stack: corosync
Current DC: sechana (version 1.1.19-8.el7_6.5-c3c624ea3d) - partition with quorum
Last updated: Tue Nov 10 17:54:13 2020
Last change: Tue Nov 10 17:53:48 2020 by root via crm_attribute on prihana

2 nodes configured
6 resources configured

Online: [ prihana sechana ]

Full list of resources:

 clusterfence   (stonith:fence_aws):    Started prihana
 Clone Set: SAPHanaTopology_HDB_00-clone [SAPHanaTopology_HDB_00]
     Started: [ prihana sechana ]
 Master/Slave Set: SAPHana_HDB_00-master [SAPHana_HDB_00]
     Masters: [ prihana ]
     Slaves: [ sechana ]
 hana-oip       (ocf::heartbeat:aws-vpc-move-ip):       Started prihana

Daemon Status:
  corosync: active/enabled
  pacemaker: active/enabled
  pcsd: active/enabled
[root@prihana ~]#
```

This concludes the configuration of the SAP HANA cluster setup. You can proceed with testing.

Testing the cluster

After the cluster setup is complete, perform the tests shown below to validate cluster setup. Run these tests in sequence.

Test 1: Stop the SAP HANA database on the primary node

Description — Stop the primary SAP HANA database during normal cluster operation.

Run node — Primary SAP HANA database node

Run steps:

- Stop the primary SAP HANA database gracefully as `<sid>adm`

```
prihana:~ # su - hdbadm
hdbadm@prihana:/usr/sap/HDB/HDB00> HDB stop
hdbdaemon will wait maximal 300 seconds for NewDB services finishing.
Stopping instance using: /usr/sap/HDB/SYS/exe/hdb/sapcontrol -prot
NI_HTTP -nr 00 -function Stop 400

12.11.2020 11:39:19
Stop
OK
Waiting for stopped instance using:
/usr/sap/HDB/SYS/exe/hdb/sapcontrol -prot NI_HTTP -nr 00 -function
WaitforStopped 600 2

12.11.2020 11:39:51
WaitforStopped
OK
hdbdaemon is stopped.
```

Expected result:

- The cluster detects stopped primary SAP HANA database (on node 1) and promotes the secondary SAP HANA database (on node 2) to take over as primary.

```
[root@prihana ~]# pcs status
Cluster name: rhelhanaha
Stack: corosync
Current DC: sechana (version 1.1.19-8.el7_6.5-c3c624ea3d) - partition with quorum
Last updated: Tue Nov 10 17:58:19 2020
Last change: Tue Nov 10 17:57:41 2020 by root via crm_attribute on sechana

2 nodes configured
6 resources configured

Online: [ prihana sechana ]
```

```
Full list of resources:

 clusterfence   (stonith:fence_aws):    Started prihana
 Clone Set: SAPHanaTopology_HDB_00-clone [SAPHanaTopology_HDB_00]
     Started: [ prihana sechana ]
 Master/Slave Set: SAPHana_HDB_00-master [SAPHana_HDB_00]
     Masters: [ sechana ]
     Slaves: [ prihana ]
 hana-oip       (ocf::heartbeat:aws-vpc-move-ip):       Started sechana

Failed Actions:
* SAPHana_HDB_00_monitor_59000 on prihana 'master (failed)' (9): call=31,
status=complete, exitreason='',
    last-rc-change='Tue Nov 10 17:56:52 2020', queued=0ms, exec=0ms


Daemon Status:
  corosync: active/enabled
  pacemaker: active/enabled
  pcsd: active/enabled
[root@prihana ~]#
```

- The overlay IP address is migrated to the new primary (on node 2).

```
sechana:~ # ip addr show
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN
group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
2: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 9000 qdisc mq state
UP group default qlen 1000
    link/ether 0e:ef:dd:3c:bf:1b brd ff:ff:ff:ff:ff:ff
    inet xx.xx.xx.xx/24 brd 11.0.2.255 scope global eth0
       valid_lft forever preferred_lft forever
    inet xx.xx.xx.xx/32 scope global eth0:1
       valid_lft forever preferred_lft forever
    inet 192.168.10.16/32 scope global eth0
       valid_lft forever preferred_lft forever
    inet6 fe80::cef:ddff:fe3c:bf1b/64 scope link
       valid_lft forever preferred_lft forever
```

- Because `AUTOMATED_REGISTER` is set to true, the cluster restarts the failed SAP HANA database and registers it against the new primary. Validate the status of the primary SAP HANA database using the following command:

```
sapcontrol -nr 00 -function GetProcessList
```

```
hdbadm@prihana:/usr/sap/HDB/HDB00> sapcontrol -nr 00 -function GetProcessList

10.11.2020 17:59:49
GetProcessList
OK
name, description, dispstatus, textstatus, starttime, elapsedtime, pid
hdbdaemon, HDB Daemon, GREEN, Running, 2020 11 10 17:58:47, 0:01:02, 25979
hdbcompileserver, HDB Compileserver, GREEN, Running, 2020 11 10 17:58:52, 0:00:57, 26152
hdbindexserver, HDB Indexserver-HDB, GREEN, Running, 2020 11 10 17:58:53, 0:00:56, 26201
hdbnameserver, HDB Nameserver, GREEN, Running, 2020 11 10 17:58:48, 0:01:01, 25997
```

```
hdbpreprocessor, HDB Preprocessor, GREEN, Running, 2020 11 10 17:58:52, 0:00:57, 26155
hdbwebdispatcher, HDB Web Dispatcher, GREEN, Running, 2020 11 10 17:59:02, 0:00:47, 27100
hdbxsengine, HDB XSEngine-HDB, GREEN, Running, 2020 11 10 17:58:53, 0:00:56, 26204
hdbadm@prihana:/usr/sap/HDB/HDB00>
```

Recovery procedure:

- Clean up the cluster “`failed actions`” on node 1 as root using the following command:

```
pcs resource cleanup SAPHana_HDB_00 --node prihana
```

```
[root@prihana ~]# pcs resource cleanup SAPHana_HDB_00 --node prihana
Cleaned up SAPHana_HDB_00:0 on prihana
Cleaned up SAPHana_HDB_00:1 on prihana
Waiting for 1 replies from the CRMd. OK
[root@prihana ~]#
```

- After you run the cleanup command, “`failed actions`” messages should disappear from the cluster status.

