

# Project Documentation: 3-Tier Architecture using ASG and NSG in Azure

The goal of this project is to design and deploy 3-tier architecture for a web application using Azure. The architecture includes three virtual machines (VMs) placed in three separate subnets within a single virtual network (VNet). Each VM will perform different roles:

- **Web Tier:** Nginx as the web server
- **App Tier:** Tomcat as the application server
- **DB Tier:** MySQL as the database serve

## Step 1. Virtual Machine Creation :-

- Created 4 Virtual Machines in East US region
- Image : Ubuntu Server 24.04 LTS - x64 Gen2 ( 2 WebVM's , 1 App VM & 1 DB VM )
- Size :- Standard\_B1s - 1 vcpu, 1 GiB memory

Microsoft Azure

Search resources, services, and docs (G+)

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DEFAULT DIRECTORY

Home >

Virtual machines

Default Directory

+ Create

Switch to classic

Reservations

Manage view

Refresh

Export to CSV

Open query

Assign tags

Start

Restart

Stop

Delete

Services

Maintenance

Filter for any field...

Subscription equals all

Type equals all

Resource group equals all

Location equals all

Add filter

Showing 1 to 4 of 4 records.

No grouping

List view

<input type="checkbox"/>	Name ↑↓	Subscription ↑↓	Resource group ↑↓	Location ↑↓	Status ↑↓	Operatin... ↑↓	Size ↑↓	Public IP addr... ↑↓	Private IP address ↑↓	
<input type="checkbox"/>	App-VM	Pay-As-You-Go	3-Tier-RG	East US	Running	Linux	Standard_B1s	40.71.197.251	10.0.3.4	...
<input type="checkbox"/>	DB-VM	Pay-As-You-Go	3-Tier-RG	East US	Running	Linux	Standard_B1s	172.191.25.23	10.0.4.4	...
<input type="checkbox"/>	Web01-VM	Pay-As-You-Go	3-Tier-RG	East US	Running	Linux	Standard_B1s	172.190.133.54	10.0.1.4	...
<input type="checkbox"/>	Web02-VM	Pay-As-You-Go	3-Tier-RG	East US	Running	Linux	Standard_B1s	172.191.65.16	10.0.2.4	...

Step 2. Created 3 Application Security groups (ASG's) :-

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Application security groups

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+ Create

Manage view

Refresh

Export to CSV

Open query

Assign tags

Filter for any field...

Subscription equals all

Resource group equals all

Location equals all

Add filter

Showing 1 to 3 of 3 records.

No grouping

List view

<input type="checkbox"/>	Name ↑↓	Network interfaces count ↑↓	Virtual network ↑↓	Type ↑↓	Resource group ↑↓	Location ↑↓	Subscription ↑↓
<input type="checkbox"/>	APP-ASG	1	↔ VNET_3Tier	Application security gr...	3-Tier-RG	East US	Pay-As-You-Go ***
<input type="checkbox"/>	DB-ASG	1	↔ VNET_3Tier	Application security gr...	3-Tier-RG	East US	Pay-As-You-Go ***
<input type="checkbox"/>	WEB-ASG	2	↔ VNET_3Tier	Application security gr...	3-Tier-RG	East US	Pay-As-You-Go ***

Step 3. Added ASG's to respective VM's [Web01-VM, Web02-VM, APP-VM & DB-VM]

Home > Virtual machines > Web01-VM

Virtual machines

Default Directory

+ Create

Switch to classic

Filter for any field...

Name ↑↓

App-VM

DB-VM

Web01-VM

Web02-VM

Overview

Activity log

Access control (IAM)

Tags

Diagnose and solve problems

Connect

Connect

Bastion

Web01-VM | Application security groups

Virtual machine

This is a new experience. Please provide feedback

+ Add application security groups

Remove

Refresh

Gi

Network interface / IP configuration

web01-vm85 (primary) / ipconfig1 (primary)

☐ Name

☐ WEB-ASG

Home > Virtual machines > Web02-VM

Virtual machines

Default Directory

+ Create

Switch to classic

Filter for any field...

