

# Project Documentation: 3-Tier Application Deployment on Azure

## 1. Project Overview

Project Name: 3-Tier Azure Deployment

Description: This project demonstrates how to design, deploy, and secure a 3-tier web application architecture on Microsoft Azure using:

- Web Server: Nginx
- Application Server: Apache Tomcat
- Database Server: MySQL

## 2. Architecture Summary

### High-Level Architecture Components:

Layer	Technology	Purpose
Web Tier	Nginx	Accepts external HTTP/HTTPS traffic
Application Tier	Apache Tomcat	Executes business logic
Database Tier	MySQL	Stores application data

### Azure Services Used:

- Azure Virtual Network (VNet)
- Azure Subnets
- Azure Virtual Machines (Linux Ubuntu 20.04)
- Azure Network Security Groups (NSGs)
- Azure Resource Group

## 3. Network Design

### Virtual Network:

VNet Address Space: 10.0.0.0/16

### Subnets:

Subnet	IP Range	Purpose
Web Subnet	10.0.1.0/24	Nginx Server
App Subnet	10.0.2.0/24	Tomcat Server
DB Subnet	10.0.3.0/24	MySQL Server

### NSG Rules Summary:

Subnet	Port	Source	Purpose
Web Subnet	80, 443	Internet	HTTP/HTTPS access
App Subnet	8080	Web Subnet	Tomcat internal access
DB Subnet	3306	App Subnet	MySQL internal access

## 4. Deployment Steps

### Step 1 — Create Azure Resources

- Create Resource Group
- Create Virtual Network with 3 subnets
- Create NSGs and associate with subnets

### Step 3 — Install & Configure Software

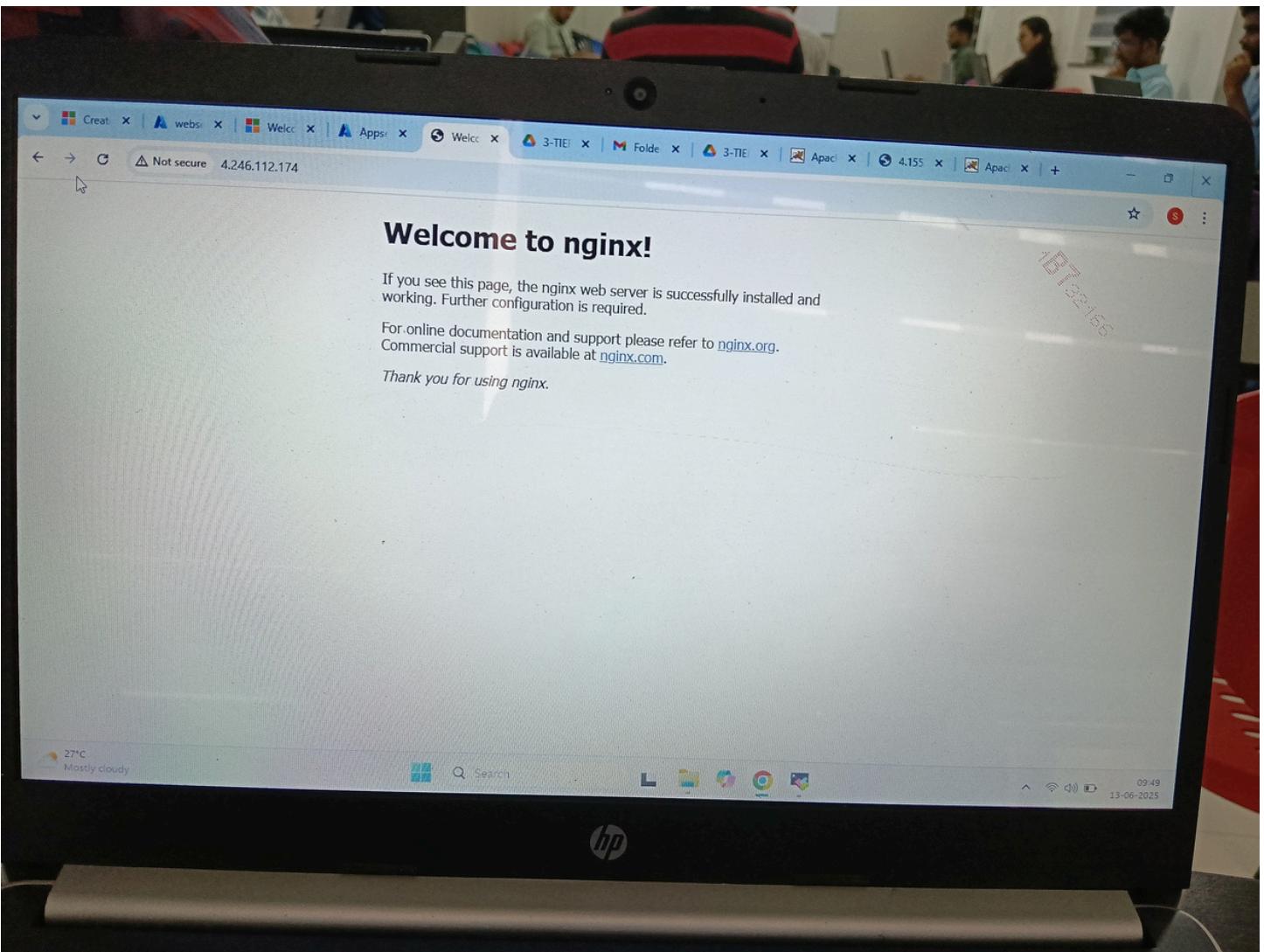
#### Web Server (Nginx)