```
 [root@prihana ~]# pcs status
Cluster name: rhelhanaha
Stack: corosync
Current DC: sechana (version 1.1.19-8.el7_6.5-c3c624ea3d) -
partition with quorum
Last updated: Tue Nov 10 18:01:02 2020
Last change: Tue Nov 10 18:00:45 2020 by root via crm_attribute on sechana

2 nodes configured
6 resources configured

Online: [ prihana sechana ]

Full list of resources:

 clusterfence   (stonith:fence_aws):    Started prihana
 Clone Set: SAPHanaTopology_HDB_00-clone [SAPHanaTopology_HDB_00]
     Started: [ prihana sechana ]
 Master/Slave Set: SAPHana_HDB_00-master [SAPHana_HDB_00]
     Masters: [ sechana ]
     Slaves: [ prihana ]
 hana-oip       (ocf::heartbeat:aws-vpc-move-ip):       Started sechana

Daemon Status:
  corosync: active/enabled
  pacemaker: active/enabled
  pcsd: active/enabled
[root@prihana ~]#
```

Test 2: Stop the SAP HANA database on the secondary node

Description — Stop the primary SAP HANA database (on Node 2) during normal cluster operation.

Run node — Primary SAP HANA database node (on Node 2)

Run steps:

- Stop the SAP HANA database gracefully as `<sid>adm` on node 2.

```
sechana:~ # su - hdbadm
hdbadm@sechana:/usr/sap/HDB/HDB00> HDB stop
hdbdaemon will wait maximal 300 seconds for NewDB services finishing.
Stopping instance using: /usr/sap/HDB/SYS/exe/hdb/sapcontrol -prot NI_HTTP -nr
00 -function Stop 400

12.11.2020 11:45:21
Stop
OK
Waiting for stopped instance using: /usr/sap/HDB/SYS/exe/hdb/sapcontrol
-prot NI_HTTP -nr 00 -function WaitforStopped 600 2


12.11.2020 11:45:53
WaitforStopped
OK
hdbdaemon is stopped.
```

Expected result:

- The cluster detects the stopped primary SAP HANA database (on node 2) and promotes the secondary SAP HANA database (on node 1) to take over as primary.

```
[root@sechana ~]# pcs status
Cluster name: rhelhanaha
Stack: corosync
Current DC: sechana (version 1.1.19-8.el7_6.5-c3c624ea3d) - partition with quorum
Last updated: Tue Nov 10 18:04:01 2020
Last change: Tue Nov 10 18:04:00 2020 by root via crm_attribute on prihana

2 nodes configured
6 resources configured

Online: [ prihana sechana ]

Full list of resources:

 clusterfence   (stonith:fence_aws):    Started prihana
 Clone Set: SAPHanaTopology_HDB_00-clone [SAPHanaTopology_HDB_00]
     Started: [ prihana sechana ]
 Master/Slave Set: SAPHana_HDB_00-master [SAPHana_HDB_00]
     SAPHana_HDB_00     (ocf::heartbeat:SAPHana):       Promoting prihana
     Slaves: [ sechana ]
 hana-oip       (ocf::heartbeat:aws-vpc-move-ip):       Started prihana

Failed Actions:
* SAPHana_HDB_00_monitor_59000 on sechana 'master (failed)' (9): call=41,
status=complete, exitreason='',
    last-rc-change='Tue Nov 10 18:03:49 2020', queued=0ms, exec=0ms


Daemon Status:
  corosync: active/enabled
  pacemaker: active/enabled
  pcsd: active/enabled
[root@sechana ~]#
```

- The overlay IP address is migrated to the new primary (on node 1).

```
prihana:~ # ip addr show
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen
 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
2: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 9000 qdisc mq state UP group default qlen
 1000
    link/ether 0a:38:1c:ce:b4:3d brd ff:ff:ff:ff:ff:ff
    inet xx.xx.xx.xx/24 brd 11.0.1.255 scope global eth0
       valid_lft forever preferred_lft forever
    inet xx.xx.xx.xx/32 scope global eth0:1
       valid_lft forever preferred_lft forever
    inet 192.168.10.16/32 scope global eth0
       valid_lft forever preferred_lft forever
    inet6 fe80::838:1cff:fece:b43d/64 scope link
       valid_lft forever preferred_lft forever
```

- With `AUTOMATED_REGISTER` set to `true`, the cluster restarts the failed SAP HANA database and registers it against the new primary.

  Check the status of the secondary using the following command:

```
sapcontrol -nr 00 -function GetProcessList
```

```
hdbadm@sechana:/usr/sap/HDB/HDB00> sapcontrol -nr 00 -function GetProcessList

10.11.2020 18:08:47
GetProcessList
OK
name, description, dispstatus, textstatus, starttime, elapsedtime, pid
hdbdaemon, HDB Daemon, GREEN, Running, 2020 11 10 18:05:44, 0:03:03, 6601
hdbcompileserver, HDB Compileserver, GREEN, Running, 2020 11 10 18:05:48, 0:02:59, 6725
hdbindexserver, HDB Indexserver-HDB, GREEN, Running, 2020 11 10 18:05:49, 0:02:58, 6828
hdbnameserver, HDB Nameserver, GREEN, Running, 2020 11 10 18:05:44, 0:03:03, 6619
hdbpreprocessor, HDB Preprocessor, GREEN, Running, 2020 11 10 18:05:48, 0:02:59, 6730
hdbwebdispatcher, HDB Web Dispatcher, GREEN, Running, 2020 11 10 18:05:58, 0:02:49, 7797
hdbxsengine, HDB XSEngine-HDB, GREEN, Running, 2020 11 10 18:05:49, 0:02:58, 6831
hdbadm@sechana:/usr/sap/HDB/HDB00>
```

Recovery procedure:

- Clean up the cluster “`failed actions`” on node 2 as root using the following command:

```
pcs resource cleanup SAPHana_HDB_00 --node sechana
```

```
[root@sechana ~]# pcs resource cleanup SAPHana_HDB_00 --node sechana
Cleaned up SAPHana_HDB_00:0 on sechana
Cleaned up SAPHana_HDB_00:1 on sechana
Waiting for 1 replies from the CRMd. OK
```

- After resource cleanup, ensure the cluster “`failed actions`” are cleaned up.

