Operating SAP Solutions on Amazon Web Services

Contents

About this Guide

This guide provides best practice guidelines for deploying SAP solutions on Amazon Web Services (AWS). The intended audience of this guide ranges from anyone who is new to AWS and is looking to install small SAP test/training/sandbox/demo systems on AWS to someone who is already familiar with AWS and is looking for detailed guidance how to deploy high performance SAP systems on AWS.

This guide is not intended to replace any of the standard SAP documentation. When installing SAP solutions on AWS you should always refer to the SAP master guide and installation guide and any SAP notes for the respective SAP solution - http://service.sap.com/instguides

Please provide any feedback you have on this guide to Bill Timm - btimm@amazon.com

Overview of Amazon Web Services

Amazon Web Services (AWS) is a suite of on-demand IT services provided over the Internet by Amazon.com. With AWS you only pay for the services you use when you are using them. There is no upfront cost or long-term commitment required to start using Amazon Web Services.

The highly flexible and scalable platform provided by AWS is an ideal platform for the operation of both non-production and production SAP systems.

This section provides an overview of AWS services that are relevant to the operation of SAP solutions. For a more detailed description of each of the services and the complete suite of AWS services please visit the AWS website - http://aws.amazon.com

Elastic Compute Cloud (EC2) – http://aws.amazon.com/ec2
The Amazon Elastic Compute Cloud (EC2) is an IT infrastructure platform that provides on-demand access to a virtual Linux/UNIX and Windows servers, storage and networking.

Components of AWS EC2

Amazon Machine Image (AMI)
An AMI is the server template that is used to launch a new instance (virtual server). The AMI contains the base operating system (Linux/Windows) that you can then install SAP software on top of. A large selection of public AMIs is available from Amazon and the Amazon EC2 community and it is possible to create your own AMIs.

Instance
After an AMI is launched, the resulting running system is called an instance. Amazon offers various instance sizes (e.g. Small, Medium, Large, XLarge).

Key Pair
Key Pairs are used to ensure that only you have access to your instances. You use a Key Pair to SSH to Linux/UNIX instances, or to decrypt the default administrator password for Windows instances.

Security Group
A security group acts as a firewall that controls the traffic allowed into a group of instances. You can assign each instance to one or more security groups at instance launch time.

Regions and Availability Zones
Amazon EC2 locations are composed of Regions and Availability Zones.

Availability Zones are distinct locations that are engineered to be insulated from failures in other Availability Zones and provide inexpensive, low latency network connectivity to other Availability Zones in the same Region.
Regions consist of one or more Availability Zones, are geographically dispersed, and will be in separate geographic areas or countries. Amazon EC2 is currently available in five

regions: US East (Northern Virginia), US West (Northern California), EU (Ireland), Asia Pacific (Singapore), and Asia Pacific (Tokyo).

Elastic Block Store (EBS) – http://aws.amazon.com/ebs
AWS Elastic Block Store (EBS) provides persistent block level storage volumes for use with EC2 instances. EBS volumes are off-instance storage that persists independently from the life of an instance. Elastic Block Store provides highly available, highly reliable storage volumes that can be attached to an Amazon EC2 instance and exposed as a device within the instance's guest operating system.

EBS Snapshot
EBS provides the ability to create point-in-time snapshots of volumes, which are persisted to Amazon S3. Snapshots can be used as the starting point for new Amazon EBS volumes and to protect data for long-term durability. If you make periodic snapshots of a volume, the snapshots are incremental so that only the blocks on the device that have changed since your last snapshot are incrementally saved in the new snapshot. Even though snapshots are saved incrementally, the snapshot deletion process is designed so that you need to retain only the most recent snapshot in order to restore the volume.

Virtual Private Cloud (VPC) – http://aws.amazon.com/vpc
Amazon Virtual Private Cloud (VPC) enables you to provision a private, isolated section of the AWS Cloud where you can launch AWS resources in a virtual network that you define. You connect to your systems in the VPC via secure VPN tunnel. Instance that you operate with a VPC can appear as if they are on your local corporate network.

Simple Storage Service (S3) – http://aws/amazon.com/s3
Amazon S3 provides a highly durable storage infrastructure designed for mission-critical and primary data storage. S3 is and object based storage system and cannot be presented to an instance as a device like EBS. In an SAP environment S3 is an excellent location for storing backups.

AWS CloudWatch - http://aws.amazon.com/cloudwatch
Amazon CloudWatch enables you to monitor your AWS EC2 resources in real-time. AWS CloudWatch provides free Basic Monitoring for all Amazon EC2 instances. Basic Monitoring provides metrics at 5-minute granularity. Optionally you can choose to enable Detailed Monitoring for an Instance which provides performance metrics at 1-minute granularity

AWS Import/Export Service – http://aws.amazon.com/importexport
AWS Import/Export accelerates moving large amounts of data into and out of AWS using portable storage devices for transport. AWS transfers your data directly onto and off of storage devices using Amazon's high-speed internal network and bypassing the Internet. For significant data sets, AWS Import/Export is often faster than Internet transfer and more cost effective than upgrading your connectivity.

AWS Premium Support – http://aws.amazon.com/premiumsupport
AWS Basic Support is included in the use is AWS services at no additional charge. AWS Basic Support offers all AWS customers access to the AWS Resource Center, AWS Service Health Dashboard, AWS Product FAQs, and AWS Discussion Forums . Customers who desire a deeper level of support can subscribe to AWS Premium Support for an additional fee.

AWS Premium Support is a one-on-one, fast-response support channel that is staffed 24x7x365 with experienced and technical support engineers. The service helps customers of all sizes and technical abilities to successfully utilize the products and features provided by Amazon Web Services.

Creating Amazon Web Services Components

This section provides a high level overview of the process to create and deploy the required AWS components needed to install an SAP solution on AWS. For detailed documentation of AWS EC2 please refer to the AWS EC2 Getting Started Guide and AWS EC2 User Guide.