##### update packages

```
sudo apt update
```

```
sudo apt install nginx-y
```

Result:



Expanded Security Maintenance for Applications is not enabled.  
14 updates can be applied immediately.  
14 of these updates are standard security updates.  
To see these additional updates run: apt list --upgradable  
  
Enable ESM Apps to receive additional future security updates.  
See <https://ubuntu.com/esm> or run: sudo pro status  
  
\_successful  
1 device has a firmware upgrade available.  
Run `fwupdmgr get-upgrades` for more information.  
  
Last login: Fri Jun 13 03:38:49 2025 from 115.98.206.140  
Satish9@webserversatish:~\$ telnet 10.1.1.4 8080  
Trying 10.1.1.4...  
Connected to 10.1.1.4.  
Escape character is '^]'.  
Connection closed by foreign host.  
Satish9@webserversatish:~\$ I  
  
monitoring  
final folder  
Computer name webbserversatish Networking Public IP address 4.246.112.174 (Netw  
- Please support MobaXterm by subscribing to the professional edition here: <https://mobaxterm.mobatek.net>  
Dual machine  
Computer name webbserversatish  
I

### Application Server (Tomcat) installation steps:

sudo apt update

Tomcat requires java.install openJDK

sudo apt install openjdk-11-jdk

Download tomcat

wget https://downloads.apache.org/tomcat/tomcat-9/v9.0.x/bin/apache-tomcat-9.0.x.tar.gz  
tar -xvzf apache-tomcat-9.0.x.tar.gz