```
root@sechana ~]# pcs status
Cluster name: rhelhanaha
Stack: corosync
Current DC: sechana (version 1.1.19-8.el7_6.5-c3c624ea3d) - partition with quorum
Last updated: Tue Nov 10 18:13:35 2020
Last change: Tue Nov 10 18:12:51 2020 by hacluster via crmd on sechana

2 nodes configured
6 resources configured

Online: [ prihana sechana ]

Full list of resources:

 clusterfence   (stonith:fence_aws):    Started prihana
 Clone Set: SAPHanaTopology_HDB_00-clone [SAPHanaTopology_HDB_00]
     Started: [ prihana sechana ]
 Master/Slave Set: SAPHana_HDB_00-master [SAPHana_HDB_00]
     Masters: [ prihana ]
     Slaves: [ sechana ]
 hana-oip       (ocf::heartbeat:aws-vpc-move-ip):       Started prihana

Daemon Status:
  corosync: active/enabled
  pacemaker: active/enabled
  pcsd: active/enabled
[root@sechana ~]#
```

Test 3: Crash the primary database on node 1

Description — Simulate a complete breakdown of the primary database system.

Run node: Primary SAP HANA database node

Run steps:

- Crash the primary database system using the following command as `<sid>adm`:

```
prihana:~ # sudo su - hdbadm
hdbadm@prihana:/usr/sap/HDB/HDB00> HDB kill -9
hdbenv.sh: Hostname prihana defined in $SAP_RETRIEVAL_PATH=/usr/sap/HDB/HDB00/
prihana differs from host name defined on command line.
hdbenv.sh: Error: Instance not found for host -9
killing HDB processes:
kill -9 6011 /usr/sap/HDB/HDB00/prihana/trace/hdb.sapHDB_HDB00 -d -nw -f
/usr/sap/HDB/HDB00/prihana/daemon.ini pf=/usr/sap/HDB/SYS/profile/HDB_HDB00_prihana
kill -9 6027 hdbnameserver
kill -9 6137 hdbcompileserver
kill -9 6139 hdbpreprocessor
kill -9 6484 hdbindexserver -port 30003
kill -9 6494 hdbxsengine -port 30007
kill -9 7068 hdbwebdispatcher
kill orphan HDB processes:
kill -9 6027 [hdbnameserver] <defunct>
kill -9 6484 [hdbindexserver] <defunct>
```

Expected result:

- The cluster detects the stopped primary SAP HANA database (on node 1) and promotes the secondary SAP HANA database (on node 2) to take over as primary.

```
[root@prihana ~]# pcs status
Cluster name: rhelhanaha
Stack: corosync
Current DC: sechana (version 1.1.19-8.el7_6.5-c3c624ea3d) - partition with quorum
Last updated: Tue Nov 10 17:58:19 2020
Last change: Tue Nov 10 17:57:41 2020 by root via crm_attribute on sechana
2 nodes configured
6 resources configured
Online: [ prihana sechana ]
Full list of resources:
 clusterfence   (stonith:fence_aws):    Started prihana
 Clone Set: SAPHanaTopology_HDB_00-clone [SAPHanaTopology_HDB_00]
     Started: [ prihana sechana ]
 Master/Slave Set: SAPHana_HDB_00-master [SAPHana_HDB_00]
     Masters: [ sechana ]
     Slaves: [ prihana ]
 hana-oip       (ocf::heartbeat:aws-vpc-move-ip):       Started sechana
Failed Actions:
* SAPHana_HDB_00_monitor_59000 on prihana 'master (failed)' (9): call=31,
status=complete, exitreason='',
    last-rc-change='Tue Nov 10 17:56:52 2020', queued=0ms, exec=0ms
Daemon Status:
  corosync: active/enabled
  pacemaker: active/enabled
  pcsd: active/enabled
[root@prihana ~]#
```

- The overlay IP address is migrated to the new primary (on node 2).
- Because `AUTOMATED_REGISTER` is set to `true`, the cluster restarts the failed SAP HANA database and registers it against the new primary.

Recovery procedure:

- Clean up the cluster “`failed actions`” on node 1 as root.

```
root@prihana ~]# pcs resource cleanup SAPHana_HDB_00 --node prihana
Cleaned up SAPHana_HDB_00:0 on prihana
Cleaned up SAPHana_HDB_00:1 on prihana
Waiting for 1 replies from the CRMd. OK
[root@prihana ~]#
```

- After resource cleanup, ensure the cluster “`failed actions`” are cleaned up.

Test 4: Crash the primary database on node 2

Description — Simulate a complete breakdown of the primary database system.

Run node — The primary SAP HANA database node (on node 2).

Run steps:

- Crash the primary database (on node 2) system using the following command as `<sid>adm`.

```
sechana:~ # su - hdbadm
hdbadm@sechana:/usr/sap/HDB/HDB00> HDB kill -9
hdbenv.sh: Hostname sechana defined in $SAP_RETRIEVAL_PATH=/usr/sap/
```

```
HDB/HDB00/sechana differs from host name defined on command line.
hdbenv.sh: Error: Instance not found for host -9
killing HDB processes:
kill -9 30751 /usr/sap/HDB/HDB00/sechana/trace/hdb.sapHDB_HDB00 -d -nw -f
/usr/sap/HDB/HDB00/sechana/daemon.ini pf=/usr/sap/HDB/SYS/profile/HDB_HDB00_sechana
kill -9 30899 hdbnameserver
kill -9 31166 hdbcompileserver
kill -9 31168 hdbpreprocessor
kill -9 31209 hdbindexserver -port 30003
kill -9 31211 hdbxsengine -port 30007
kill -9 31721 hdbwebdispatcher
kill orphan HDB processes:
kill -9 30899 [hdbnameserver] <defunct>
kill -9 31209 [hdbindexserver] <defunct>
```

Expected result:

- The cluster detects the stopped primary SAP HANA database (on node 2) and promotes the secondary SAP HANA database (on node 1) to take over as primary.