Perquisites

- Access to the Internet
- Amazon Web Services Account – Create an AWS Account
- Activate your account for AWS EC2

✓ **Log into the Amazon Management Console**

1) Using your AWS account and password log into the AWS Management Console - http://console.aws.amazon.com

✓ **Create a Key Pair**

1) From within the AWS Management Console click on the ***EC2*** tab
2) In the Navigation frame on the left select ***Key Pairs***
3) Click on the ***Create Key Pair*** button
4) Enter the name for the key pair and then click ***Create***
5) You will then be prompted to download and save the private key file to your local drive.

> **Important**
> Do not lose the private key you have downloaded. The key pair is useless for authentication if you do not have the private half.

✓ **Create a Security Group**

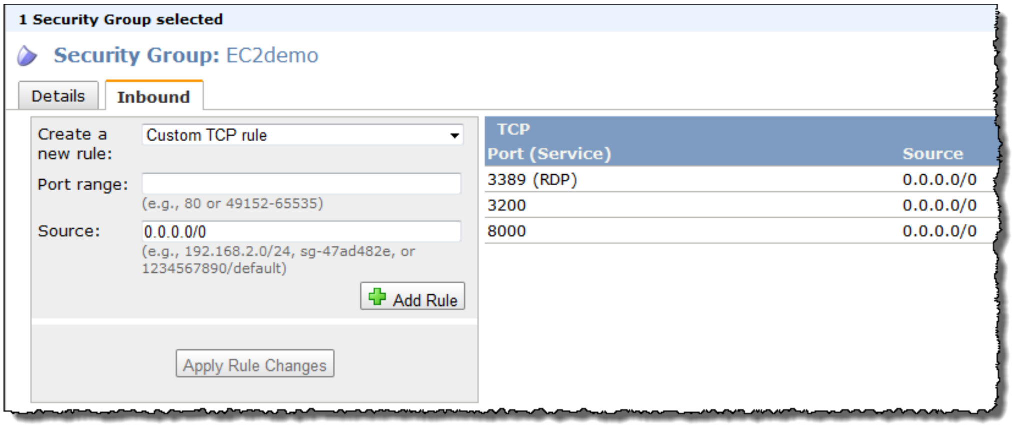
1) From within the AWS Management Console click on the ***EC2*** tab
2) In the Navigation frame on the left select ***Security Groups***
3) Click on the ***Create Security Group*** button
4) Enter a Name and Description for the Security Group and then click the ***Yes, Create*** button

Once the Security Group has been created your can then add rules to the Security Group to allow access to your instances over the required ports. For example if you are creating a Linux server you will need to open port 22 so you can SSH to your instance or for Windows you will need to open port 3389 so you can RDP to your server. If installing an SAP system with system number = 00 you will need to open port 3200 to allow access via SAPgui.

To add a rule to your newly created Security Group…

1) Select your Security Group in the list
2) Click on the ***Inbound*** tab in the bottom half of the window
3) Select one of the predefined rules from the list or select ***Custom TCP/UDP/ICMP*** rule
4) If creating a custom rule enter the port range (e.g. 3200)
5) In the Source field you can enter a range of IP address to limit the IP address that will have access
6) Click on ***Add Rule***
7) Repeat steps 3-6 for each additional rule you would like to add
8) Click on ***Apply Rule Changes***

Figure 1 is an example of a Security Group with port 3389 opened for RDP access and the standard SAP ports opened for SAPGui (3200) and HTTP (8000) access.



Create a new rule: Custom TCP rule

Port range:

(e.g., 80 or 49152-65535)

Source: 0.0.0.0/0

(e.g., 192.168.2.0/24, sg-47ad482e, or 1234567890/default)

TCP Port (Service)	Source
3389 (RDP)	0.0.0.0/0
3200	0.0.0.0/0
8000	0.0.0.0/0

Figure 1

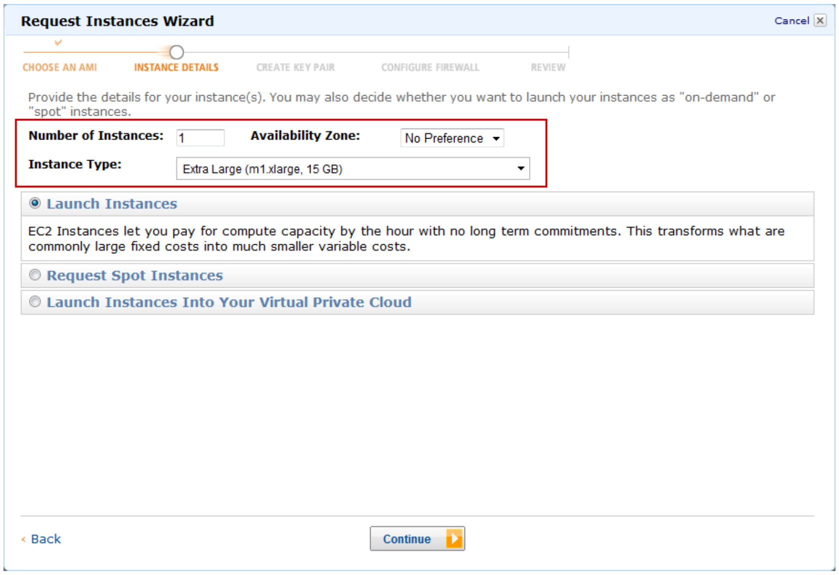
✓ **Launch a new Instance**

1) From within the AWS Management Console click on the ***EC2*** tab
2) In the Navigation frame on the left select ***Instances***
3) Click on the ***Launch Instance*** button
4) Choose an AMI from the list and then click on the ***Select*** button

Note

It is highly recommend that you always start with an Amazon provided AMI. If you make changes specific for your environment to the Instance you can then bundle the Instance into a new AMI and use that AMI for future SAP installations.