Extract and configure Tomcat

tar -xvzf apache-tomcat-10.1.18.tar.gz

ls

Mv apache-tomcat-10.1.18 tomcat

ls

To start apache tomcat manually from bin directory

. Cd/tomcat/bin

Start tomcat

./startup.sh

Access tomcat

http://your.server.ip:8080

Editing context.xml

Vi /opt/tomcat/webapps/host-manager/META-INF/context.xml

Configure Tomcat user

Vi tomcat/conf/tomcat-users.xml

Restart tomcat

Sudo systemctl restart tomcat

Access Tomcat manager

http://localhost:8080/manager/html

stop tomcat

./shutdown.sh

```
root@appwebserver:/home/Satish9/apache-tomcat-9.0.106# cd bin
bootstrap.jar
catalina-tasks.xml
catalina.bat
catalina.sh
ciphers.bat
ciphers.sh
commons-daemon-native.tar.gz
commons-daemon.jar
configtest.bat
root@appwebserver:/home/Satish9/apache-tomcat-9.0.106/bin# ./startup
Using CATALINA_BASE:   /home/Satish9/apache-tomcat-9.0.106
Using CATALINA_HOME:   /home/Satish9/apache-tomcat-9.0.106
Using CATALINA_TMPDIR: /home/Satish9/apache-tomcat-9.0.106/temp
Using JRE_HOME:        /usr
Using CLASSPATH:       /home/Satish9/apache-tomcat-9.0.106/bin/bootstrap
/home/Satish9/apache-tomcat-9.0.106/bin/tomcat-juli.jar
Using CATALINA_OPTS:
Tomcat started.
root@appwebserver:/home/Satish9/apache-tomcat-9.0.106/bin#
```

appwebserver 1% 0.46 GB / 0.88 GB 0.02 Mb/s 0.03 Mb/s 4.

Please support MobaXterm by subscribing to the professional edition here: <https://mobaxterm.mobatek.net/mobaxterm.html>

Create Your Azure Free Acco | Resource groups - Microsoft | Welcome to nginx! | Apache Tomcat® - Apache | /manager

Not secure 4.155.12.62:8080/manager/html

## Tomcat Web Application Manager

**Manager**

[List Applications](#) [HTML Manager Help](#) [Manager Help](#) [Server Status](#)

### Applications

Path	Version	Display Name	Running	Sessions	Commands
/	<i>None specified</i>	Welcome to Tomcat	true	0	<a href="#">Start</a> <a href="#">Stop</a> <a href="#">Reload</a> <a href="#">Undeploy</a> <a href="#">Expire sessions</a> with idle ≥ <input type="text" value="30"/> minutes
/docs	<i>None specified</i>	Tomcat Documentation	true	0	<a href="#">Start</a> <a href="#">Stop</a> <a href="#">Reload</a> <a href="#">Undeploy</a> <a href="#">Expire sessions</a> with idle ≥ <input type="text" value="30"/> minutes
/examples	<i>None specified</i>	Servlet and JSP Examples	true	0	<a href="#">Start</a> <a href="#">Stop</a> <a href="#">Reload</a> <a href="#">Undeploy</a> <a href="#">Expire sessions</a> with idle ≥ <input type="text" value="30"/> minutes
/host-manager	<i>None specified</i>	Tomcat Host Manager Application	true	0	<a href="#">Start</a> <a href="#">Stop</a> <a href="#">Reload</a> <a href="#">Undeploy</a> <a href="#">Expire sessions</a> with idle ≥ <input type="text" value="30"/> minutes
/manager	<i>None specified</i>	Tomcat Manager Application	true	1	<a href="#">Start</a> <a href="#">Stop</a> <a href="#">Reload</a> <a href="#">Undeploy</a> <a href="#">Expire sessions</a> with idle ≥ <input type="text" value="30"/> minutes

### Deploy

Deploy directory or WAR file located on server

Context Path:

26°C Mostly cloudy Search L 🌐 📺 🎙 10:00 14-06-2025

hp

Create Your Azure Free Acc... x appserver - Microsoft Azure x Welcome to nginx! x Apache Tomcat® - Apache x manager x +