```
root@sechana ~]# pcs status
Cluster name: rhelhanaha
Stack: corosync
Current DC: prihana (version 1.1.19-8.el7_6.5-c3c624ea3d) - partition with quorum
Last updated: Tue Nov 10 18:13:35 2020
Last change: Tue Nov 10 18:12:51 2020 by hacluster via crmd on sechana

2 nodes configured
6 resources configured

Online: [ prihana sechana ]

Full list of resources:

 clusterfence   (stonith:fence_aws):    Started prihana
 Clone Set: SAPHanaTopology_HDB_00-clone [SAPHanaTopology_HDB_00]
     Started: [ prihana sechana ]
 Master/Slave Set: SAPHana_HDB_00-master [SAPHana_HDB_00]
     Masters: [ prihana ]
     Slaves: [ sechana ]
 hana-oip       (ocf::heartbeat:aws-vpc-move-ip):       Started prihana

Failed Actions:
* SAPHana_HDB_00_monitor_59000 on sechana 'master (failed)' (9): call=41,
status=complete, exitreason='',
    last-rc-change='Tue Nov 10 18:03:49 2020', queued=0ms, exec=0ms


Daemon Status:
  corosync: active/enabled
  pacemaker: active/enabled
  pcsd: active/enabled
```

- The overlay IP address is migrated to the new primary (on node 1).
- Because `AUTOMATED_REGISTER` is set to true, the cluster restarts the failed SAP HANA database and registers it against the new primary.

Recovery procedure:

- Clean up the cluster "`failed actions`" on node 2 as root.

```
root@prihana ~]# pcs resource cleanup SAPHana_HDB_00
--node sechana
Cleaned up SAPHana_HDB_00:0 on prihana
Cleaned up SAPHana_HDB_00:1 on prihana
Waiting for 1 replies from the CRMd. OK
[root@prihana ~]#
```

- After resource cleanup, ensure the cluster "`failed actions`" are cleaned up.

Test 5: Reboot SAP HANA node1

Description — Simulate a crash of the primary node running the primary SAP HANA database.

Run node: Primary SAP HANA database node

Run steps:

- Crash the primary database system using the following command as root:

```
[root@prihana ~]# pcs status
Cluster name: rhelhanaha
Stack: corosync
Current DC: sechana (version 1.1.19-8.el7_6.5-c3c624ea3d) - partition with quorum
Last updated: Tue Nov 10 17:54:13 2020
Last change: Tue Nov 10 17:53:48 2020 by root via crm_attribute on prihana
2 nodes configured
6 resources configured
Online: [ prihana sechana ]
Full list of resources:
 clusterfence   (stonith:fence_aws):    Started prihana
 Clone Set: SAPHanaTopology_HDB_00-clone [SAPHanaTopology_HDB_00]
     Started: [ prihana sechana ]
 Master/Slave Set: SAPHana_HDB_00-master [SAPHana_HDB_00]
     Masters: [ prihana ]
     Slaves: [ sechana ]
 hana-oip       (ocf::heartbeat:aws-vpc-move-ip):       Started prihana
Daemon Status:
  corosync: active/enabled
  pacemaker: active/enabled
  pcsd: active/enabled
[root@prihana ~]# echo 'b' > /proc/sysrq-trigger
```

> **Note**
> To simulate a system crash, you must first ensure that `/proc/sys/kernel/sysrq` is set to 1.

Expected result:

- The cluster detects the failed node (node 1), declares it "`UNCLEAN`", and sets the secondary node (node 2) to status "`partition WITHOUT quorum`".
- The cluster fences node 1, promotes the secondary SAP HANA database, and registers it against the new primary when the EC2 instance is back up. Node 1 is currently in a stopped state because it is being rebooted.

```
[root@sechana ~]# pcs status
Cluster name: rhelhanaha
```

```
Stack: corosync
Current DC: sechana (version 1.1.19-8.el7_6.5-c3c624ea3d) - partition with quorum
Last updated: Tue Nov 10 18:17:24 2020
Last change: Tue Nov 10 18:17:06 2020 by root via crm_attribute on sechana

2 nodes configured
6 resources configured

Online: [ prihana sechana ]

Full list of resources:

 clusterfence   (stonith:fence_aws):    Started sechana
 Clone Set: SAPHanaTopology_HDB_00-clone [SAPHanaTopology_HDB_00]
     Started: [ prihana sechana ]
 Master/Slave Set: SAPHana_HDB_00-master [SAPHana_HDB_00]
     Masters: [ sechana ]
     OFFLINE: [ prihana ]
 hana-oip       (ocf::heartbeat:aws-vpc-move-ip):       Started sechana

Daemon Status:
  corosync: active/enabled
  pacemaker: active/enabled
  pcsd: active/enabled
[root@sechana ~]#
```

- The overlay IP address is migrated to the new primary (on node 2).
- Because `AUTOMATIC_REGISTER` = `true`, the cluster restarts the failed HANA database and registers it against the new primary when the EC2 instance is back up.

Recovery procedure:

- Start node 1 (EC2 Instance) using AWS Management Console or AWS CLI tools.

Test 6: Reboot SAP HANA node 2

Description — Simulate a crash of the primary node (on node 2) running the primary SAP HANA database.

Run node — Primary SAP HANA database node (on node 2)

Run steps:

- Crash the node running primary SAP HANA (on node 2) using the following command as root:

```
shutdown
```

```
[root@sechana ~]# pcs status
Cluster name: rhelhanaha
Stack: corosync
Current DC: sechana (version 1.1.19-8.el7_6.5-c3c624ea3d) - partition with quorum
Last updated: Tue Nov 10 17:54:13 2020
Last change: Tue Nov 10 17:53:48 2020 by root via crm_attribute on prihana
2 nodes configured
6 resources configured
Online: [ prihana sechana ]
Full list of resources:
 clusterfence   (stonith:fence_aws):    Started prihana
 Clone Set: SAPHanaTopology_HDB_00-clone [SAPHanaTopology_HDB_00]
```

```
     Started: [ prihana sechana ]
 Master/Slave Set: SAPHana_HDB_00-master [SAPHana_HDB_00]
     Masters: [ sechana ]
     Slaves: [ prihana ]
 hana-oip       (ocf::heartbeat:aws-vpc-move-ip):       Started sechana
Daemon Status:
  corosync: active/enabled
  pacemaker: active/enabled
  pcsd: active/enabled
[root@sechana ~]# echo 'b' > /proc/sysrq-trigger
```

Note

To simulate a system crash, you must first ensure that `/proc/sys/kernel/sysrq` is set to `1`.

Expected result:

- The cluster detects the failed node (node 2), declares it “`UNCLEAN`”, and sets the secondary node (node 1) to status “`partition WITHOUT quorum`”.
- The cluster fences node 2 and promotes the secondary SAP HANA database (on node 1) to take over as primary.