5) - Enter the number of instances you would like to launch (usually just one)
   - Select the Availability Zone you would like to launch the instance in
   - Select the Instance Type you would like to launch (see the next section for additional information regarding Instance Types) and then click on ***Continue***



Request Instances Wizard

Provide the details for your instance(s). You may also decide whether you want to launch your instances as "on-demand" or "spot" instances.

Number of Instances: 1 **Availability Zone:** No Preference

Instance Type: Extra Large (m1.xlarge, 15 GB)

● Launch Instances

EC2 Instances let you pay for compute capacity by the hour with no long term commitments. This transforms what are commonly large fixed costs into much smaller variable costs.

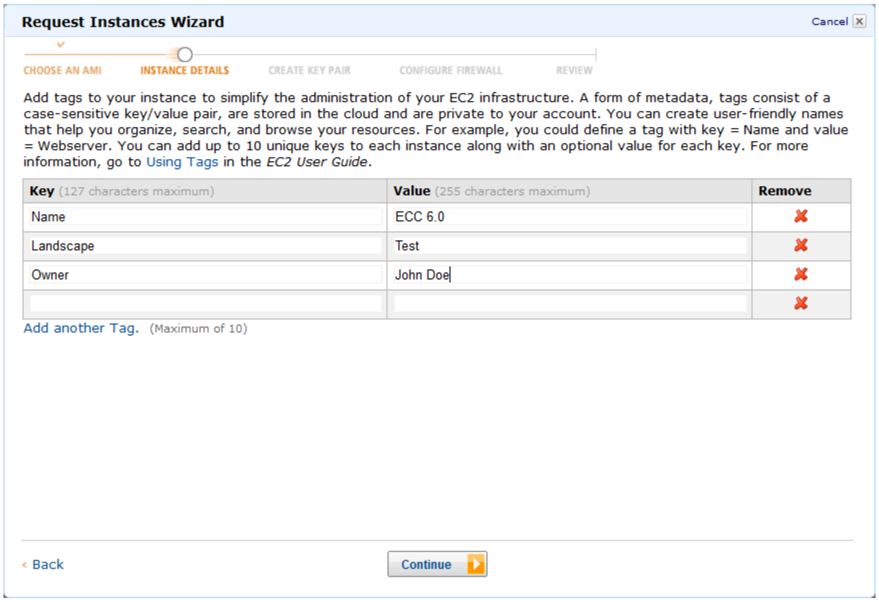
○ Request Spot Instances

○ Launch Instances Into Your Virtual Private Cloud

Tip
When launching your first instance it is recommend to select “No Preference” for the Availability Zone and let AWS select the Availably Zone for you.

6) On the next screen leave the defaults an click on ***Continue***
7) Enter any Tags you would like to maintain and then click on ***Continue***
   You can specify up to 10 key/value pairs to help you organize, search and browse your resources

Tip
You should maintain the Name tag at a minimum. Adding tags to your objects will make managing your environment much easier.



Add tags to your instance to simplify the administration of your EC2 infrastructure. A form of metadata, tags consist of a case-sensitive key/value pair, are stored in the cloud and are private to your account. You can create user-friendly names that help you organize, search, and browse your resources. For example, you could define a tag with key = Name and value = Webserver. You can add up to 10 unique keys to each instance along with an optional value for each key. For more information, go to Using Tags in the *EC2 User Guide*.

Key (127 characters maximum)	**Value** (255 characters maximum)	**Remove**
Name	ECC 6.0	✗
Landscape	Test	✗
Owner	John Doe	✗
		✗

Add another Tag. (Maximum of 10)

8) Select the Key Pair you created earlier and then click *Continue*
9) Select the Security Group you created earlier and then click *Continue*
10) Review the selections and then click on *Launch*

Your instance will take about 5-10 minutes to launch. During this time the instance will go through a few phases which are visible in the Status field within the AWS Management Console.

pending – the virtual server is in the process of starting

running – the virtual server has started. The system may not be immediately accessible when the status first changes to running. This is because the operating is still booting. You can check the status of the operating system by right clicking on the instance and selecting *Get System Log.* A window will open displaying the system log where you can then check the status of the operating system.

✓ **Connecting to your new Instance**

After you have launched your instance and it has finished starting you can then log into the instance using with SSH (Linux) or Remote Desktop (Windows).

For information about connecting to **Linux** Instances, please read section Connect to Your Linux/UNIX Instance in the *Amazon Elastic Compute Cloud Getting Started Guide*.

For information about connecting to **Windows** Instances, please read section Connect to Your Windows Instance in the *Amazon Elastic Compute Cloud Getting Started Guide*.

✓ **Create an EBS Volume**

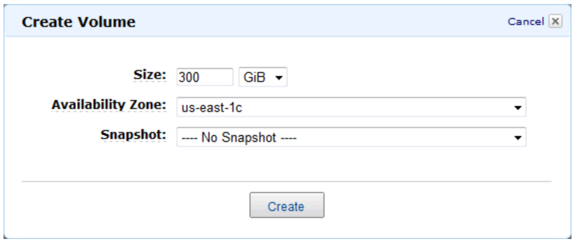
Each EC2 instances comes with a certain amount of instance storage that is included in the hourly cost of the instance. This instance storage is ephemeral, meaning that it only exists for the life of the instance and is not persistent if the instance is shutdown or fails. This ephemeral storage should not be used to store any component of an SAP system.

Amazon EBS provides persistent block level storage that can be mounted by an EC2 instance.

Note
For a small SAP test/training/demo system a single EBS volume will provide sufficient performance. For SAP systems that require maximum IO performance please read the section *Performance Best Practices* later in this document.

1) From within the AWS Management Console click on the ***EC2*** tab
2) In the Navigation frame on the left select ***Volumes***
3) Enter the size of the Volume and chose the Availability Zone the Volume should be created in.