Not secure 4.155.12.62:8080/manager/html

## Tomcat Web Application Manager

Message: OK

**Manager**

List Applications      HTML Manager Help      Manager Help

**Applications**

Path	Version	Display Name	Running	Sessions	Commands
/	None specified	Welcome to Tomcat	true	0	<a href="#">Start</a> <a href="#">Stop</a> <a href="#">Re</a> <a href="#">Expire sessions</a>
/docs	None specified	Tomcat Documentation	true	0	<a href="#">Start</a> <a href="#">Stop</a> <a href="#">Re</a> <a href="#">Expire sessions</a>
/examples	None specified	Servlet and JSP Examples	true	0	<a href="#">Start</a> <a href="#">Stop</a> <a href="#">Re</a> <a href="#">Expire sessions</a> with idle ≥ 30 minutes
/host-manager	None specified	Tomcat Host Manager Application	true	0	<a href="#">Start</a> <a href="#">Stop</a> <a href="#">Reload</a> <a href="#">Undeploy</a> <a href="#">Expire sessions</a> with idle ≥ 30 minutes
/manager	None specified	Tomcat Manager Application	true	1	<a href="#">Start</a> <a href="#">Stop</a> <a href="#">Reload</a> <a href="#">Undeploy</a> <a href="#">Expire sessions</a> with idle ≥ 30 minutes

**Deploy**

Deploy directory or WAR file located on server

Content Path:

Rainy days ahead 27°C

Search  L     

09:39 14-06-2025

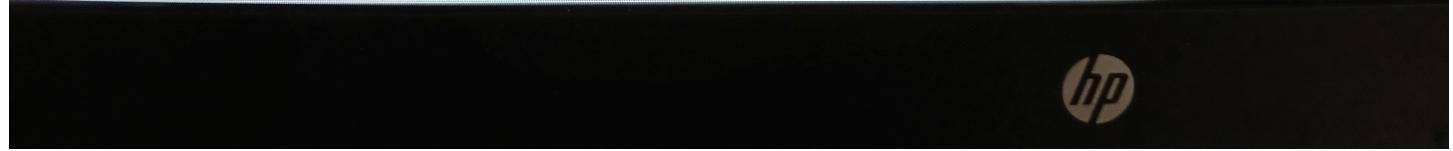
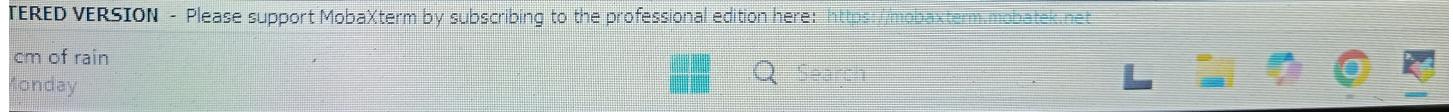
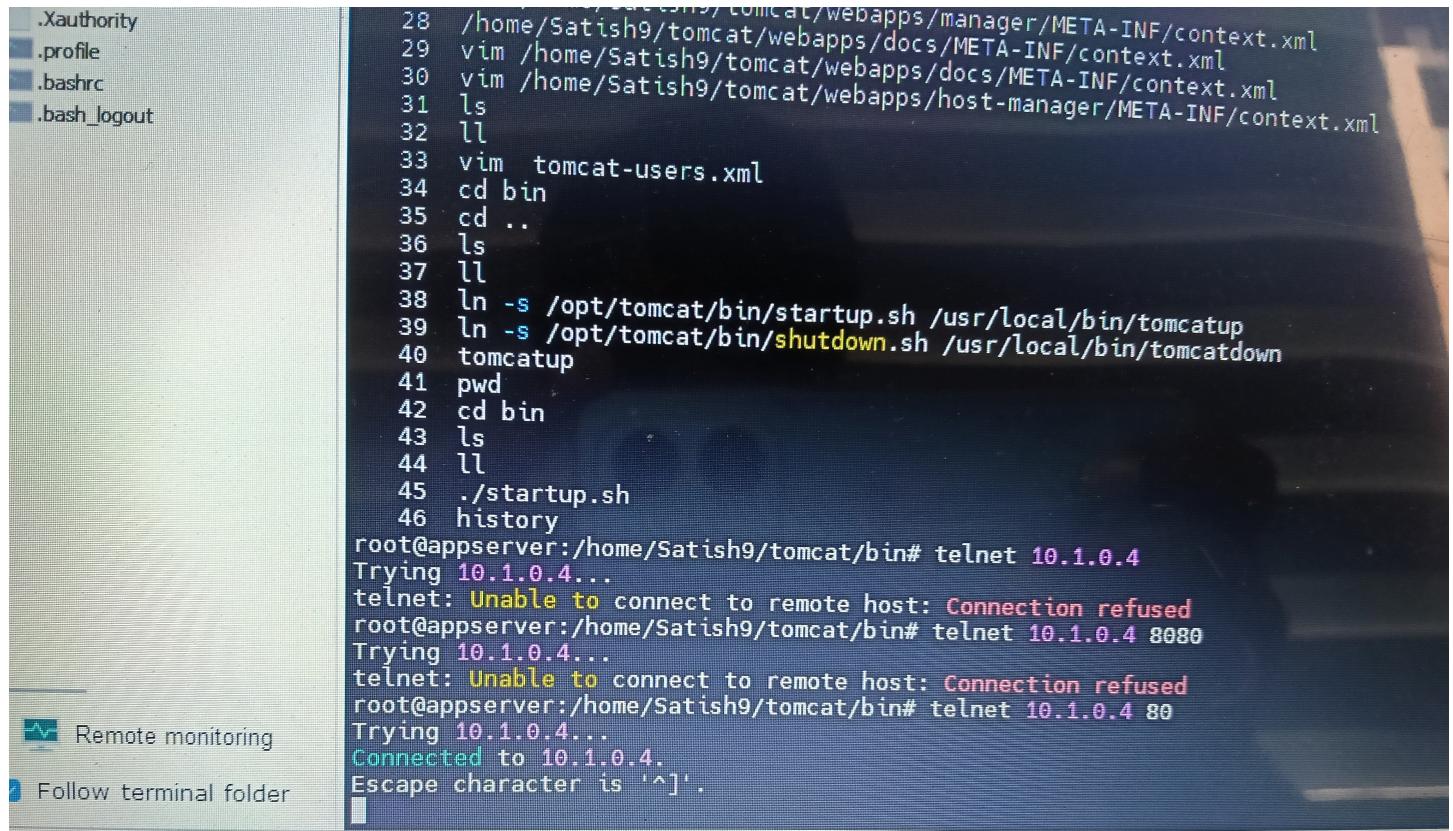
Save password?  Save  Never