Name ↑↓

App-VM

DB-VM

Web01-VM

Web02-VM

Overview

Activity log

Access control (IAM)

Tags

Diagnose and solve problems

Connect

Connect

Bastion

Web02-VM | Application security groups

Virtual machine

This is a new experience. Please provide feedback

+ Add application security groups

Remove

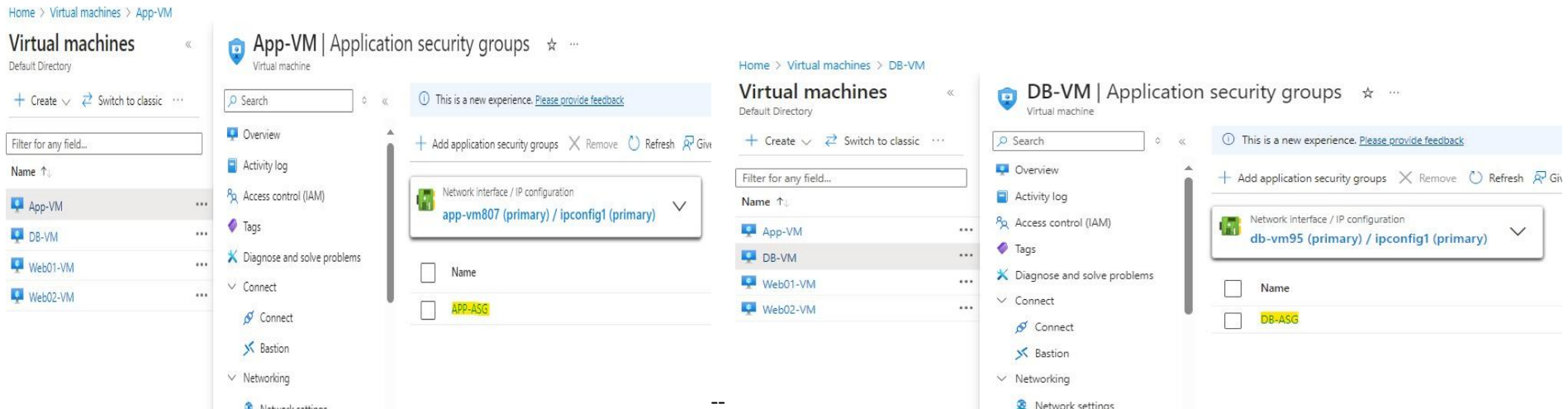
Refre:

Network interface / IP configuration

web02-vm175 (primary) / ipconfig1 (primary)

☐ Name

☐ WEB-ASG



#### Step 4. Created Network Security Group [NSG] & Added 4 Inbound Rules Based on below scenario

Microsoft Azure

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Home > Network security groups > NSG

NSG | Inbound security rules

Network security group

+ Add Hide default rules Refresh Delete Give feedback

Network security group security rules are evaluated by priority using the combination of source, source port, destination, destination port, and protocol to allow or deny the traffic. A security rule can't have the same priority and direction as an existing rule. You can't delete default security rules, but you can override them with rules that have a higher priority. [Learn more](#)

Filter by name Port == all Protocol == all Source == all Destination == all Action == all

Priority	Name	Port	Protocol	Source	Destination	Action
100	AllowAnyCustom80Inbou...	80	Any	Any	WEB-ASG	Allow
110	AllowApplicationSecurity...	8080	Any	WEB-ASG	APP-ASG	Allow
120	AllowApplicationSecurity...	3306	Any	APP-ASG	DB-ASG	Allow
130	DenyApplicationSecurity...	Any	Any	WEB-ASG	DB-ASG	Deny

1. From Any Source I need to connect to Web-ASG via port 80, Action =Allow
2. From Source Web ASG – App ASG via port 8080 , Action =Allow
3. From Source App ASG – DB ASG via port 3306 , Action =Allow
4. From source Web ASG – DB ASG trying to connect from any port it should deny connection.