Note
EBS Volumes must be created in the same Availability Zone as the instance you plan to attach it to. If you did not specify an Availability Zone when you launched your instances you can determine which Availability Zone it is in by selecting the instance in the AWS Management Console and looking at the *Zone:* field in the bottom frame of the page.



Create Volume

Size: 300 GiB
Availability Zone: us-east-1c
Snapshot: ---- No Snapshot ----

✓ **Attach EBS Volume to Instance**

1) From within the AWS Management Console click on the ***EC2*** tab
2) In the Navigation frame on the left select ***Volumes***
3) Right click on the Volume you just created and select ***Attach Volume***
4) A list of all instances in the same Availability Zone as the Volume will be displayed. Select the Instance you wish to attach the Volume to.
5) Specify how to expose the volume to the instance in the ***Device*** field (/dev/sdb through /dev/sdz in Linux and xvdb through xvdh in Windows)
6) Click on the ***Attach*** button

✓ **Format and Mount Volume**

After you have attached the volume to the Instance you can log into the Instance and format and mount the volume using the standard procedures for your operating system.

Note
Instructions how to create a stripped file system / drive on both Linux and Windows are provide in the appendix of this document

✓ **Install SAP System**

Once you have your new instance up and running with the required storage formatted and mounted you can proceed with the installation of the SAP system on the server.

There are some special considerations that you need to be aware before installing an SAP system on AWS. These special considers are outlined in the following section of this guide.

Once you have read and understand the special requirements of operating an SAP system on AWS you can proceed with the installation of the system in the same manner as you would on any other physical or virtual server. As always you should follow the procedures documented in the SAP Master and Installation Guides specific to the solution you are installing.

✓ **Create AMI**

Once you have completed the installation of the SAP system you can create an AMI of the Instance which can later be used to launch additional copies of the system or to recover the system if the Instance fails.

1) From within the AWS Management Console click on the ***EC2*** tab
2) In the Navigation frame on the left select ***Instance***
3) Right click on the Instance you just created and select ***Create Image***
4) Enter an *Image Name* and an *Image Description* and then click on ***Create This Image***

Special Considerations for SAP Systems on AWS

This section covers topics specific to the operation of SAP solutions on AWS.

- SAP on AWS notes
- AWS Instance Types
- Operating Systems
- Hostnames
- SAP Hardware Key
- AWS Monitoring
- SAP Virtual Server Monitoring
- SAP and AWS Support
- Termination Protection
- Copying SAP Installation Media to AWS

SAP AWS notes

Before installing any SAP solution on AWS you must read the following SAP Notes. These SAP Notes contain the most recent information on the operation of SAP systems on AWS. Make sure that you have the latest version of each SAP Note, which you can find at http://service.sap.com/notes

Note #	Description
1588667	Operation of SAP systems on Amazon Web Services
	https://service.sap.com/sap/support/notes/1588667 (SMP Credentials required)

AWS Instance Types

AWS offers various instance types (server sizes) that can be used for running SAP systems. Currently only two instance types are supported for production SAP systems (see table below). Non-production systems (Sandbox, Demo, DEV, QAS, etc.) are supported on all instances types.

Below is a list of AWS instance types appropriate for SAP systems.

Instance Type	ECU	Cores	Mem	Prod	SAPS
Standard Large	4.0	2	7.5 GB	No	NA
Standard Extra Large	8.0	4	15.0 GB	No	NA
High-memory Extra Large	6.5	2	17.1 GB	No	NA
High-memory Double Extra Large	13.0	4	34.2 GB	Yes	3700
High-memory Quadruple Extra Large	26.0	8	68 GB	Yes	7400

For a detailed description of the AWS instance types and Elastic Compute Units (ECU) please visit:
http://aws.amazon.com/ec2/#instance

Operating Systems

Amazon Web Services offers the following Operating systems which are supported for the operation of SAP systems as per the SAP PAM. Currently only SUSE Linux is supported for the operation of SAP production systems on AWS.

Operating System	Production
Windows 2003 R2	No
Windows 2008	No
Windows 2008 R2	No
SUSE Linux Enterprise Server 11	Yes
Red Hat Enterprise Linux 5.5	No

Hostnames

1) The generated hostname (Linux) / computername (Windows) that is assigned to a new EC2 Instance is too long and does not meet the requirements of an SAP system. You must change the hostname / computername of a new EC2 Instance to meet the requirements of an SAP system before installing an SAP solution on the Instance. For additional information about the allowed hostname length and characters, see SAP Note 611361.

2) The default behavior of an AWS instance is to generate a new hostname / computername at the time an instance is launched from an AMI or a stopped instance is restarted. This behavior is not appropriate for an SAP system and must be disabled by following the steps provided below.

   - **Windows**
     1) Start -> Program -> EC2ConfigService Settings
     2) On the General tab, deselect “Set Computer Name”

- **SUSE**
  1) Start yast
  2) Navigate to Network Devices -> Network Settings (press enter)
  3) Select Hostname/DNS in the menu
  4) Change the values of the Hostname and Domain Name fields as required
  5) Uncheck "Change Hostname via DHCP"
  6) F10 (to save)
  7) F9 (to exit)

AWS Monitoring

AWS CloudWatch enables AWS customers to monitor their AWS EC2 resources in real-time. AWS CloudWatch provides free Basic Monitoring for all Amazon EC2 instances. Basic Monitoring provides metrics at 5-minute frequency.

Any AWS Instance that is used to run an SAP production system must have AWS CloudWatch Detailed Monitoring enabled. AWS CloudWatch Detailed Monitoring provides metrics on CPU utilization, disk reads and writes, and network traffic at 1-minute frequency.

You can enable Detailed Monitoring for an Instance by right clicking on the Instance in the AWS Management Console and then selecting Enable Detailed Monitoring.

Note
There is additional cost associated with the use of CloudWatch Detailed Monitoring. Please visit http://aws.amazon.com/cloudwatch/ for additional information.