```
[root@prihana ~]# pcs status
Cluster name: rhelhanaha
Stack: corosync
Current DC: prihana (version 1.1.19-8.el7_6.5-c3c624ea3d) - partition with quorum
Last updated: Tue Nov 10 18:22:00 2020
Last change: Tue Nov 10 18:21:49 2020 by root via crm_attribute on prihana

2 nodes configured
6 resources configured

Online: [ prihana ]
OFFLINE: [ sechana ]

Full list of resources:

 clusterfence   (stonith:fence_aws):    Started prihana
 Clone Set: SAPHanaTopology_HDB_00-clone [SAPHanaTopology_HDB_00]
     Started: [ prihana ]
     Stopped: [ sechana ]
 Master/Slave Set: SAPHana_HDB_00-master [SAPHana_HDB_00]
     Masters: [ prihana ]
     Stopped: [ sechana ]
 hana-oip       (ocf::heartbeat:aws-vpc-move-ip):       Started prihana

Daemon Status:
  corosync: active/enabled
  pacemaker: active/enabled
  pcsd: active/enabled
[root@prihana ~]#
```

- The overlay IP address is migrated to the new primary (on node 2).
- Because `AUTOMATED_REGISTER` is set to `true`, the cluster restarts the failed SAP HANA database and registers it against the new primary when the EC2 instance is back up.

Recovery procedure:

- Start node 2 (EC2 instance) using AWS Management Console or AWS CLI tools.

Test 7: Simulating a cluster network failure

Description —To simulate a network failure to test the cluster behavior in case of a split brain.

Run node: Can be run on any node. In this test case, this is done on node B.

Run steps:

- Drop all the traffic coming from and going to node A with the following command:

```
iptables -A INPUT -s <<Primary IP address of Node A>> -j DROP;
iptables -A OUTPUT -d <<Primary IP address of Node A>> -j DROP
```

```
[root@sechana ~]# pcs status
Cluster name: rhelhanaha
Stack: corosync
Current DC: prihana(version 1.1.19-8.el7_6.5-c3c624ea3d) - partition with quorum
Last updated: Fri Jan 22 14:45:24 2021
Last change: Fri Jan 22 14:45:11 2021 by hacluster via crmd on  sechana
2 nodes configured
6 resources configured
Online: [ prihana sechana ]
Full list of resources:
 clusterfence   (stonith:fence_aws):    Started prihana
 Clone Set: SAPHanaTopology_DRL_00-clone [SAPHanaTopology_DRL_00]
     Started: [ prihana sechana ]
 Master/Slave Set: SAPHana_DRL_00-master [SAPHana_DRL_00]
     Masters: [ prihana]
     Slaves: [ sechana ]
 hana-oip       (ocf::heartbeat:aws-vpc-move-ip):       Started prihana
Daemon Status:
  corosync: active/enabled
  pacemaker: active/enabled
  pcsd: active/enabled
[root@ sechana ~]#sechana:~ # iptables -A INPUT -s xxx.xxx.xxx.xxx -j DROP;
iptables -A OUTPUT -d xxx.xxx.xxx.xxx -j DROP
```

Expected result:

- The cluster detects network failure and fences node 1. The cluster promotes the secondary SAP HANA database (on node 2) to take over as primary without going to a split brain situation.

```
[root@sechana ~]# pcs status
Cluster name: rhelhanaha
Stack: corosync
Current DC: sechana (version 1.1.19-8.el7_6.5-c3c624ea3d) - partition with quorum
Last updated: Fri Jan 22 15:11:43 2021
Last change: Fri Jan 22 15:10:48 2021 by root via crm_attribute on sechana
2 nodes configured
6 resources configured
Online: [ sechana ]
OFFLINE: [ prihana]
Full list of resources:
 clusterfence   (stonith:fence_aws):    Started sechana
 Clone Set: SAPHanaTopology_DRL_00-clone [SAPHanaTopology_DRL_00]
     Started: [ sechana ]
     Stopped: [ prihana]
 Master/Slave Set: SAPHana_DRL_00-master [SAPHana_DRL_00]
     Masters: [ sechana ]
     Stopped: [ prihana]
 hana-oip       (ocf::heartbeat:aws-vpc-move-ip):       Started sechana
```

```
Failed Actions:
* clusterfence_monitor_60000 on sechana 'unknown error' (1): call=-1,
status=Timed Out, exitreason='',
    last-rc-change='Fri Jan 22 14:59:14 2021', queued=0ms, exec=0ms
Daemon Status:
  corosync: active/enabled
  pacemaker: active/enabled
  pcsd: active/enabled
[root@sechana ~]#
```

Recovery procedure:

- Clean up the cluster “`failed actions`”.

Administration and troubleshooting

Monitor the status of cluster

You can check the status of the cluster with the following command as root user:

```
pcs status
```

```
root@prihana ~]# pcs status
Cluster name: rhelhanaha
Stack: corosync
Current DC: sechana (version 1.1.19-8.el7_6.5-c3c624ea3d) - partition with quorum
Last updated: Thu Nov 12 09:44:08 2020
Last change: Thu Nov 12 09:43:20 2020 by root via crm_attribute on sechana

2 nodes configured
6 resources configured

Online: [ prihana sechana ]

Full list of resources:

 clusterfence   (stonith:fence_aws):    Started prihana
 Clone Set: SAPHanaTopology_HDB_00-clone [SAPHanaTopology_HDB_00]
     Started: [ prihana sechana ]
 Master/Slave Set: SAPHana_HDB_00-master [SAPHana_HDB_00]
     Masters: [ prihana ]
     Slaves: [ sechana ]
 hana-oip       (ocf::heartbeat:aws-vpc-move-ip):       Started prihana