Step 5:- Associated NSG to Subnet's ( Web, App , DB Subnets )

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Home > Network security groups > NSG

NSG | Subnets

Network security group

Search

Overview

Activity log

Access control (IAM)

Tags

Diagnose and solve problems

Settings

Inbound security rules

Outbound security rules

Network interfaces

Subnets

Associate

Search subnets

Name	Address range	Virtual network
WebSubnet01	10.0.1.0/24	VNET_3Tier
WebSubnet02	10.0.2.0/24	VNET_3Tier
AppSubnet01	10.0.3.0/24	VNET_3Tier
DbSubnet01	10.0.4.0/24	VNET_3Tier

## Step 6 :- Installed NGINX in Web01 & Web02 VM with the below commands

```
#!/bin/bash
```

```
sudo su
```

```
apt update
```

```
apt install nginx -y
```

 Added in Advance Session under Custom Data while creating VM

[Home](#) > [Virtual machines](#) >

### Create a virtual machine

[Help me create a low cost VM](#) [Help me create a VM optimized for high availability](#) [Help me choose the right VM size for my workload](#)

Basics Disks Networking Management Monitoring **Advanced** Tags Review + create

Add additional configuration, agents, scripts or applications via virtual machine extensions or cloud-init.

#### Extensions

Extensions provide post-deployment configuration and automation.

Extensions [Select an extension to install](#)

#### VM applications

VM applications contain application files that are securely and reliably downloaded on your VM after deployment. In addition to the application files, an install and uninstall script are included in the application. You can easily add or remove applications on your VM after create. [Learn more](#)

[Select a VM application to install](#)

#### Custom data and cloud init

Pass a cloud-init script, configuration file, or other data into the virtual machine **while it is being provisioned**. The data will be saved on the VM in a known location. [Learn more about custom data for VMs](#)

#### Custom data

```
#!/bin/bash
sudo su
apt update
apt install nginx -y
```



## Step 7. Installing Tomcat server in App VM

Tomcat Installation on Ubuntu Link :-

<https://drive.google.com/file/d/1aN85dgS4QtFuEQgc7v6Z7V3n8ftFHw2t/view>

With the steps in above link I have successfully installed Tomcat & I got the below window

azure@App-VM: /tmp

```
azure@App-VM:/tmp$ sudo chmod +x /opt/tomcat/bin/startup.sh
azure@App-VM:/tmp$ sudo chmod +x /opt/tomcat/bin/shutdown.sh
sudo chmod +x /opt/tomcat/bin/catalina.sh
azure@App-VM:/tmp$ sudo chown -R tomcat:tomcat /opt/tomcat
azure@App-VM:/tmp$ sudo systemctl start tomcat
azure@App-VM:/tmp$ sudo systemctl status tomcat
● tomcat.service - Tomcat
   Loaded: loaded (/etc/systemd/system/tomcat.service; enabled; preset: enabled)
   Active: active (running) since Mon 2025-02-03 13:44:22 UTC; 9s ago
  Process: 8018 ExecStart=/opt/tomcat/bin/startup.sh (code=exited, status=0/SUCCESS)
 Main PID: 8025 (java)
    Tasks: 30 (limit: 1064)
  Memory: 147.5M (peak: 147.6M)
     CPU: 4.581s
  CGroup: /system.slice/tomcat.service
          └─8025 /usr/lib/jvm/java-1.21.0-openjdk-amd64/bin/java -Djava.util.logging.config.file=/opt/tomcat

Feb 03 13:44:12 App-VM systemd[1]: Starting tomcat.service - Tomcat...
Feb 03 13:44:12 App-VM systemd[1]: tomcat.service: Control process exited, code=exited, status=203/EXEC
Feb 03 13:44:12 App-VM systemd[1]: tomcat.service: Failed with result 'exit-code'.
Feb 03 13:44:12 App-VM systemd[1]: Failed to start tomcat.service - Tomcat.
Feb 03 13:44:22 App-VM systemd[1]: tomcat.service: Scheduled restart job, restart counter is at 344.
Feb 03 13:44:22 App-VM systemd[1]: Starting tomcat.service - Tomcat...
Feb 03 13:44:22 App-VM startup.sh[8018]: Tomcat started.
Feb 03 13:44:22 App-VM systemd[1]: Started tomcat.service - Tomcat.
lines 1-19/19 (END)
```