SAP and AWS Support

- To receive support from both SAP and AWS for the operation of SAP production systems on AWS you must follow the guidelines outlined in the SAP's Performance Measurements Standards (SAPS) Benchmarks for SAP Certified Amazon Web Services

When operating SAP production systems on AWS you must have either a "Gold" or "Platinum" AWS Premium Support contract in place. For additional information regarding AWS Premium Support please visit - http://aws.amazon.com/premiumsupport

Termination Protection

Termination Protection prevents an EC2 instance from accidently being terminated(deleted) by a user either via the Amazon Management Console or the Amazon EC2 API. You can enable Termination Protection at instance launch time or by right clicking on a running instance in the Amazon Management Console and selecting "Change Termination Protection".

It is highly recommend that you enable Termination Protection for any SAP production system that you operate on AWS.

Copying SAP Installation Media to AWS

There are two primary options for copying SAP installation media to AWS.

- If you already have the installation media downloaded to a location on your network you can copy the media from your network to AWS S3 or directly to an AWS EC2 Instance. Depending on the connection speed between your network and AWS this may not be the optimal solution.
- AWS EC2 Instances have a very high-speed connection to the Internet which enables fast downloads from the SAP Service Marketplace. In most cases downloading from the SAP Service Marketplace directly to an AWS EC2 Instance will be the fastest method for getting SAP installation media to AWS. Using this solution you can create a dedicated EBS volume to store all of your installation media which you can then detach/attach to different Instances as needed. You can also create a Snapshot of the EBS volume and create multiple EBS copies that you can attach to multiple Instances in parallel.

Copying SAP System to AWS

Currently the only method supported by SAP for copying an SAP system is the SAP homogeneous / heterogeneous system copy procedure. This is also the recommended method for copying an existing on-premise SAP system to AWS.

For small SAP systems you can copy the export directly to AWS over the network. For larger SAP systems the Amazon Import/Export service can be utilized. The Amazon Import/Export service enables you to ship a portable storage device to Amazon, the data is then copied from the storage device to one of your S3 buckets. You can then download the data from S3 directly to your EC2 instance via the local AWS high speed network.

For additional information on the Amazon Import/Export services please visit:
http://aws/amazon.com/importexport/

Sizing and Performance

Sizing

The standard SAP sizing procedure should be utilized when sizing SAP solutions to run on AWS. After you have completed an SAP sizing using the SAP Quick Sizer and have determined your SAPS requirements you can then architect your SAP solution on AWS. The SAPS ratings of the various EC2 instance types can be found in SAP Note # 1588667.

AWS is continually introducing new instance types and enhancing the AWS platform. You should frequently check note SAP Note # 1588667 for the latest SAPS ratings of the various AWS instance types.

Performance

Storage

AWS Elastic Block Store (EBS) is a shared resource. EBS volumes function like Network Attached Storage (NAS) devices and all communication with the EBS volumes occur over the network provided to the Amazon EC2 instance.

To meet the high IO requirements of an SAP production system it is recommend to stripe multiple EBS volumes using software RAID to increase the total number of IOPS available to the SAP system. Each EBS volume is protected from physical drive failure by the means of drive mirroring so using a RAID level higher than RAID-0 is not necessary. The annual failure rate (AFR) for an EBS volume is 0.1% and 0.5%, compared to 4% for a commodity hard drive.

Following standard SAP storage recommendations the DB log files should be stored on separate EBS volume(s) than the DB data files.

Below is a sample minimum EBS configuration for an SAP production system.

File system	EBS Volumes	Striping
root	1	NA
/usr/sap	1	NA
Database software	1	NA
DB log files	4	RAID-0
DB data files	6	RAID-0

High Availability and Disaster Recovery

High Availability

The standard method for providing high availability for an SAP system, by protecting the single points of failure (SPOF), is to use a failover cluster. Currently on AWS it is not possible to install a traditional failover cluster but this does not mean that it is not possible to provide different levels of high availability for an SAP system. The following section describes different failure scenarios and possible architectural solutions that can be utilized to provide maximum availability for an SAP system.

- **EC2 Instance Failure**
  - **DB Instance**

    Option #1 - DB replication between two EC2 Instances (e.g. Oracle Data Guard, MS SQL Server Mirroring, etc.) between two EC2 instances. To provide additional protection you can create the secondary database in a second Availability Zone (see Disaster Recovery in next section).
    Option #2 - Launch new DB instance from AMI and attach EBS volumes from failed DB instance to new DB instance
  - **SAP Central Instance**

    Option #1 – Setup standby SAP CI and configure Enqueue replication between systems. In case of primary SAP CI failure manually failover to secondary SAP CI
    Option #2 – Launch new SAP CI instance from AMI

- **EBS Failure**
  - **DB Instance**

    Option #1 DB replication between two EC2 Instances (e.g. Oracle Data Guard, MS SQL Server Mirroring, etc.) between two EC2 instances. To provide additional protection you can create the secondary database in a second Availability Zone (see Disaster Recovery in next section).
  - **SAP Central Instance**

    Option #1 – Setup standby SAP CI and configure Enqueue replication between systems. In case of primary SAP CI failure manually failover to secondary SAP CI
    Option #2 – Launch new SAP CI instance from AMI

Disaster Recovery

Depending on the requirements of your business AWS provides multiple solutions for addressing Disaster Recovery. To protect your SAP systems against various natural and manmade disasters you can utilize the different AWS Regions and Availability Zones.

