NTWK8141

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APPLIED NETWORK INFRASTRUCTURE AND SYSTEM ADMINISTRATION

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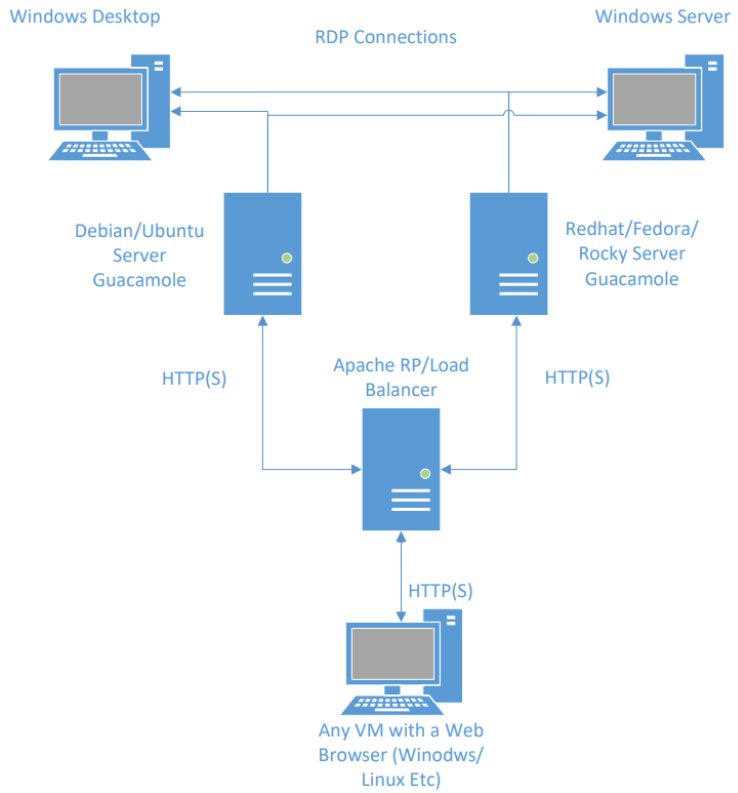
1. Introduction and Objectives

- **Windows DC**: A Windows Server acting as Domain Controller
- **Windows Client**: A Windows client machine configured to connect to DC using Remote Desktop Protocol
- **Linux Servers and Client**: Three Linux servers and one client (Optional) to be added to Windows domain
- **Guacamole Setup**: Deploy Guacamole on Ubuntu and Fedora servers for remote desktop access
- **Customization**: Modify Guacamole web page titles to show their OS
- **Load Balancer**: Set up load balancer to distribute traffic between Guacamole instances
- **Reverse proxy**: Set up reverse proxy for load balancer

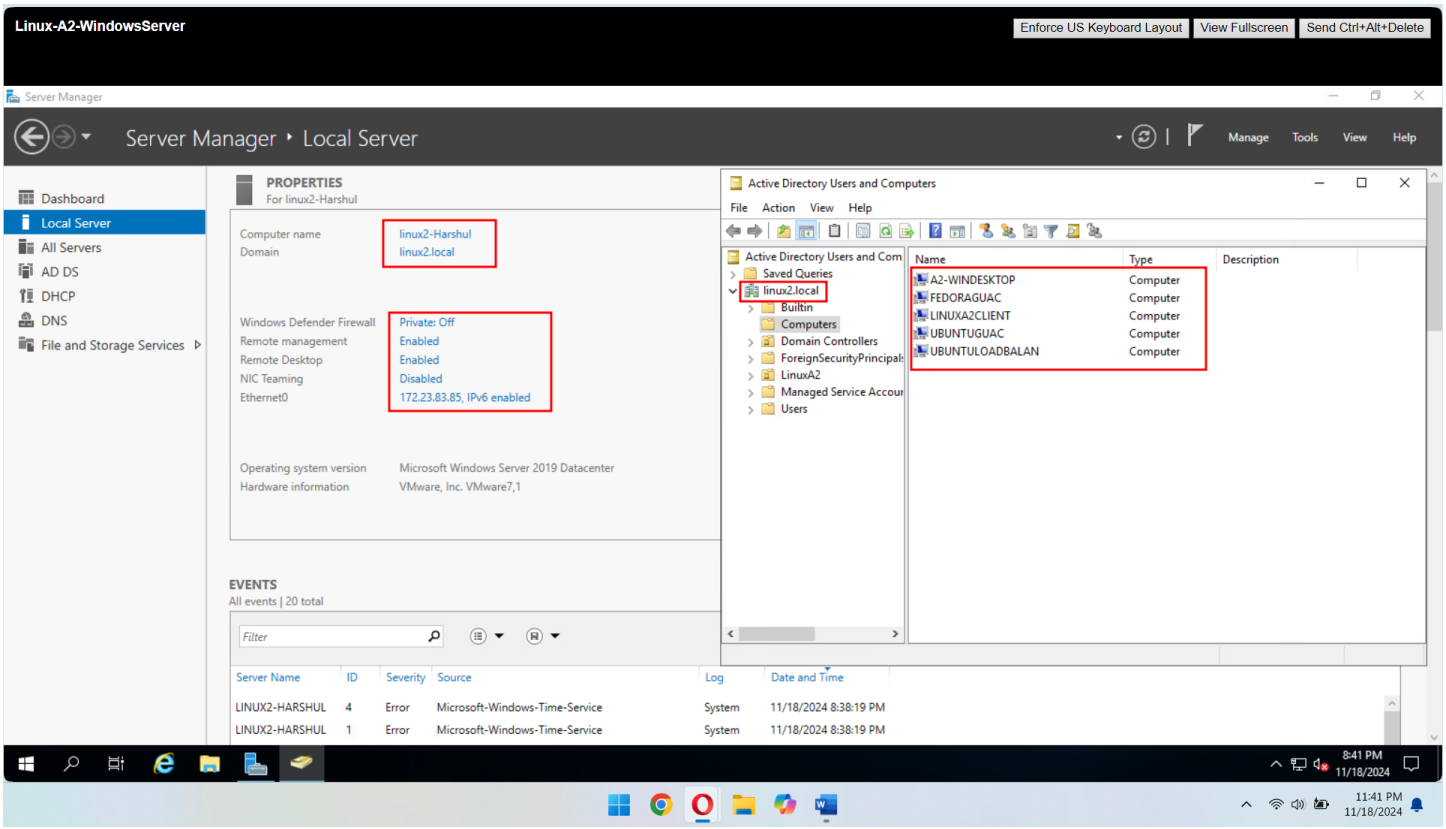
Component	IP Address	Role
Windows Server	172.23.83.85	Domain Controller (DC) for Linux2.local
Windows Client	172.23.83.86	RDP connection via Guacamole
Linux Client	172.23.83.21	SSH , SCP to servers, joined to domain
Ubuntu Server	172.23.83.87	Ubuntu-Guacamole server with usermapping.xml
Fedora Server	172.23.83.111	Rocky Linux ,Guacamole server with LDAP
Load Balancer	172.23.83.88	Apache reverse proxy with load balancing



2. Windows Server (DC) Setup

Configure the Domain and Enable RDP

1. Log in to the **Windows Server**.
2. Open **Server Manager** and install **Active Directory Domain Services (AD DS)** and **DNS Server**.
3. Promote server to a Domain Controller(DC) - Domain Name: **Linux2.local.**
4. Check if DNS is correctly configured to resolve hostnames in domain
5. Make sure remote desktop is enabled for RDP.



NOTE :

Check that all virtual machines have enough resources to operate so we are giving the following specs for each VM

- **Memory**: 3 GB
- **CPU**: 4 cores
- **Hard Drive**: 90 GB

3. Windows Client Setup

Step 1: Join the Domain

1. Open **Control Panel > System > Change Settings**.
2. Under the **Computer Name** tab, click **Change**.
3. Enter the domain name: **Linux2.local.**
4. Provide the domain administrator credentials to join the domain.