## Installing MYSQL in APP Server

Link :- [https://drive.google.com/file/d/1\\_JUyUKel6Y9mjBFPBpzb\\_5yRD-zfVOxd/view?usp=sharing](https://drive.google.com/file/d/1_JUyUKel6Y9mjBFPBpzb_5yRD-zfVOxd/view?usp=sharing)

After all the steps I received below results

azure@App-VM: ~

```
● mysql.service - MySQL Community Server
   Loaded: loaded (/usr/lib/systemd/system/mysql.service; enabled; preset: enabled)
   Active: active (running) since Mon 2025-02-03 16:18:11 UTC; 47min ago
     Process: 702 ExecStartPre=/usr/share/mysql/mysql-systemd-start pre (code=exited, status=0/SUCCESS)
    Main PID: 912 (mysqld)
      Status: "Server is operational"
        Tasks: 37 (limit: 1064)
      Memory: 371.2M (peak: 418.4M)
         CPU: 26.127s
      CGroup: /system.slice/mysql.service
              └─912 /usr/sbin/mysqld

Feb 03 16:18:02 App-VM systemd[1]: Starting mysql.service - MySQL Community Server...
Feb 03 16:18:11 App-VM systemd[1]: Started mysql.service - MySQL Community Server.
```

```
~
~
~
~
~
```



Connection testing

1. From any source to WebASG via port 80

[Home](#) >

# Virtual machines

Default Directory (maikodurajugmail.onmicrosoft.com)

+

Create

↺

Switch to classic

🕒

Reservations

⚙️

Manage view

🔄

Refresh

📄

Export to CSV

🔗

Open query

🏷️

Assign tags

▶

Start

↺

Restart

⏹

Stop

🗑️

Delete

☰

Services

🔧

Maintenance

Filter for any field...

Subscription equals all

Type equals all

Resource group equals all

Location equals all

+ Add filter

Showing 1 to 4 of 4 records.

☐

Name ↑↓

☐

Subscription ↑↓

☐

Resource group ↑↓

☐

Location ↑↓

☐

Public IP address ↑↓

☐

Private IP address ↑↓

☐

\*\*\*

<input type="checkbox"/>	App-VM	Pay-As-You-Go	3-Tier-R	rd_B1s	40.71.197.251	10.0.3.4	***
<input type="checkbox"/>	DB-VM	Pay-As-You-Go	3-Tier-R	rd_B1s	172.191.25.23	10.0.4.4	***
<input type="checkbox"/>	Web01-VM	Pay-As-You-Go	3-Tier-R	rd_B1s	172.190.133.54	10.0.1.4	***
<input type="checkbox"/>	Web02-VM	Pay-As-You-Go	ARM-RG	rd_B1s	172.191.65.16	10.0.2.4	***

azure@Web01-VM: ~

azure@Web01-VM:~\$ telnet 10.0.2.4 80  
Trying 10.0.2.4...  
Connected to 10.0.2.4.  
Escape character is '^]'.  
^ZConnection closed by foreign host.  
azure@Web01-VM:~\$  
azure@Web01-VM:~\$  
azure@Web01-VM:~\$ telnet 10.0.1.4 80  
Trying 10.0.1.4...  
Connected to 10.0.1.4.  
Escape character is '^]'.  
[



2. Web to App connection Testing by using Telnet command via 8080 port

Home >

Virtual machines

Default Directory

+ Create

Switch to classic

Reservations

Manage view

Refresh

Export to CSV

Open query

Assign tags

Start

Restart

Stop

Delete

Services

Maintenance

Filter for any field...