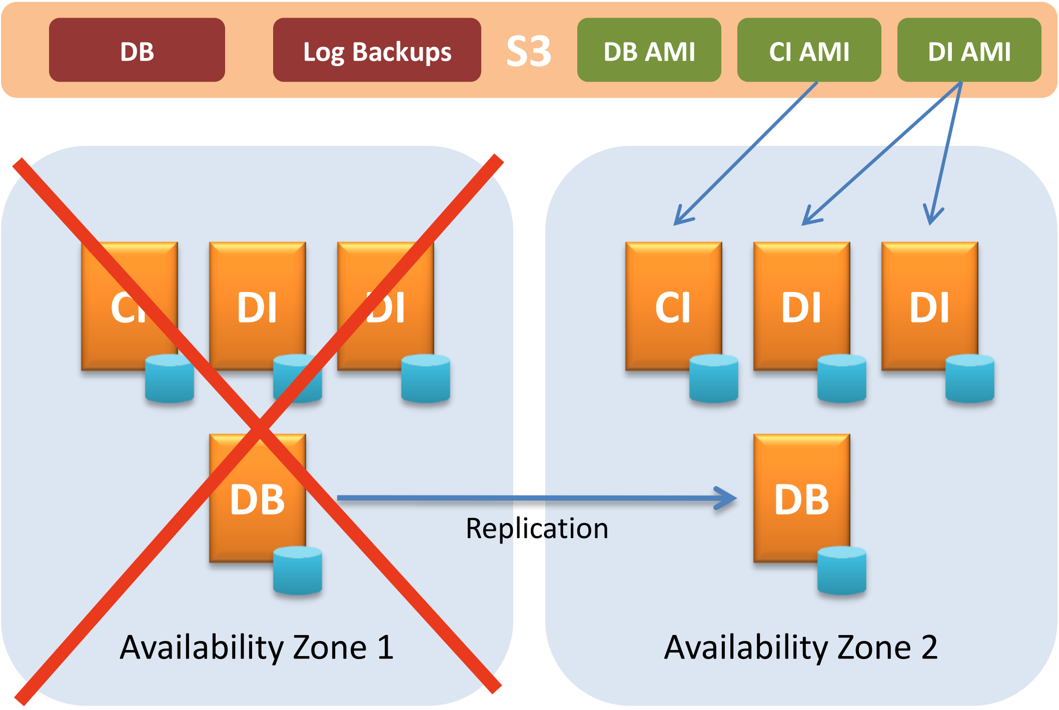
- **Multi Availability Zone**

  Each AWS Availability Zone is designed as an independent failure zone. This means that Availability Zones are typically physically separated within a metropolitan region and are in different flood plains. In addition to discrete uninterruptable power source (UPS) and onsite backup generation facilities, they are each fed via different grids from independent utilities to further reduce single points of failure. Availability Zones are all redundantly connected to multiple tier-1 transit providers.

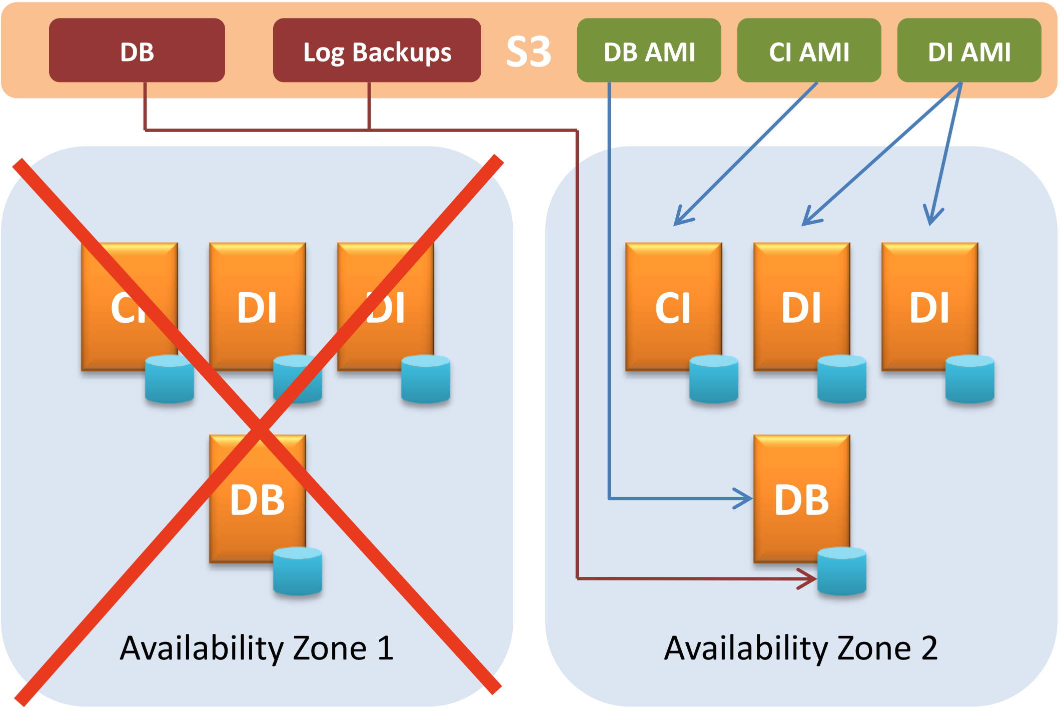
  Depending on the Recovery Point Objective (RPO) and Recovery Time Objective (RTO) requirements of your business there are two primary Multi AZ scenarios that you can utilize to protect your SAP environment in case of an AZ failure.

  Multi AZ Replication

  The SAP database is replicated to a standby database in a secondary AZ by means of log shipping or database replication (Oracle Data Guard, MS SQL Server Mirroring, etc.).
  If the primary AZ fails the DB in the secondary AZ is available to take over as the primary DB. You can then quickly rebuild your SAP CI and DIs utilizing AMIs to launch new instances.



Multi AZ Backup/Restore
If the RPO and RTO requirements of the business do not warrant the additional cost of DB replication you can use a simple DB backup/restore between AZs to recover your SAP database in the case of primary AZ failure. Like the Multi AZ replication scenario you can quickly rebuild your SAP CI and DIs utilizing AMIs to launch new instances.



- **Multi Region**
  If the fault separation provided by multiple Availability Zones does not meet the requirements of your business then multiple Regions can be utilized for Disaster Recovery.