Username: tomcat  
Password: \*\*\*\*\*

You can use saved passwords on any device. They're saved to Google Password Manager for nivannreddy015@gmail.com.



```
.Xauthority  
.profile  
.bashrc  
.bash_logout  
28 /home/Satish9/tomcat/webapps/manager/META-INF/context.xml  
29 vim /home/Satish9/tomcat/webapps/docs/META-INF/context.xml  
30 vim /home/Satish9/tomcat/webapps/docs/META-INF/context.xml  
31 ls  
32 ll  
33 vim tomcat-users.xml  
34 cd bin  
35 cd ..  
36 ls  
37 ll  
38 ln -s /opt/tomcat/bin/startup.sh /usr/local/bin/tomcatup  
39 ln -s /opt/tomcat/bin/shutdown.sh /usr/local/bin/tomcatdown  
40 tomcatup  
41 pwd  
42 cd bin  
43 ls  
44 ll  
45 ./startup.sh  
46 history  
root@appserver:/home/Satish9/tomcat/bin# telnet 10.1.0.4  
Trying 10.1.0.4...  
telnet: Unable to connect to remote host: Connection refused  
root@appserver:/home/Satish9/tomcat/bin# telnet 10.1.0.4 8080  
Trying 10.1.0.4...  
telnet: Unable to connect to remote host: Connection refused  
root@appserver:/home/Satish9/tomcat/bin# telnet 10.1.0.4 80  
Trying 10.1.0.4...  
Connected to 10.1.0.4.  
Escape character is '^]'.  
  
TERED VERSION - Please support MobaXterm by subscribing to the professional edition here: https://mobaxterm.mobatek.net
```