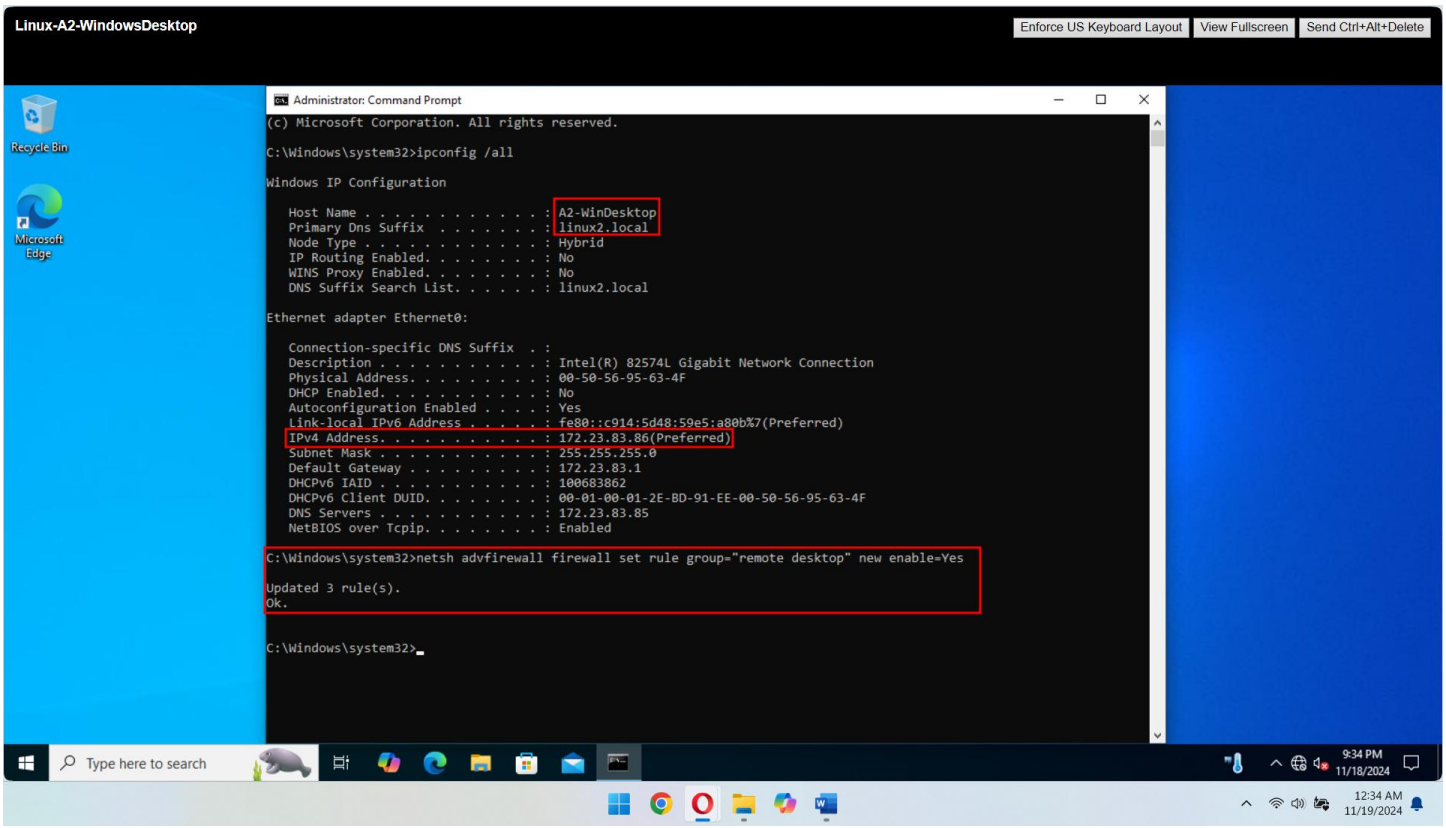
Step 2: Enable RDP

1. Open **Control Panel > System and Security > System > Remote Settings**.
2. Under **Remote Desktop**, select

   "Allow remote connections to this computer."

   "Allow connections only from computers running Remote Desktop with Network Level Authentication."

3. Open the firewall to allow RDP traffic: Go to cmd and enter "**netsh advfirewall firewall set rule group="remote desktop" new enable=Yes**"



4. Steps to Join a Linux System to a Domain

Update Package Manager
sudo apt update

Install the packages needed for domain joining and authentication
sudo apt -y install realmd libnss-sss libpam-sss sssd sssd-tools adcli samba-common-bin oddjob oddjob-mkhomedir

Install Kerberos User Tools
sudo apt install krb5-user

Set Hostname
sudo hostnamectl set-hostname linux-Harshul.Linux2.local

Disable and Stop systemd-resolved
sudo systemctl disable systemd-resolved
sudo systemctl stop systemd-resolved

Edit DNS Resolver Configuration
Update the /etc/resolv.conf file with the domain's DNS server details:
sudo nano /etc/resolv.conf

Add the following lines:
nameserver 172.23.83.85
options edns0 trust-ad
search Linux2.local

Authenticate as Domain Administrator
Use kinit to authenticate with Kerberos:
sudo kinit Administrator@LINUX2.LOCAL

Join the Domain
Execute the realm command to join the domain:
sudo realm join -U Administrator LINUX2.LOCAL

Check
Realm list

Note: Use dnf instead of apt for fedora/red hat-based systems.

5. Linux Client (SSH, SCP)

Step 1: Install and Configure SSH

The same package installs both SSH and SCP

Install the SSH server on the Linux client

sudo apt update && sudo apt install -y openssh-server

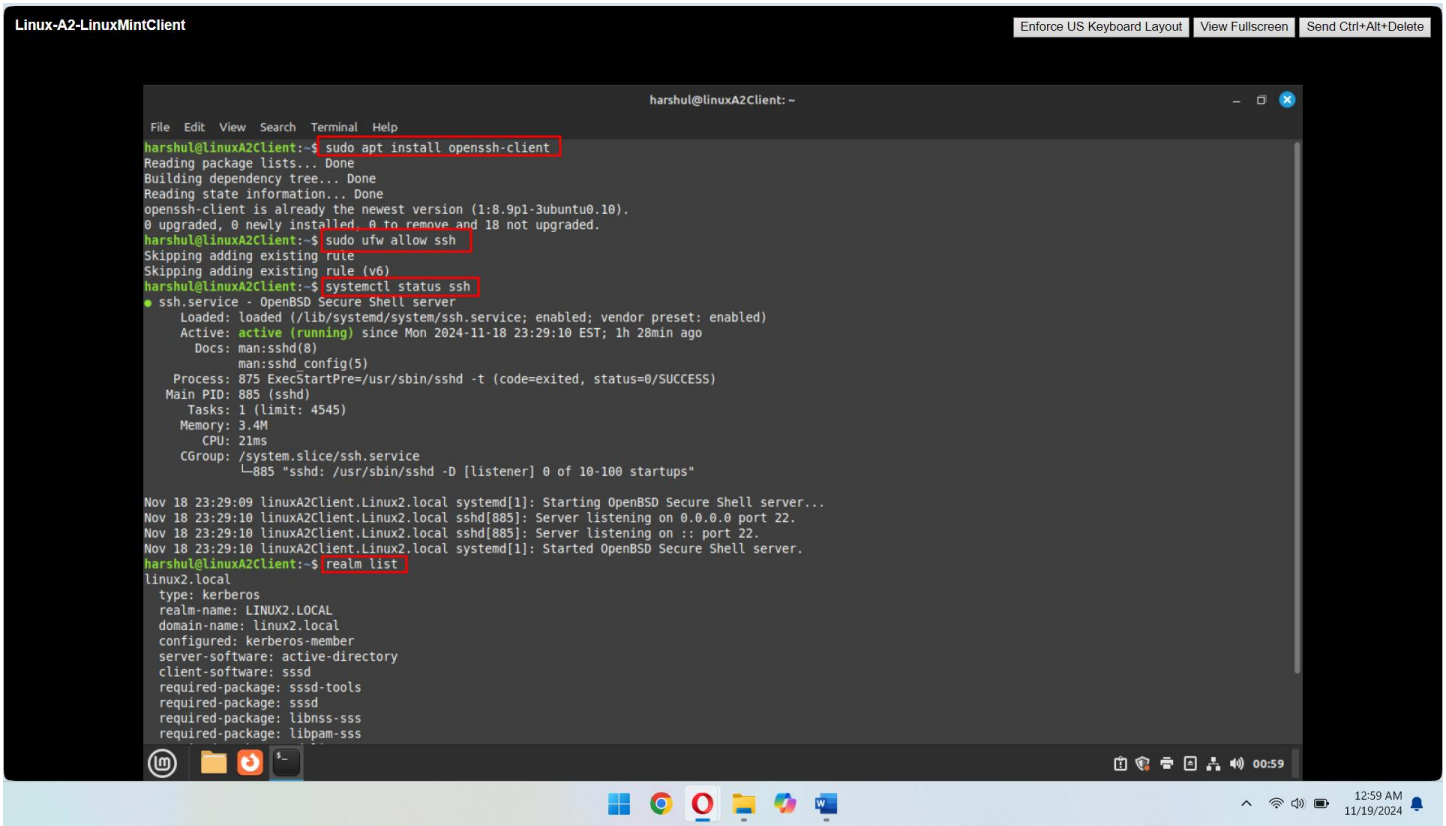
Ensure the SSH service is running

sudo systemctl enable ssh

sudo systemctl start ssh

Allow SSH through the firewall

sudo ufw allow ssh



6. Configuring Guacamole in Ubuntu

Once you join the domain Linux2.local , we can proceed with the configuring the Guacamole in ubuntu server, make sure to follow the steps:

Make sure to update and install all necessary packages and dependencies:

Update Package Lists: sudo apt update

Upgrade Installed Packages: sudo apt upgrade

Install Required Dependencies:

sudo apt install build-essential libcairo2-dev libjpeg-turbo8-dev libpng-dev libtool-bin libossp-uuid-dev libvncserver-dev freerdp2-dev libssh2-1-dev libtelnet-dev libwebsockets-dev libpulse-dev libvorbis-dev libwebp-dev libssl-dev libpangol.0-dev libswscale-dev libavcodec-dev libavutil-dev libavformat-dev -y

Download the tar file directly or download from linux client and send via SSH and proceed to unzip it

Ssh guacamole-server-1.4.0.tar harshul@172.23.83.87:~

Once Download is complete Unzip the file and go to that folder and then we can install and proceed.