  Multi Region Disaster Recovery requires additional effort compared to Multi AZ Disaster Recovery since AMIs and Snapshots created in a Region are only accessible from within that Region. Currently AWS does not provide tools to replicate these objects between Regions. Also unlike Availability Zones within the same region there is no high speed low latency network connection between Regions.

  While it is possible to architect a Disaster Recovery solution using multiple Regions the details of such a solution are beyond the scope of this document. If your business requires Multi Region Disaster Recovery you should consult with an AWS Service Provider who is experienced in Multi Region architectures.

Reserved Instances
All of the techniques examined above rely on the assumption that you will be able to procure Amazon EC2 instances whenever you need them.

Amazon Web Services has massive hardware resources at its disposal, but like any cloud computing provider, those resources are finite. The best way for users to maximize their access to these resources is by reserving a portion of the computing capacity that they require. This can be done through a feature called Reserved Instances.

With Reserved Instances, you literally reserve computing capacity in the Amazon Web Services cloud. Doing so enables you to take advantage of a lower price, but more importantly in the context of fault tolerance, it will maximize your chances of getting the computing capacity you need.

For additional information on Reserved Instances please visit - http://aws.amazon.com/ec2/#pricing

Backing Up SAP Systems on AWS

Amazon Web Services does not offer backup services for EC2 instances but does provide the infrastructure to allow you to execute and manage backups yourself. Different options for backing up SAP system on AWS are discussed below.

File system / OS Backups

Create Image (EBS AMI) - Creating an Image of an Instance essentially creates an OS level backup of the Instance and creates an EBS Snapshot for each attached EBS Volume. Image creation does require that the Instance be stopped and then restarted (this happens automatically as part of the Image creation process). Images are a good solution for backing up small non-production SAP systems (sandbox/training/test/demo/etc.) where offline backups are possible.

EBS Snapshots – For production systems that cannot tolerate downtime EBS Snapshots can be utilized to backup root EBS volumes and any other EBS volumes that do not contain database data files or log files (e.g. /usr/sap, DB software, etc.). Creating an EBS Snapshot of a root EBS Volume does not require the Instances to be stopped and then restarted. The EBS Snapshot that is created can then be registered as an AMI and then be used to launch a new Instance incase the original Instance fails.

Database Backups

EBS Snapshots – EBS Snapshots provide a simple solution for backing up non-production SAP databases (i.e. test/training/demo/sandbox/etc.) EBS Snapshots should not be used for database backups of SAP production systems. In order to ensure a consistent backup the SAP application and database should be stopped before creating the Snapshot.

Database Backup to EBS – Another option is to mount an EBS volume to an instance and then perform online database and/or database log backups to the EBS volume. Once the database backup has been completed a Snapshot of the EBS volume can then be created to save the backup to S3. To save cost you can attached/detach the EBS “backup” volume before and after the backup is run so you only pay for the “backup” volume when it is in use. This process could be scripted using the AWS EC2 Command Line tools.

Database Backup to S3 – A few Enterprise Backup software vendors offer the ability to backup directly to AWS S3. This scenario would allow you to perform and manage your backups on AWS much like you would on-premise by replacing tapes with S3.

If the backup software you are currently using does not yet support direct backup to S3 there are software solutions for both Linux and Windows that can present S3 as local storage. This solution would then allow any existing enterprise backup software or native backup software to backup directly to S3.

Oracle RMAN currently supports direct backup to AWS S3

Appendix:

Setting up RAID on SUSE Enterprise Linux

1) Create special device

```
prompt> mknod /dev/md0 b 9 5
```

2) Create RAID-0 group

```
prompt> mdadm --create /dev/md0 -v --raid-devices=6 --chunk=32  --
level=raid0 /dev/sdh /dev/sdi /dev/sdj /dev/sdk /dev/sdl /dev/sdm
```

3) Format file system

```
prompt> mkfs.ext3 /dev/md0
```

4) Mount file system

```
prompt> mount /dev/md0 /sapdb/data -o noatime
```

5) Add the below entry to the /etc/fstab file

```
/dev/md0       /sapdb/log1     ext3    defaults,noatime     0  0
```

6) Create /etc/mdadm.conf file

```
prompt> mdadm --misc --detail --brief /dev/md0
```

Output from above command

```
ARRAY /dev/md0 level=raid0 num-devices=6
UUID=f06414c0:39e569bb:a4e94613:1aa6b923 devices /dev/sdh,/dev/sdi
,/dev/sdj,/dev/sdk,/dev/sdl,/dev/sdm
```

From the above output create the mdadm.con file

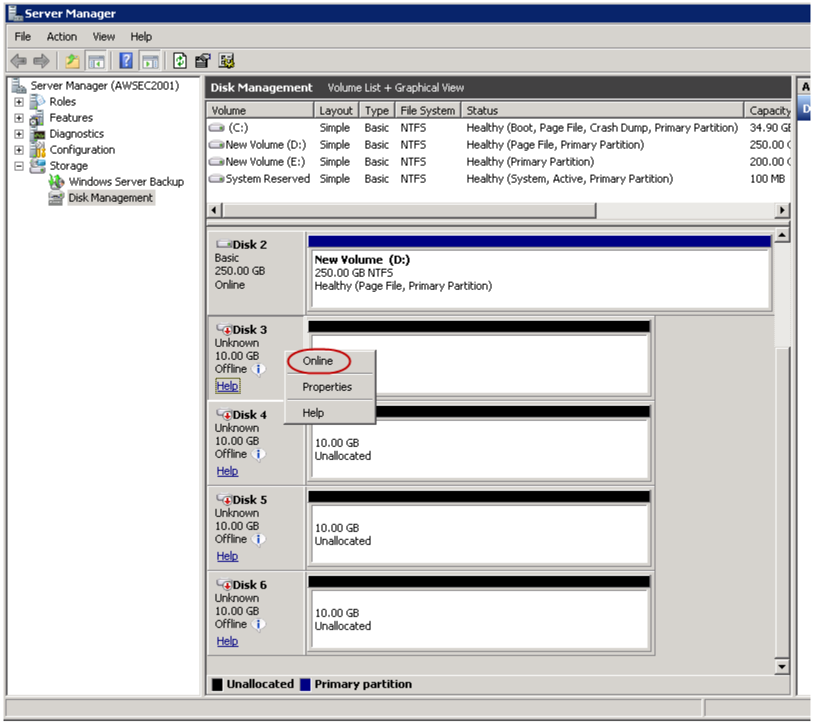
```
prompt> echo "DEVICE /dev/sdh /dev/sdi /dev/sdj /dev/sdk /dev/sdl
/dev/sdm " >> /etc/mdadm.conf

prompt> echo "ARRAY /dev/md0 level=raid0 num-devices=6
UUID=f06414c0:39e569bb:a4e94613:1aa6b923" >> /etc/mdadm.conf
```