Subscription equals all

Type equals all

Resource group equals all

Location equals all

Add filter

Showing 1 to 4 of 4 records.

No grouping

List view

<input type="checkbox"/> Name	Subscription	Resource group	Location	Status	Operating system	Size	Public IP address	Private IP address
<input type="checkbox"/> App-VM	Pay-As-You-Go	3-Tier-RG	East US	Running	Linux	Standard_B1s	40.71.197.251	10.0.3.4
<input type="checkbox"/> DB-VM	Pay-As-You-Go	3-Tier-RG	East US	Running	Linux	Standard_B1s	172.191.25.23	10.0.4.4
<input type="checkbox"/> Web01-VM	Pay-As-You-Go	3-Tier-RG	East US	Running	Linux	Standard_B1s	172.190.133.54	10.0.1.4
<input type="checkbox"/> Web02-VM	Pay-As-You-Go	3-Tier-RG	East US	Running	Linux	Standard_B1s	172.191.65.16	10.0.2.4

azure@Web01-VM: ~

azure@Web01-VM:~\$ telnet 10.0.3.4 8080

Trying 10.0.3.4...

Connected to 10.0.3.4.

Escape character is '^['.

Connection closed by foreign host.

azure@Web01-VM:~\$

3. Connection Test – WEB to DB by using Telnet command via port 3306

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Home >

Virtual machines

Default Directory (mailkodurajugmail.onmicrosoft.com)

CreateSwitch to classicReservationsManage viewRefreshExport to CSVOpen queryAssign tagsStartRestartStopDeleteServicesMaintenance

Filter for any field...Subscription equals allType equals allResource group equals allLocation equals allAdd filter

Showing 1 to 3 of 3 records.

No groupingList view

Name	Subscription	Resource group	Location	Status	Operating system	Size	Public IP address	Private IP address
App-VM	Pay-As-You-Go	3Tier-RG	East US	Running	Linux	Standard_B1s	74.235.249.87	10.0.2.5
DB-VM	Pay-As-You-Go	3Tier-RG	East US	Running	Linux	Standard_B1s	172.172.187.212	10.0.3.4
Web-VM	Pay-As-You-Go	3Tier-RG	East US	Running	Linux	Standard_B1s	104.45.137.235	10.0.1.4

azure@App-VM: ~  
azure@App-VM:~\$ telnet 10.0.3.4 3306  
Trying 10.0.3.4...  
Connected to 10.0.3.4.  
Escape character is '^J'.

4. Web to DB connection

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Home >

Virtual machines

Default Directory

CreateSwitch to classicReservationsManage viewRefreshExport to CSVOpen queryAssign tagsStartRestartStopDeleteServicesMaintenance

Filter for any field...Subscription equals allType equals allResource group equals allLocation equals allAdd filter

Showing 1 to 4 of 4 records.

No groupingList view

Name	Subscription	Resource group	Location	Status	Operating system	Size	Public IP address	Private IP address
App-VM	Pay-As-You-Go	3-Tier-RG	East US	Running	Linux	Standard_B1s	40.71.197.251	10.0.3.4
DB-VM	Pay-As-You-Go	3-Tier-RG	East US	Running	Linux	Standard_B1s	172.191.25.23	10.0.4.4
Web01-VM	Pay-As-You-Go	3-Tier-RG	East US	Running	Linux	Standard_B1s	172.190.133.54	10.0.1.4
Web02-VM	Pay-As-You-Go	3-Tier-RG	East US	Running	Linux	Standard_B1s	172.191.65.16	10.0.2.4

azure@Web01-VM: ~  
azure@Web01-VM:~\$ telnet 10.0.4.4  
Trying 10.0.4.4...  
[ ]