Extract the Tar File: tar -xzf guacamole-server-1.4.0.tar.gz

Navigate to the Extracted Directory: cd guacamole-server-1.4.0/

Configure the Build Environment: ./configure --with-init-dir=/etc/init.d

Compile the Source Code: sudo make

Install Guacamole Server: sudo make install

Updating system cache

Update System Cache: sudo ldconfig

Reload Systemd Daemon: sudo systemctl daemon-reload

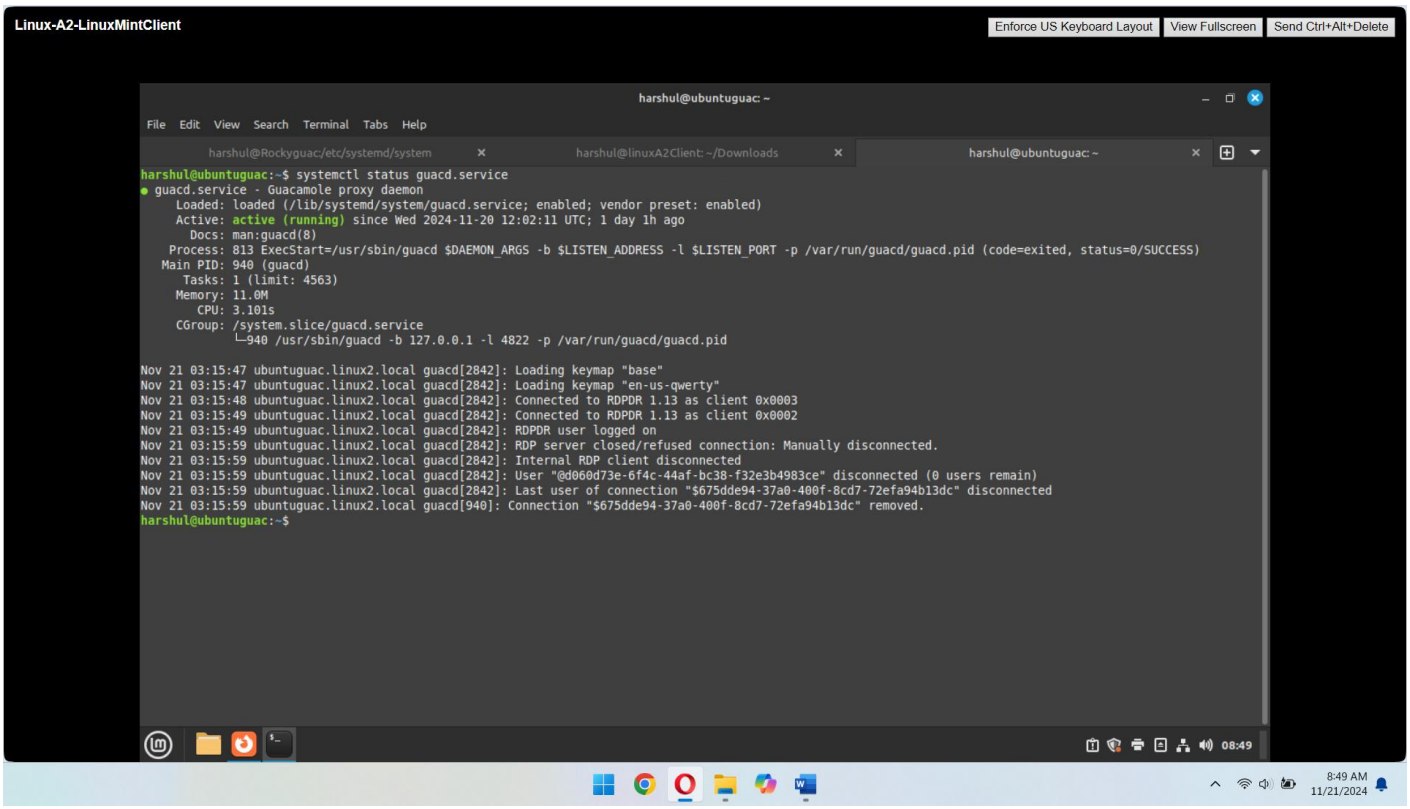
Enable Guacamole Daemon guacd to Start at Boot: sudo systemctl enable guacd

Start Guacamole Daemon: sudo systemctl start guacd

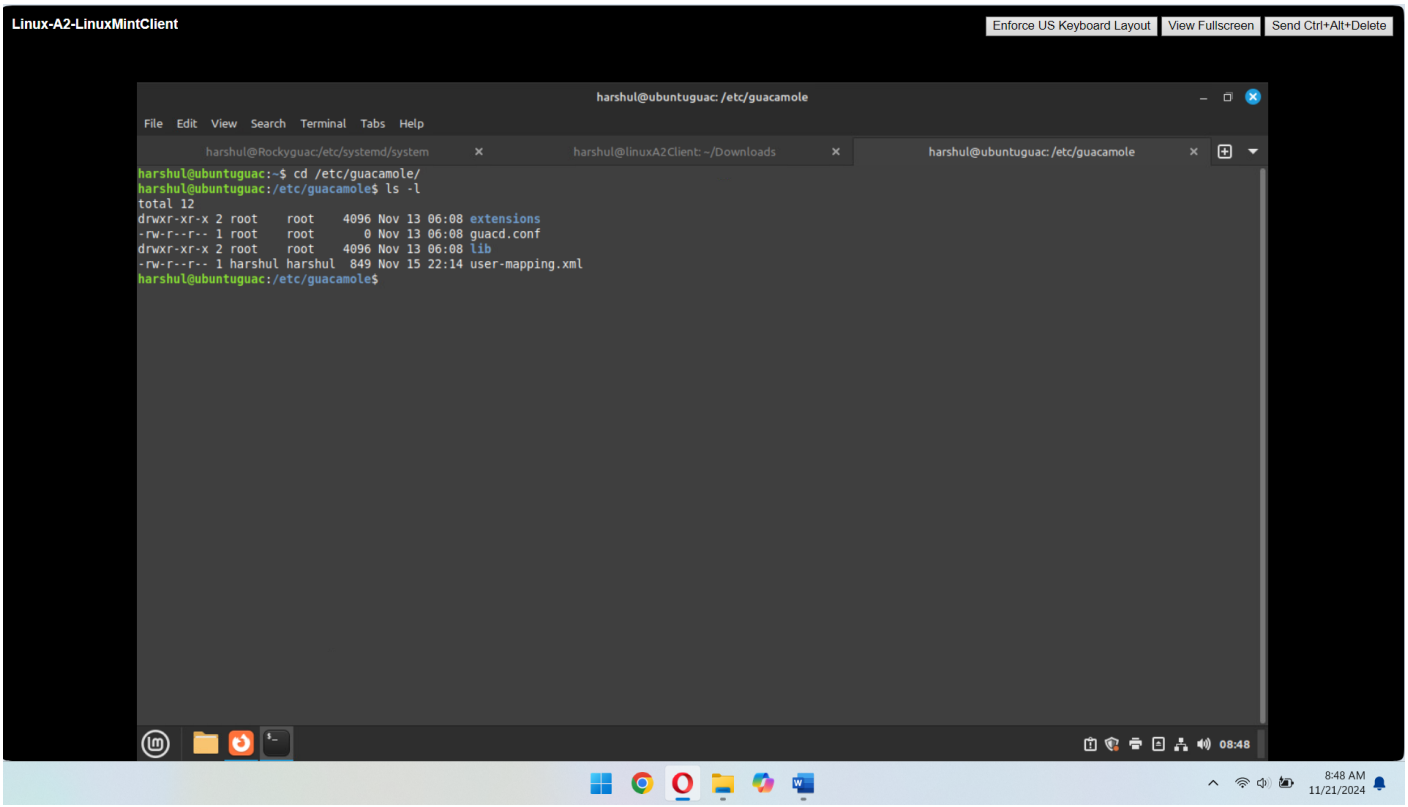
Note: Make sure all the dependencies are installed correctly and not missing anything for guacamole to run properly.