7) Turn on boot.md

```
prompt> chkconfig boot.md on
```

Setting up RAID on Windows 2008 R2

1) Right click on ***Computer*** and select ***Manage***
2) In the left frame navigate to ***Server Manager -> Storage -> Disk Management***
3) In the bottom right frame you will see the unallocated disks listed. For each disk right click and select ***Online***



Volume	Layout	Type	File System	Status	Capacity
(C:)	Simple	Basic	NTFS	Healthy (Boot, Page File, Crash Dump, Primary Partition)	34.90 GI
New Volume (D:)	Simple	Basic	NTFS	Healthy (Page File, Primary Partition)	250.00 (
New Volume (E:)	Simple	Basic	NTFS	Healthy (Primary Partition)	200.00 (
System Reserved	Simple	Basic	NTFS	Healthy (System, Active, Primary Partition)	100 MB

Disk 2
Basic
250.00 GB
Online

New Volume (D:)
250.00 GB NTFS
Healthy (Page File, Primary Partition)

Disk 3
Unknown
10.00 GB
Offline
Help

Disk 4
Unknown
10.00 GB
Offline
Help

10.00 GB
Unallocated

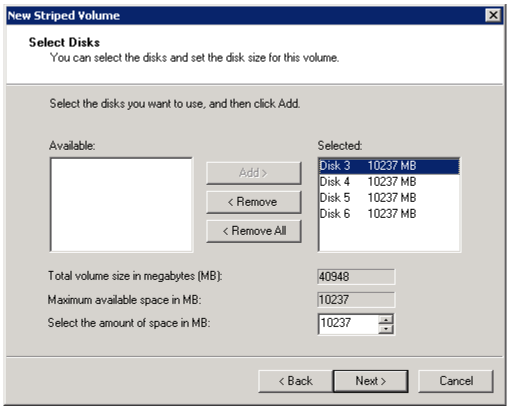
Disk 5
Unknown
10.00 GB
Offline
Help

10.00 GB
Unallocated

Disk 6
Unknown
10.00 GB
Offline
Help

10.00 GB
Unallocated

4) After setting each disk to online right click on each disk and select ***Initialize Disk***
5) Right click on any of the disks and select ***New Stripped Volume…***
6) Add the disks listed in the Available list and then click ***Next***



Select Disks
You can select the disks and set the disk size for this volume.

Select the disks you want to use, and then click Add.

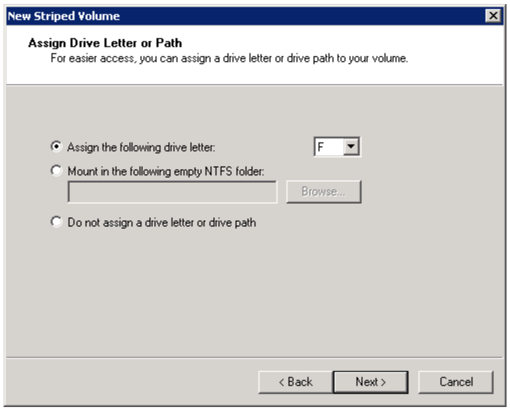
Available:

Selected:

Disk 3	10237 MB
Disk 4	10237 MB
Disk 5	10237 MB
Disk 6	10237 MB

Total volume size in megabytes (MB): 40948
Maximum available space in MB: 10237
Select the amount of space in MB: 10237

7) Chose a driver letter and then click ***Next***


New Striped Volume

Assign Drive Letter or Path

For easier access, you can assign a drive letter or drive path to your volume.

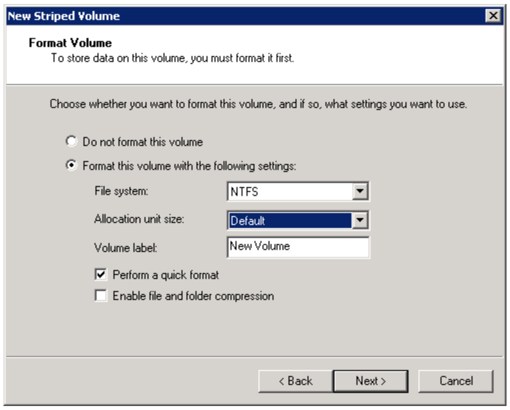
● Assign the following drive letter: F

○ Mount in the following empty NTFS folder:

○ Do not assign a drive letter or drive path

8) Select the ***Allocation unit size*** and then click ***Next***

*Note** – Different databases may recommend different values for the Allocation unit size so check the documentation for your database for the recommend size.


New Striped Volume

Format Volume

To store data on this volume, you must format it first.

Choose whether you want to format this volume, and if so, what settings you want to use.

○ Do not format this volume

● Format this volume with the following settings:

File system: NTFS

Allocation unit size: Default

Volume label: New Volume

☑ Perform a quick format

□ Enable file and folder compression

9) Click on ***Finish***