## Database Server (MySQL)

Steps for installation:

Update system packages:

```
sudo apt update
```

```
Install mysql
```

```
sudo apt install mysql-server
```

Security

```
sudo mysql_secure_installation nano/etc/MySQL/MySQL.conf.d/mysqld.cnf
```

Locate following line

```
Bin address=0.0.0.0
```

```
Systemct restart.mysql
```

```
system status mysql
```

MySQL

View X server Tools Games Settings Macros Help

Tools Games Sessions View Split MultiExec Tunneling Packages Settings Help

X server Exit

... 3. 4.155.32.132 (Satish9) 9. 4.155.221.235 (Satish9)

Reload privilege tables now? (Press y|Y for Yes, any other key for No) : y Success.

All done!

```
root@Dbserver:/home/Satish9# nano /etc/mysql/mysql.conf.d/mysqld.cnf
root@Dbserver:/home/Satish9# systemctl restart mysql
root@Dbserver:/home/Satish9# systemctl status mysql
● mysql.service - MySQL Community Server
   Loaded: loaded (/usr/lib/systemd/system/mysql.service; enabled; preset: en
   Active: active (running) since Fri 2025-06-13 11:20:21 UTC; 23s ago
     Process: 7026 ExecStartPre=/usr/share/mysql/mysql-systemd-start pre (code=e>
 Main PID: 7035 (mysqld)
    Status: "Server is operational"
      Tasks: 38 (limit: 1056)
     Memory: 393.8M (peak: 413.8M)
        CPU: 1.004s
      CGroup: /system.slice/mysql.service
              └─7035 /usr/sbin/mysqld

Jun 13 11:20:20 Dbserver systemd[1]: Starting mysql.service - MySQL Community S>
Jun 13 11:20:21 Dbserver systemd[1]: Started mysql.service - MySQL Community Se>
[lines 1-14/14 (END)]
```

Dbserver 1% 0.70 GB / 0.88 GB 0.01 Mb/s 0.00 Mb/s 36 min ← → ×

ON - Please support MobaXterm by subscribing to the professional edition here: <https://mobaxterm.mobatek.net>

virtual machine  
Computer name: Appserver Networking  
Public IP address:

```
ons View Split MultiExec Tunneling Packages Settings Help X server
 2. 4.246.112.174 (Satish) 3. 4.155.3.226 (Satish9) 4. 4.246.106.171 (Satish) +
```

Remove test database and access to it? (Press y|Y for Yes, any other key for No) : y  
- Dropping test database...  
Success.

- Removing privileges on test database...  
Success.

Reloading the privilege tables will ensure that all changes made so far will take effect immediately.

Reload privilege tables now? (Press y|Y for Yes, any other key for No) : y  
Success.

All done!

```
root@dbserveratish:/home/Satish9# nano/etc/mysql/mysql.conf.d/mysqld.cnf
bash: nano/etc/mysql/mysql.conf.d/mysqld.cnf: No such file or directory
root@dbserveratish:/home/Satish9# nano /etc/mysql/mysql.conf.d/mysqld.cnf
root@dbserveratish:/home/Satish9# systemctl restart mysql
root@dbserveratish:/home/Satish9#
```

MobaXterm by subscribing to the professional edition here: <https://mobaxterm.mobatek.net>

## 5. Testing & Validation

- Verify external access to Web Server (Nginx)
- Verify internal connectivity between Web → App → DB
- Validate NSG rules are correctly restricting traffic

## 6. Conclusion

Successfully deployed a secure, scalable 3-tier web application in Azure using IaaS (Infrastructure-as-a-Service)