Verify status

sudo systemctl status guacd



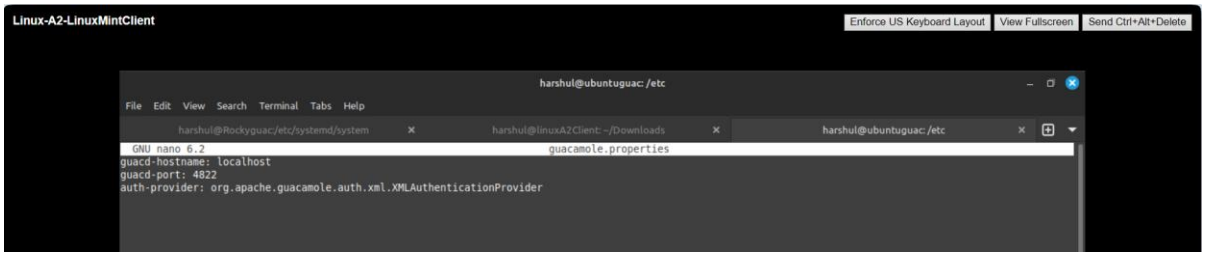
Files configurations : We need to create /etc/guacamole and two more directories called lib and extensions



Configuring User-Mapping for Guacamole on Ubuntu

/etc/guacamole.properties file Will be updated

Open guacamole.properties : sudo nano guacamole.properties and enter the following as shown in image.



Update user-mapping.xml

sudo nano /etc/guacamole/user-mapping.xml

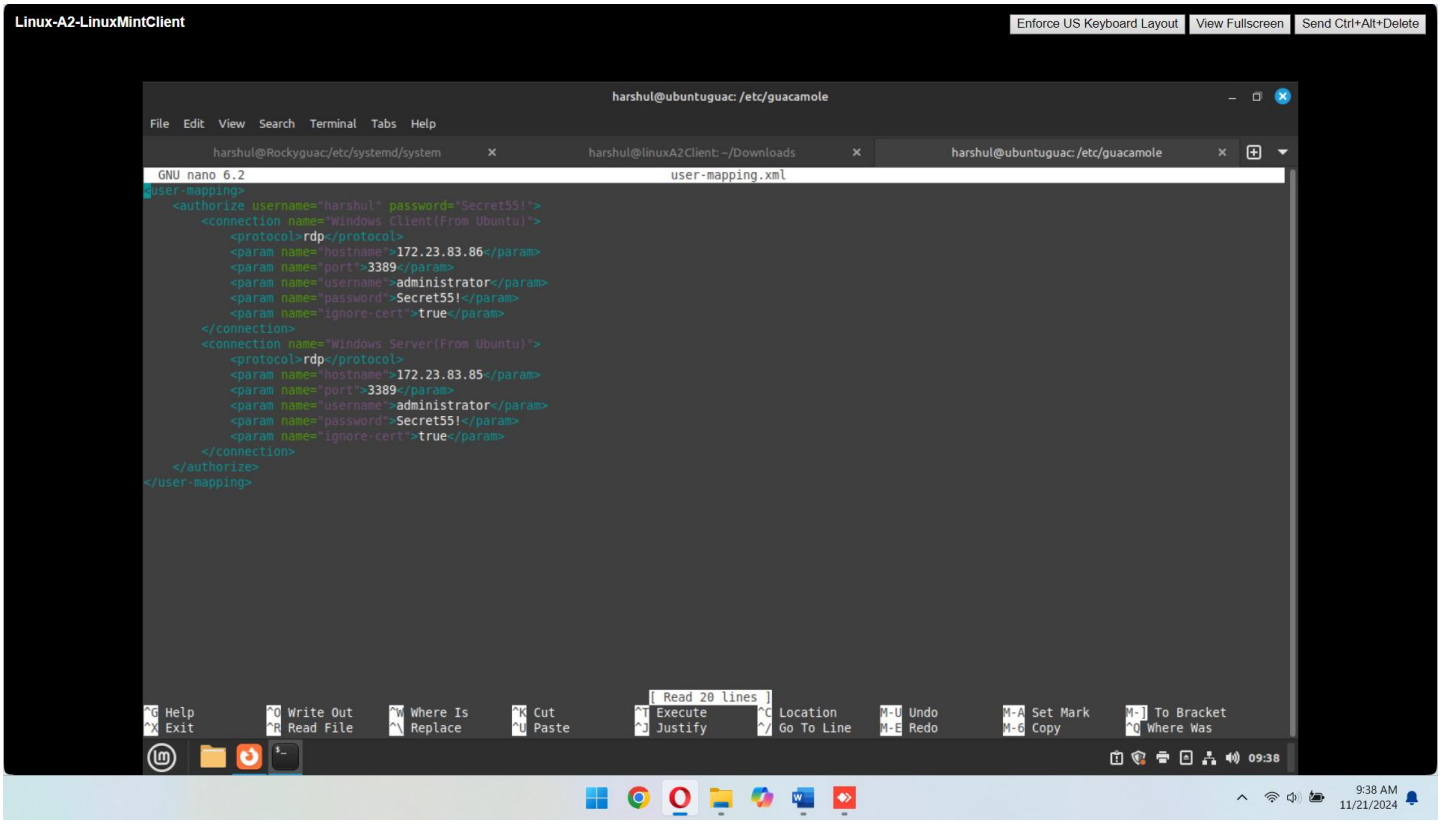
Enter the username, password, connection name, protocol, and port details without any mistakes or extra spaces.Follow the below image for proper configurations.

After entering details, save file by entering Ctrl + O

Exit with Ctrl + X.

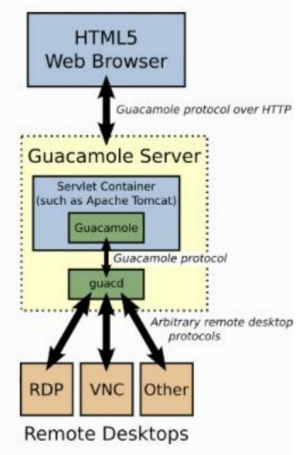
After updating configuration files, restart Guacamole service to apply changes

sudo systemctl restart guacd



Apache Tomcat

Guacamole service require web application to run, we are using Apache Tomacat.



Steps to Install Apache Tomcat in Ubuntu:

Install OpenJDK and Apache Tomcat

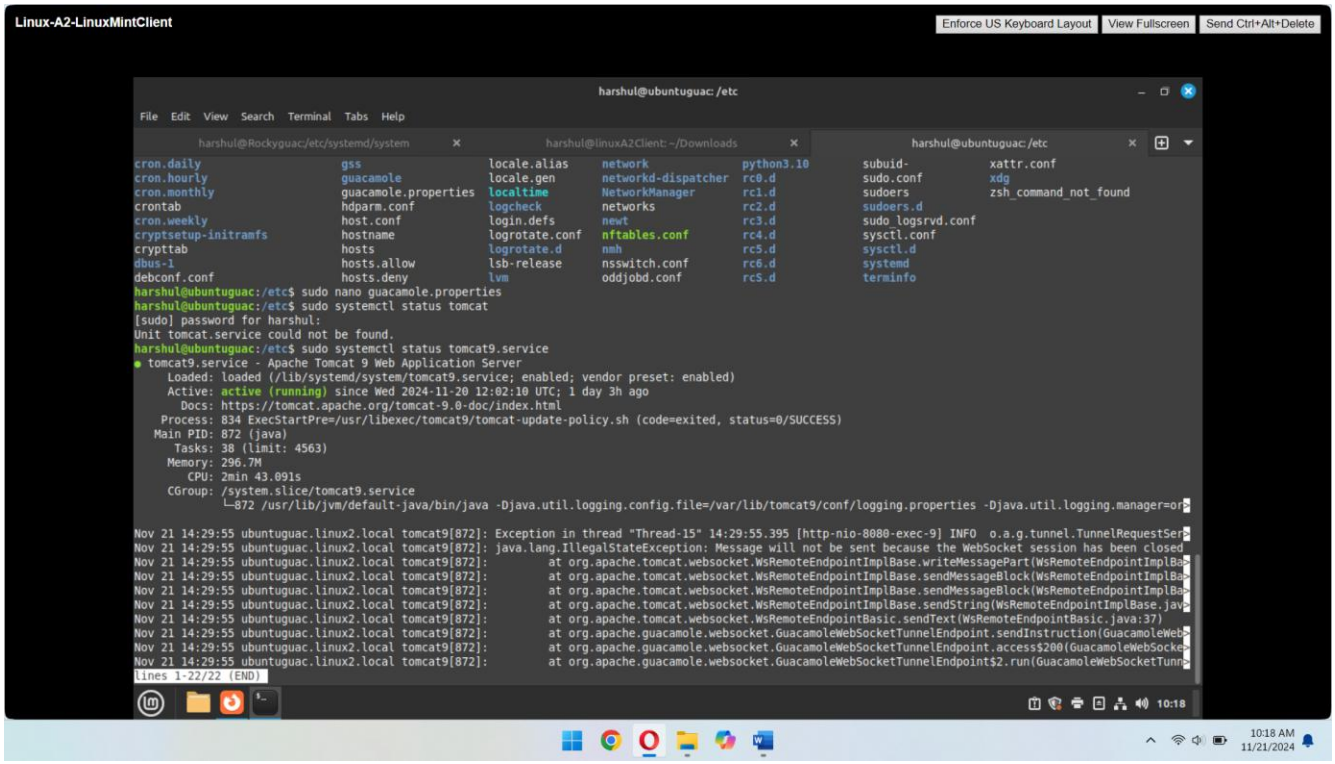
sudo apt install openjdk-11-jdk tomcat9 tomcat9-admin tomcat9-common tomcat9-user