Daemon Status:
  corosync: active/enabled
  pacemaker: active/enabled
  pcsd: active/enabled
[root@prihana ~]#
```

You can check the SAP HANA replication status with the following command as a `<sid>adm` user:

```
hdbadm@prihana:/usr/sap/HDB/HDB00> python
/usr/sap/HDB/HDB00/exe/python_support/systemReplicationStatus.py
| Database | Host        | Port   | Service Name | Volume ID | Site
ID | Site Name  | Secondary  | Secondary | Secondary | Secondary
| Secondary     | Replication | Replication | Replication    |
|          |             |        |              |           |
|            | Host        | Port      | Site ID    | Site Name     |
Active Status | Mode        | Status       | Status Details |
| -------- | ---------- | ----- | ------------ | ---------- | -------
| ---------- | ---------- | --------- | --------- | ------------
| ------------- | ----------- | ----------- | -------------- |
| SYSTEMDB | prihana | 30001 | nameserver   |         1 |       1 |
HDBPrimary | sechana |     30001 |         2 | HDBSecondary | YES
| SYNCMEM     | ACTIVE      |            |
| HDB      | prihana | 30007 | xsengine     |         2 |       1 |
HDBPrimary | sechana |     30007 |         2 | HDBSecondary | YES
| SYNCMEM     | ACTIVE      |            |
| HDB      | prihana | 30003 | indexserver  |         3 |       1 |
HDBPrimary | sechana |     30003 |         2 | HDBSecondary | YES
| SYNCMEM     | ACTIVE      |            |

status system replication site "2": ACTIVE
overall system replication status: ACTIVE

Local System Replication State
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

mode: PRIMARY
site id: 1
site name: HDBPrimary
hdbadm@prihana:/usr/sap/HDB/HDB00>
```

Cluster administration

You can manually migrate cluster resources from one node to another with the following command as root user:

```
root@prihana ~]# pcs resource move SAPHana_HDB_00-master
Warning: Creating location constraint cli-ban-SAPHana_HDB_00-
master-on-prihana with a score of -INFINITY for resource
SAPHana_HDB_00-master on node prihana.
This will prevent SAPHana_HDB_00-master from running on prihana
until the constraint is removed. This will be the case even if
prihana is the last node in the cluster.
```

You can check the status of the cluster again to verify the status of resource migration.

```
[root@prihana ~]#pcs status
Thu Nov 12 10:45:14 2020

Cluster name: rhelhanaha
Stack: corosync
Current DC: sechana (version 1.1.19-8.el7_6.5-c3c624ea3d) - partition with quorum
Last updated: Thu Nov 12 10:45:14 2020
Last change: Thu Nov 12 10:45:06 2020 by root via crm_attribute on sechana

2 nodes configured
6 resources configured

Online: [ prihana sechana ]

Full list of resources:

 clusterfence   (stonith:fence_aws):    Started prihana
 Clone Set: SAPHanaTopology_HDB_00-clone [SAPHanaTopology_HDB_00]
     Started: [ prihana sechana ]
 Master/Slave Set: SAPHana_HDB_00-master [SAPHana_HDB_00]
     Masters: [ sechana ]
     Stopped: [ prihana ]
 hana-oip       (ocf::heartbeat:aws-vpc-move-ip):       Started sechana
```

```
Daemon Status:
  corosync: active/enabled
  pacemaker: active/enabled
  pcsd: active/enabled
```

Clean up the failed actions as shown in next section. With each `pcs` resource move command invocation, the cluster creates location constraints to cause the resource to move. These constraints must be removed to allow automated failover in the future. To remove the constraints created by the move, run the following command:

```
root@prihana ~]# pcs resource clear SAPHana_HDB_00-master
```

Check the status of the cluster:

```
root@prihana ~]# pcs status
Cluster name: rhelhanaha
Stack: corosync
Current DC: sechana (version 1.1.19-8.el7_6.5-c3c624ea3d) - partition with quorum
Last updated: Thu Nov 12 10:49:44 2020
Last change: Thu Nov 12 10:49:12 2020 by root via crm_attribute on sechana

2 nodes configured
6 resources configured

Online: [ prihana sechana ]

Full list of resources:

 clusterfence   (stonith:fence_aws):    Started prihana
 Clone Set: SAPHanaTopology_HDB_00-clone [SAPHanaTopology_HDB_00]
     Started: [ prihana sechana ]
 Master/Slave Set: SAPHana_HDB_00-master [SAPHana_HDB_00]
     Masters: [ sechana ]
     Slaves: [ prihana ]
 hana-oip       (ocf::heartbeat:aws-vpc-move-ip):       Started sechana

Daemon Status:
  corosync: active/enabled
  pacemaker: active/enabled
  pcsd: active/enabled
[root@prihana ~]#
```

Resource cleanup activities

Clean up the failed actions using following command:

```
pcs resource cleanup <resource> --node <node-name>
```

```
[root@prihana ~]# pcs resource cleanup SAPHana_HDB_00 --node prihana
Cleaned up SAPHana_HDB_00:0 on prihana
Cleaned up SAPHana_HDB_00:1 on prihana
Waiting for 1 replies from the CRMd. OK
[root@prihana ~]#
```

```
[root@prihana ~]#pcs status
Thu Nov 12 10:45:14 2020

Cluster name: rhelhanaha
```

```
Stack: corosync
Current DC: sechana (version 1.1.19-8.el7_6.5-c3c624ea3d) - partition with quorum
Last updated: Thu Nov 12 10:45:14 2020
Last change: Thu Nov 12 10:45:06 2020 by root via crm_attribute on sechana

2 nodes configured
6 resources configured

Online: [ prihana sechana ]

Full list of resources:

 clusterfence   (stonith:fence_aws):    Started prihana
 Clone Set: SAPHanaTopology_HDB_00-clone [SAPHanaTopology_HDB_00]
     Started: [ prihana sechana ]
 Master/Slave Set: SAPHana_HDB_00-master [SAPHana_HDB_00]
     Masters: [ sechana ]
     Stopped: [ prihana ]
 hana-oip       (ocf::heartbeat:aws-vpc-move-ip):       Started sechana

Daemon Status:
  corosync: active/enabled
  pacemaker: active/enabled
  pcsd: active/enabled
```

Manual migration of resources from one node to another node (as shown in the preceding section) will create constraints in `pcs` configuration “`pcs config show`”.