Download Guacamole.war file from website and SCP to the server just like previous file.

Transfer the File via SCP: Scp Guacamole-1.4.0.war harshul@172.23.83.87:~

Then move the file : sudo mv guacamole-1.4.0.war /var/lib/tomcat9/webapps/guacamole.war

Check to make sure it works : Sudo systemctl status tomcat9.service



Changing the Web Page Appearance for Guacamole

Next step is to change the way Web page looks to differentiate between ubuntu and Rocky linux login page , so we will be making small change to make it look different. We will change en.json

Navigate to the Webapps Directory: cd /var/lib/tomcat/webapps/

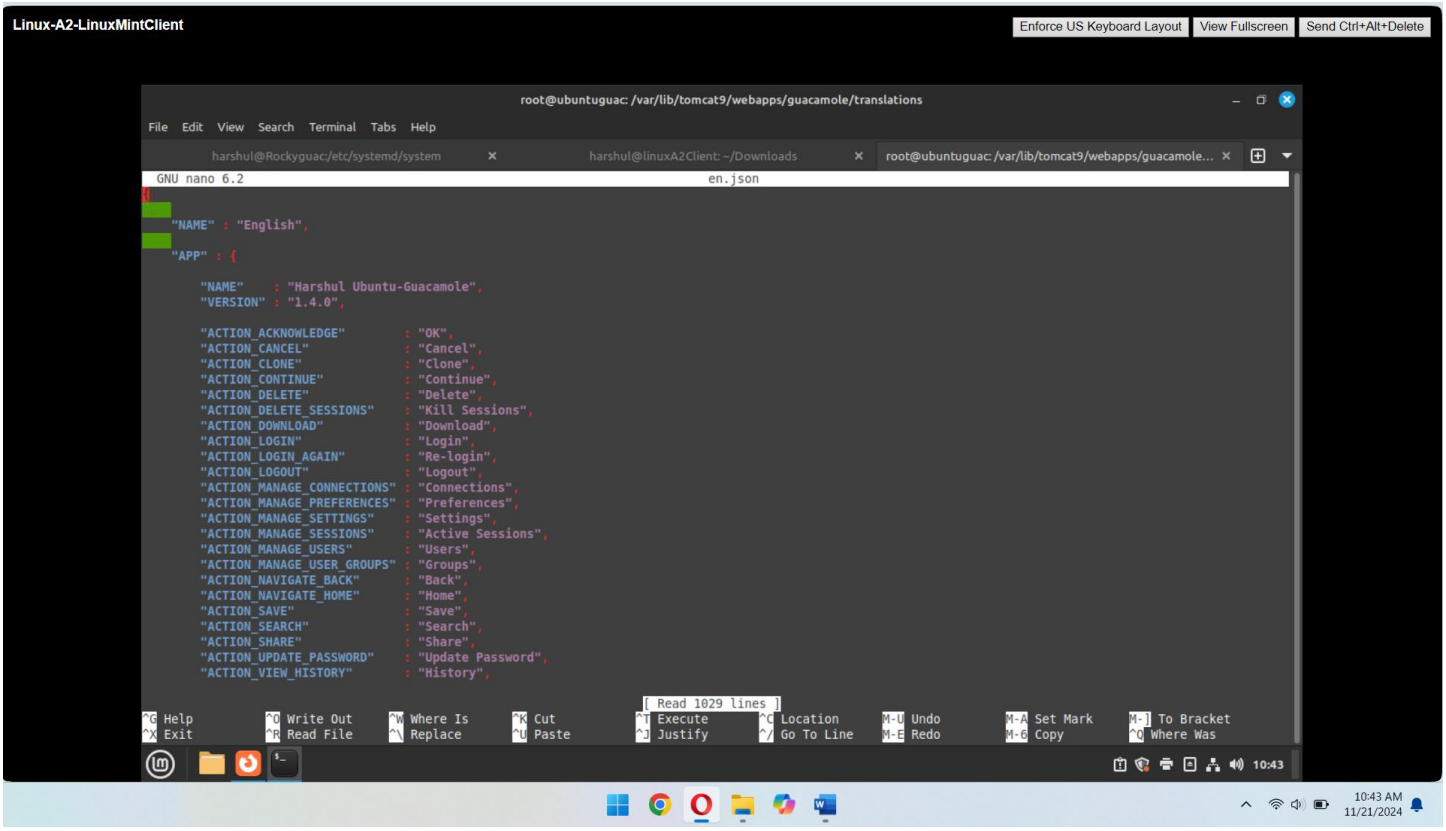
Change Ownership of Guacamole Directory: sudo chown harshul:harshul guacamole

Change Ownership of Translations Directory: sudo chown harshul:harshul translations.

Modify en.json: Open the en.jsonFile: sudo nano /var/lib/tomcat9/websapp/guacamole/translations/en.json

open the file and change the name as shown in below image **New name : Harshul Ubuntu-Guacamole**

Save and Exit: ctrl + o , ctrl + x

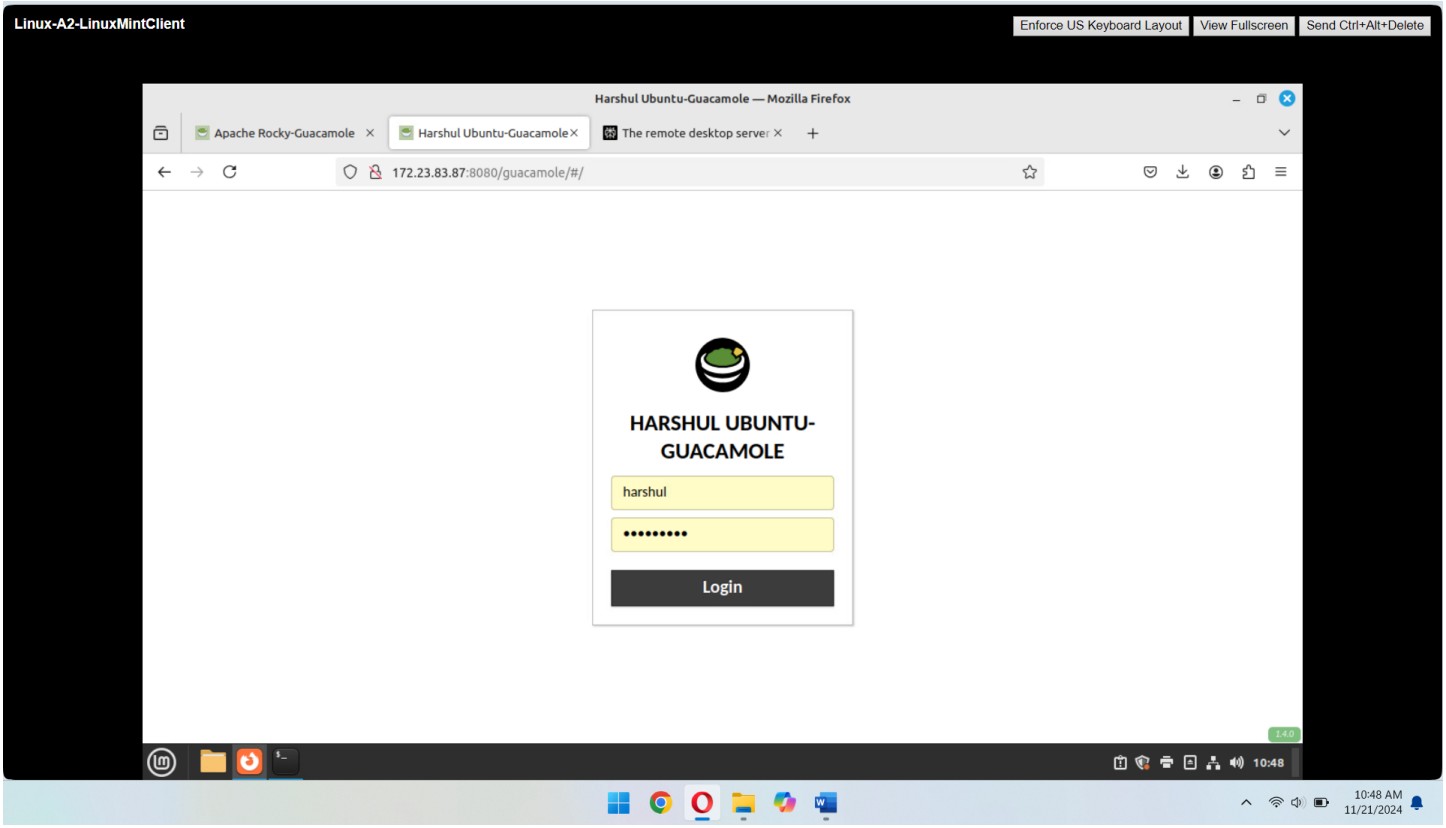


Restore Original Permissions

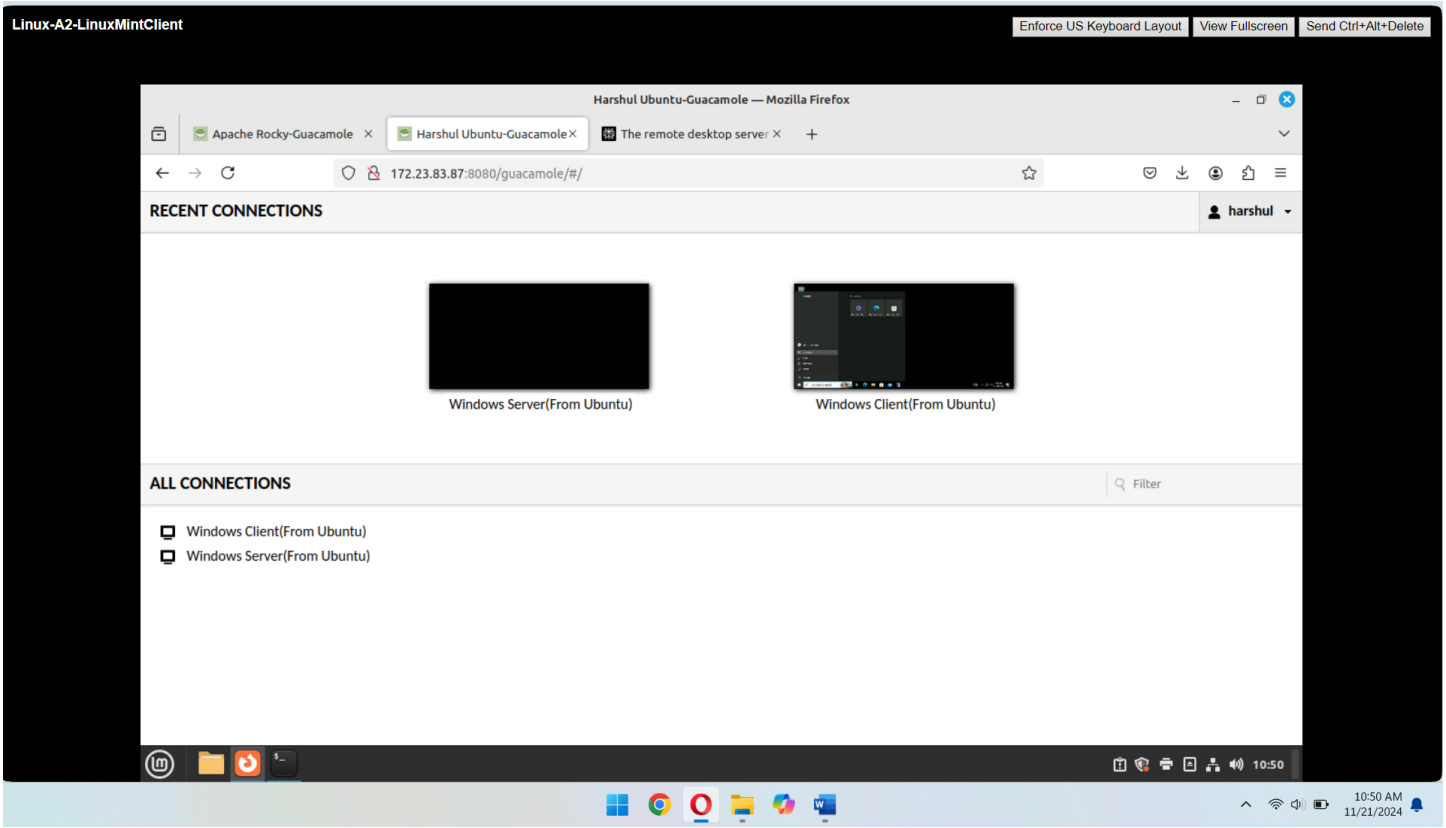
Change Ownership Back to tomcat:tomcat: sudo chown tomcat:tomcat guacamole

For the Translations directory: sudo chown tomcat:tomcat translations

Login to the Guacamole to check the connection , using IP of ubuntu server as shown below.



Once we log in we will be able to Do RDP for both Desktop as well as Server using Guacamole from Ubuntu as shown.



7. Configuring Guacamole in Rocky Linux

We will be using similar set up but instead of XML file we will be doing LDAP configurations from this machine

Install Necessary Packages:
sudo dnf install -y gcc glibc-devel mariadb mariadb-devel mariadb-server openssl-devel freerdp freerdp-devel pango-devel libssh2-devel libtelnet-devel libvncserver-devel libjpeg-turbo-devel libpng-devel uuid-devel tomcat tomcat-admin-webapp tomcat-webapps.

Enable Code Ready Builder Repository: sudo dnf config-manager –set-enabled crb

We can download the file from client browser and SCP it to the server just like we did for ubuntu
scp guacamole-server-1.5.5.tar.gz 172.23.83.111:~

Extract the TAR File: tar -xvzf guacamole-server-1.5.5.tar.gz.

Go in to the extracted directory: cd guacamole-server-1.5.5/

configure and compilation: ./configure --with-init-dir=/etc/init.d

check that dependencies are met. You should see protocol support like:

Protocol suppoer:

Kubernetes … yes
RDP ..... Yes
SSH ..... Yes
Telnet ..... Yes
VNC ..... Yes

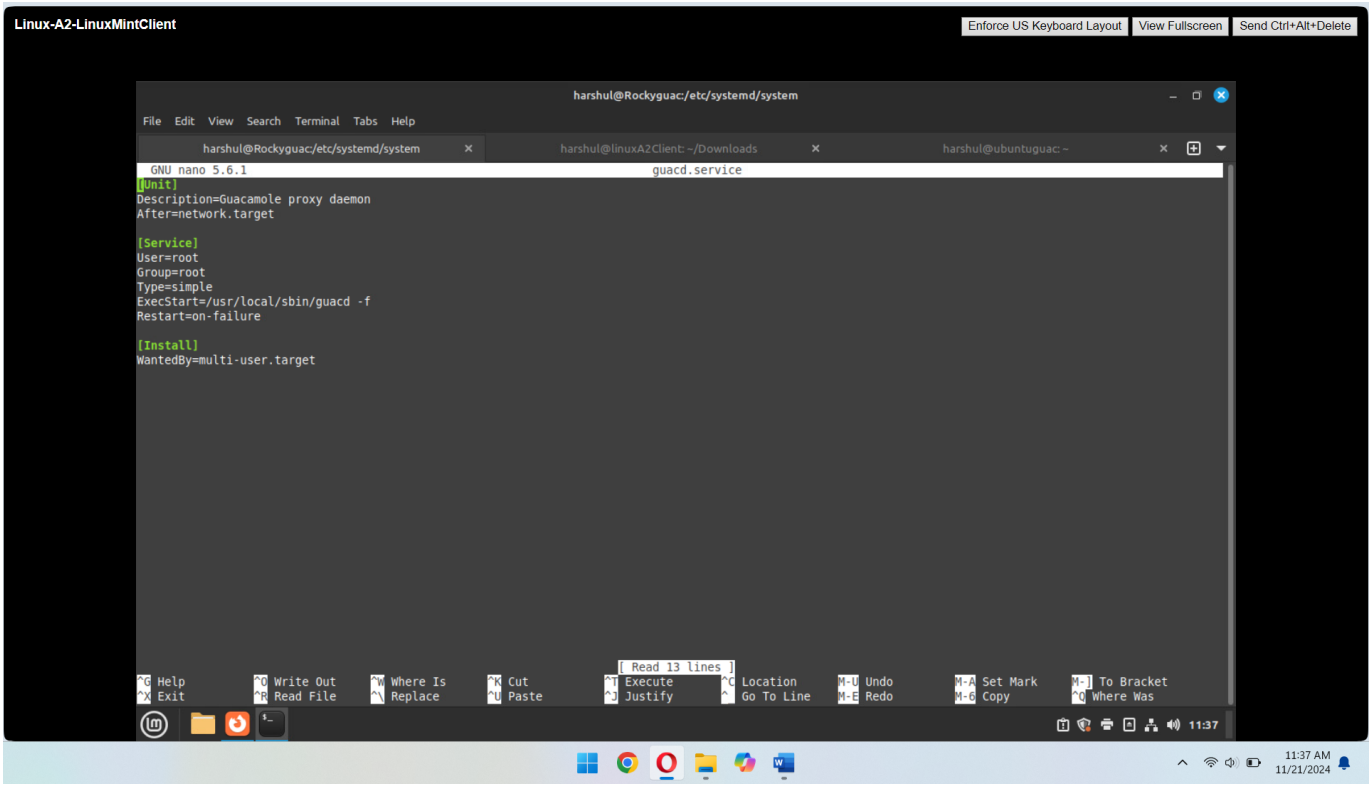
Compile and Install Guacamole Server

Compile the Source Code
sudo make
Install Guacamole Server
sudo make install
Updating system cache
sudo ldconfig

Create and Configure guacd.service

Manually Creating guacd.service file
sudo nano /etc/systemd/system/guacd.service

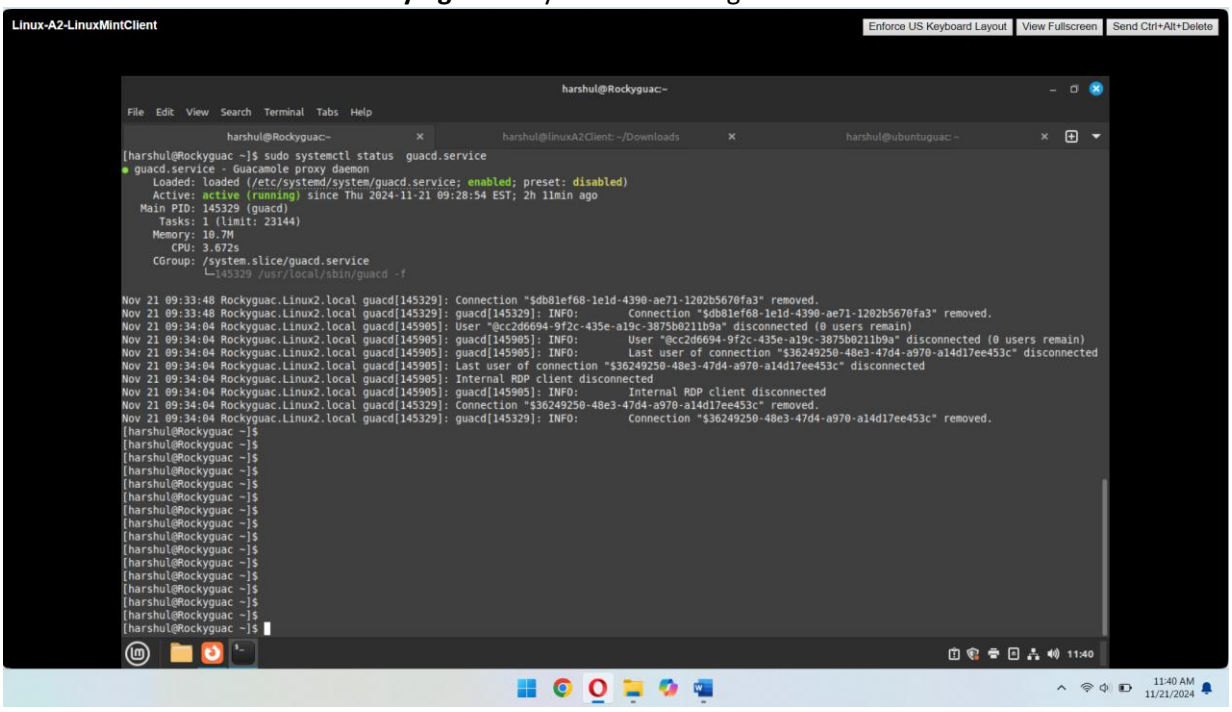
Add the following lines as shown in image inside the file



Reload and enable the services

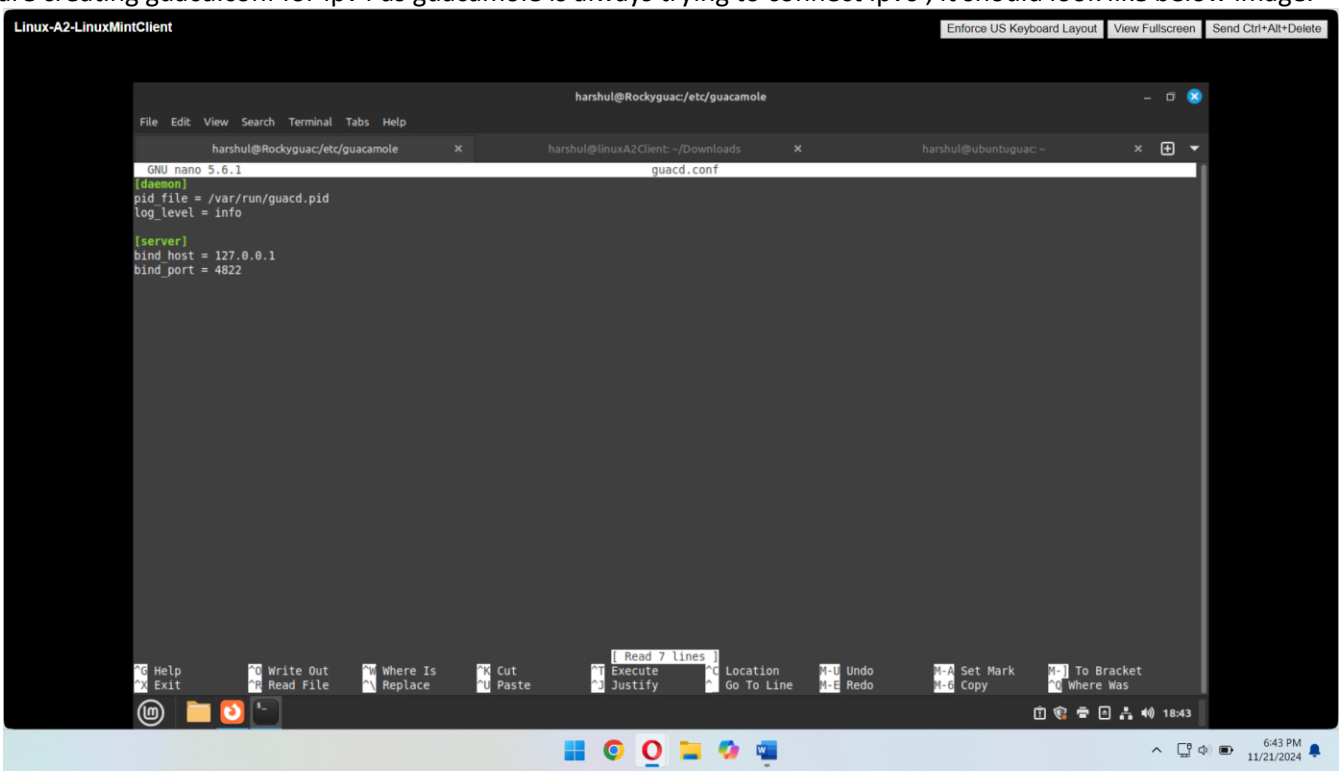
Reload Systemd Daemon: sudo systemctl daemon-reload
Enable guacd to Start at Boot: sudo systemctl enable guacd.service
Start guacd Service: sudo systemctl start guacd.service