```
root@prihana ~]# pcs config show
Cluster Name: rhelhanaha
Corosync Nodes:
 prihana sechana
Pacemaker Nodes:
 prihana sechana

Resources:
 Clone: SAPHanaTopology_HDB_00-clone
  Meta Attrs: clone-max=2 clone-node-max=1 interleave=true
  Resource: SAPHanaTopology_HDB_00 (class=ocf provider=heartbeat type=SAPHanaTopology)
   Attributes: InstanceNumber=00 SID=HDB
   Operations: methods interval=0s timeout=5 (SAPHanaTopology_HDB_00-methods-interval-0s)
               monitor interval=10 timeout=600 (SAPHanaTopology_HDB_00-monitor-interval-10)
               reload interval=0s timeout=5 (SAPHanaTopology_HDB_00-reload-interval-0s)
               start interval=0s timeout=600 (SAPHanaTopology_HDB_00-start-interval-0s)
               stop interval=0s timeout=300 (SAPHanaTopology_HDB_00-stop-interval-0s)
 Master: SAPHana_HDB_00-master
  Meta Attrs: clone-max=2 clone-node-max=1 interleave=true notify=true
  Resource: SAPHana_HDB_00 (class=ocf provider=heartbeat type=SAPHana)
   Attributes: AUTOMATED_REGISTER=true DUPLICATE_PRIMARY_TIMEOUT=7200
               InstanceNumber=00 PREFER_SITE_TAKEOVER=true SID=HDB
   Operations: demote interval=0s timeout=3600 (SAPHana_HDB_00-demote-interval-0s)
               methods interval=0s timeout=5 (SAPHana_HDB_00-methods-interval-0s)
               monitor interval=61 role=Slave timeout=700 (SAPHana_HDB_00-monitor-
interval-61)
               monitor interval=59 role=Master timeout=700 (SAPHana_HDB_00-monitor-
interval-59)
               promote interval=0s timeout=3600 (SAPHana_HDB_00-promote-interval-0s)
               reload interval=0s timeout=5 (SAPHana_HDB_00-reload-interval-0s)
               start interval=0s timeout=3600 (SAPHana_HDB_00-start-interval-0s)
               stop interval=0s timeout=3600 (SAPHana_HDB_00-stop-interval-0s)
 Resource: hana-oip (class=ocf provider=heartbeat type=aws-vpc-move-ip)
  Attributes: interface=eth0 ip=192.168.1.99 routing_table=rtb-0027679b7a9eff404
  Operations: monitor interval=60s timeout=30s (hana-oip-monitor-interval-60s)
              start interval=0s timeout=180s (hana-oip-start-interval-0s)
              stop interval=0s timeout=180s (hana-oip-stop-interval-0s)

Stonith Devices:
 Resource: clusterfence (class=stonith type=fence_aws)
  Attributes: pcmk_host_map=prihana:i-01b7ceb0d8799eccf;sechana:i-05b924af2f83ffe0b
  pcmk_reboot_retries=4 pcmk_reboot_timeout=480 power_timeout=240 region=us-east-1
  Operations: monitor interval=60s (clusterfence-monitor-interval-60s)
Fencing Levels:

Location Constraints:
Ordering Constraints:
  start SAPHanaTopology_HDB_00-clone then start SAPHana_HDB_00-master
  (kind:Mandatory) (non-symmetrical)
Colocation Constraints:
  hana-oip with SAPHana_HDB_00-master (score:2000) (rsc-role:Started)
  (with-rsc-role:Master)
Ticket Constraints:

Alerts:
 No alerts defined

Resources Defaults:
 resource-stickiness: 1000
 migration-threshold: 5000
Operations Defaults:
 No defaults set

Cluster Properties:
 cluster-infrastructure: corosync
 cluster-name: rhelhanaha
 dc-version: 1.1.19-8.el7_6.5-c3c624ea3d
 have-watchdog: false
 last-lrm-refresh: 1605053571
Node Attributes:
 prihana: hana_hdb_op_mode=logreplay hana_hdb_remoteHost=sechana
  hana_hdb_site=HDBPrimary hana_hdb_srmode=syncmem hana_hdb_vhost=prihana
  lpa_hdb_lpt=1605196167
 sechana: hana_hdb_op_mode=logreplay hana_hdb_remoteHost=prihana
  hana_hdb_site=HDBSecondary hana_hdb_srmode=syncmem hana_hdb_vhost=sechana
  lpa_hdb_lpt=30

Quorum:
  Options:
[root@prihana ~]
```

These location constraints need to be cleaned up before you perform any further cluster actions with the following command:

```
pcs constraint remove constaint-id
```

```
[root@prihana ~]# pcs constraint list --full
Location Constraints:
Ordering Constraints:
  start SAPHanaTopology_HDB_00-clone then start SAPHana_HDB_00-master
(kind:Mandatory) (non-symmetrical) (id:order-SAPHanaTopology_HDB_00-
clone-SAPHana_HDB_00-master-mandatory)
Colocation Constraints:
  hana-oip with SAPHana_HDB_00-master (score:2000) (rsc-role:Started)
(with-rsc-role:Master) (id:colocation-hana-oip-SAPHana_HDB_00-master-2000)
Ticket Constraints:
[root@prihana ~]#
```

```
root@prihana ~]# pcs constraint remove colocation-hana-oip-SAPHana_HDB_00-master-2000

[root@prihana ~]# pcs constraint list --full
Location Constraints:
Ordering Constraints:
  start SAPHanaTopology_HDB_00-clone then start SAPHana_HDB_00-master
(kind:Mandatory) (non-symmetrical) (id:order-SAPHanaTopology_HDB_00-clone-
SAPHana_HDB_00-master-mandatory)
Colocation Constraints:
Ticket Constraints:
[root@prihana ~]#
```

Checking the logs

Start your troubleshooting by checking logs at `/var/log/messages`. You can find additional information in cluster and Pacemaker logs.

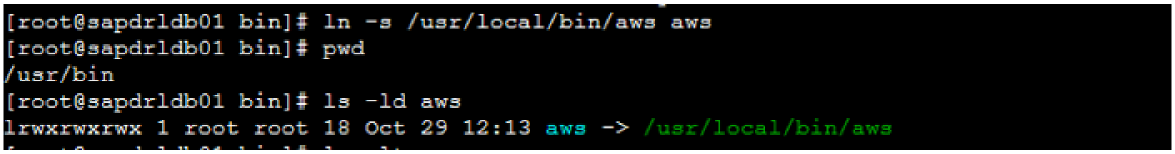
- **Cluster logs** — Cluster logs are updated in the `corosync.log` file located at `var/log/cluster/corosync.log`.
- **Pacemaker logs** — Pacemaker logs are updated in the pacemaker.log file located at `/var/log/pacemaker`.

Known Error:

In case you see the following error message:

```
Failed Actions:
* hana-oip_start_0 on sechana 'unknown error' (1): call=276,
status=complete, exitreason='',
    last-rc-change='Thu Oct 29 12:16:22 2020', queued=0ms,
exec=1056ms
```

This is caused by a missing executable file under `/usr/bin`. Ensure that there is an executable file with name "aws" under `/usr/bin`. If it doesn't exit, create a symlink pointing to the "aws" executable. You may find the path of aws using the command "`which aws`".



```
[root@sapdrldb01 bin]# ln -s /usr/local/bin/aws aws
[root@sapdrldb01 bin]# pwd
/usr/bin
[root@sapdrldb01 bin]# ls -ld aws
lrwxrwxrwx 1 root root 18 Oct 29 12:13 aws -> /usr/local/bin/aws
```

Example of successful creation of `symlink`

Sample working configuration

```
[root@sechana ~]# pcs config
Cluster Name: rhelhanaha
Corosync Nodes:
 prihana sechana
Pacemaker Nodes:
 prihana sechana

Resources:
 Clone: SAPHanaTopology_HDB_00-clone
  Meta Attrs: clone-max=2 clone-node-max=1 interleave=true
  Resource: SAPHanaTopology_HDB_00 (class=ocf provider=heartbeat type=SAPHanaTopology)
   Attributes: InstanceNumber=00 SID=HDB
   Operations: methods interval=0s timeout=5 (SAPHanaTopology_HDB_00-methods-interval-0s)
               monitor interval=60 timeout=60 (SAPHanaTopology_HDB_00-monitor-interval-60)
               start interval=0s timeout=180 (SAPHanaTopology_HDB_00-start-interval-0s)
               stop interval=0s timeout=60 (SAPHanaTopology_HDB_00-stop-interval-0s)
 Master: SAPHana_HDB_00-master
  Resource: SAPHana_HDB_00 (class=ocf provider=heartbeat type=SAPHana)
   Attributes: AUTOMATED_REGISTER=true DUPLICATE_PRIMARY_TIMEOUT=7200 InstanceNumber=00
               PREFER_SITE_TAKEOVER=true SID=HDB
   Meta Attrs: clone-max=2 clone-node-max=1 interleave=true notify=true
   Operations: demote interval=0s timeout=320 (SAPHana_HDB_00-demote-interval-0s)
               methods interval=0s timeout=5 (SAPHana_HDB_00-methods-interval-0s)
               monitor interval=120 timeout=60 (SAPHana_HDB_00-monitor-interval-120)
               monitor interval=121 role=Slave timeout=60 (SAPHana_HDB_00-monitor-
interval-121)
               monitor interval=119 role=Master timeout=60 (SAPHana_HDB_00-monitor-
interval-119)
               promote interval=0s timeout=320 (SAPHana_HDB_00-promote-interval-0s)
               start interval=0s timeout=180 (SAPHana_HDB_00-start-interval-0s)
               stop interval=0s timeout=240 (SAPHana_HDB_00-stop-interval-0s)
 Resource: hana-oip (class=ocf provider=heartbeat type=aws-vpc-move-ip)
  Attributes: interface=eth0 ip=192.168.0.1 routing_table=rtb-dbe0eba1
  Operations: monitor interval=60 timeout=30 (hana-oip-monitor-interval-60)
              start interval=0s timeout=180 (hana-oip-start-interval-0s)
              stop interval=0s timeout=180 (hana-oip-stop-interval-0s)

Stonith Devices:
 Resource: clusterfence (class=stonith type=fence_aws)
  Attributes: pcmk_host_map=prihana:i-0df8622xxxxxxxxxxx;sechana:i-0b2e372xxxxxxxxxxx
pcmk_reboot_retries=4 pcmk_reboot_timeout=480 power_timeout=240 region=us-east-1
 pcmk_reboot_action=off
  Operations: monitor interval=60s (clusterfence-monitor-interval-60s)
Fencing Levels:

Location Constraints:
Ordering Constraints:
  start SAPHanaTopology_HDB_00-clone then start SAPHana_HDB_00-master (kind:Mandatory)
  (non-symmetrical)
Colocation Constraints:
  hana-oip with SAPHana_HDB_00-master (score:2000) (rsc-role:Started) (with-rsc-
role:Master)
Ticket Constraints:

Alerts:
 No alerts defined

Resources Defaults:
 No defaults set
Operations Defaults:
 No defaults set

Cluster Properties:
 cluster-infrastructure: corosync
 cluster-name: rhelhanaha
 dc-version: 1.1.19-8.el7_6.4-c3c624ea3d
 have-watchdog: false
 last-lrm-refresh: 1553719142
 maintenance-mode: false
Node Attributes:
 prihana: hana_hdb_op_mode=logreplay hana_hdb_remoteHost=sechana hana_hdb_
 site=SiteA hana_hdb_srmode=syncmem hana_hdb_vhost=prihana lpa_hdb_lpt=10
 sechana: hana_hdb_op_mode=logreplay hana_hdb_remoteHost=prihana hana_hdb_
 site=SiteB hana_hdb_srmode=syncmem hana_hdb_vhost=sechana lpa_hdb_lpt=1553719113
Cluster name: rhelhanaha
Stack: corosync
```

Contributors

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Further reading

SAP on AWS technical documentation:

- SAP on AWS documentation
- SAP on AWS Whitepapers
- SAP on AWS Blog

SAP documentation:

- SAP Knowledge Base
- SAP Product Availability Matrix
- SAP Quick Sizer
- TCP/IP Ports of All SAP Products

Document revisions

Date	Change
March 25, 2021	Initial publication

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