Verifying: sudo systemctl status guacd.service

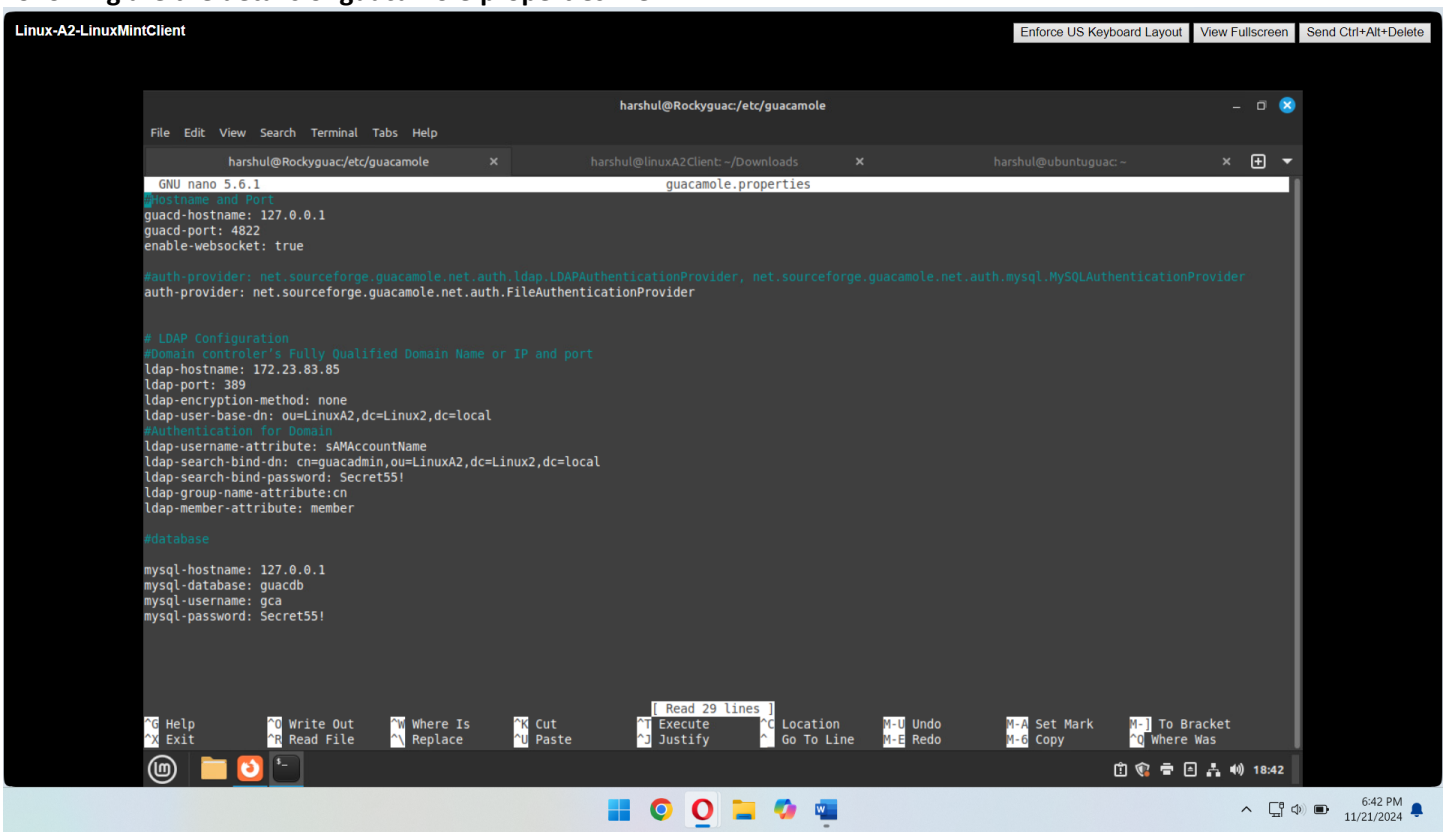


LDAP method for login

we will modify or create **guacamole.properties** and **gucad.conf** files into guacamole home directory.
We are creating guacd.conf for Ipv4 as guacamole is always trying to connect ipv6 , it should look like below image.



Following are the details of guacamole.properties file.



Download and Install LDAP Authentication Extension

Download LDAP Extension: wget https://guacamole.apache.org/releases/1.5.5/guacamole-auth-ldap-1.5.5.tar.gz

Extract the file: tar -xvf guacamole-auth-ldap-1.5.5.tar.gz

Move the JAR File to Extensions Folder:

sudo cp /etc/guacamole/extensions/guacamole-auth-ldap-1.5.5/guacamole-auth-ldap-1.5.5.jar /etc/guacamole /extensions/

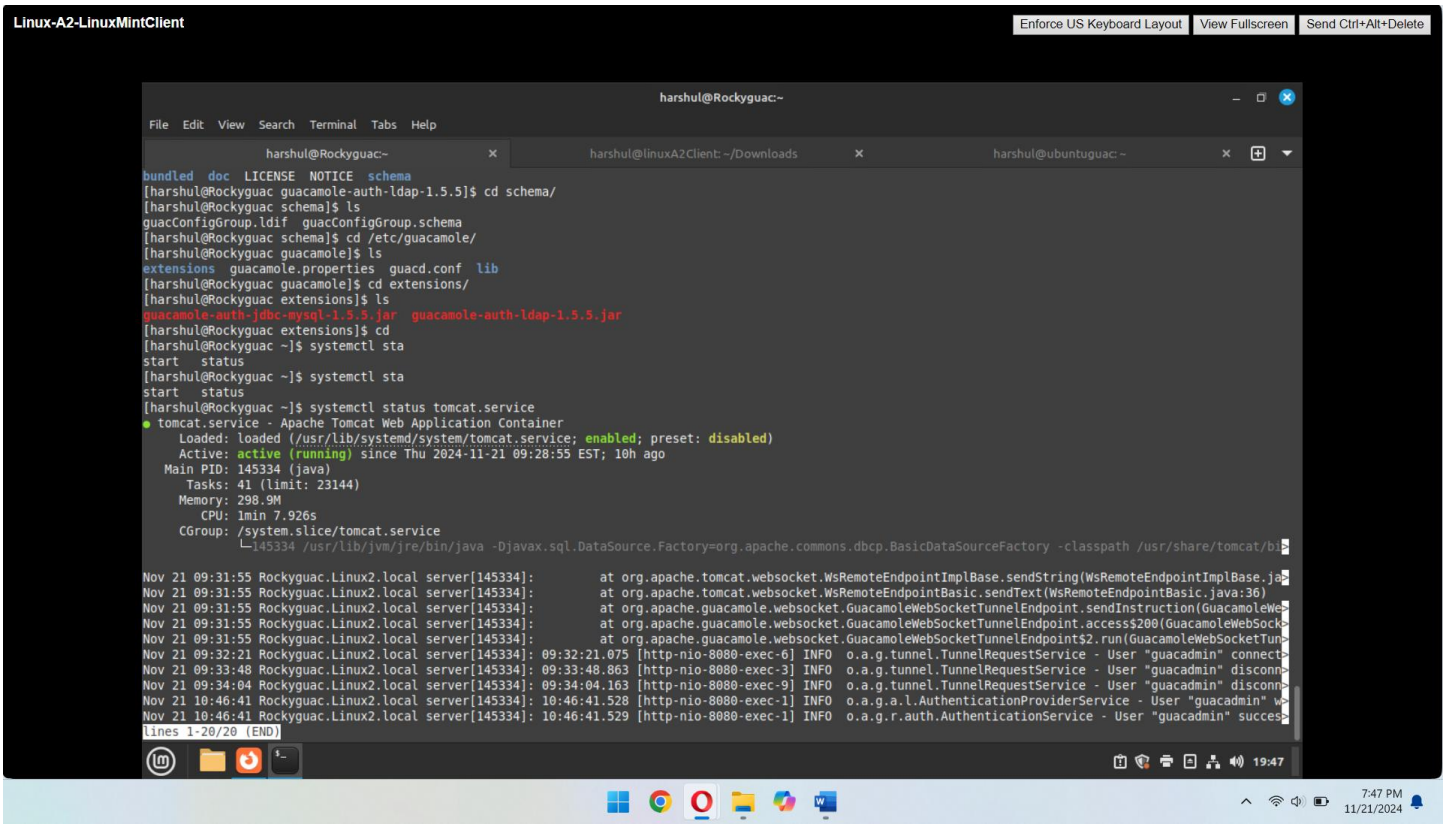
Apache Tomcat in Rocky Linux

Install Apache Tomcat and OpenJDK:
sudo dnf install java-17-openjdk-devel tomcat tomcat-admin-webapps tomcat-webapps

Download and Deploy Guacamole WAR File
Rename and move it to tomcat : sudo mv guacamole-1.5.5.war /var/lib/tomcat/webapps/guacamole.war

Restart the service: sudo systemctl restart tomcat.service

Check the status: sudo systemctl status tomcat.service

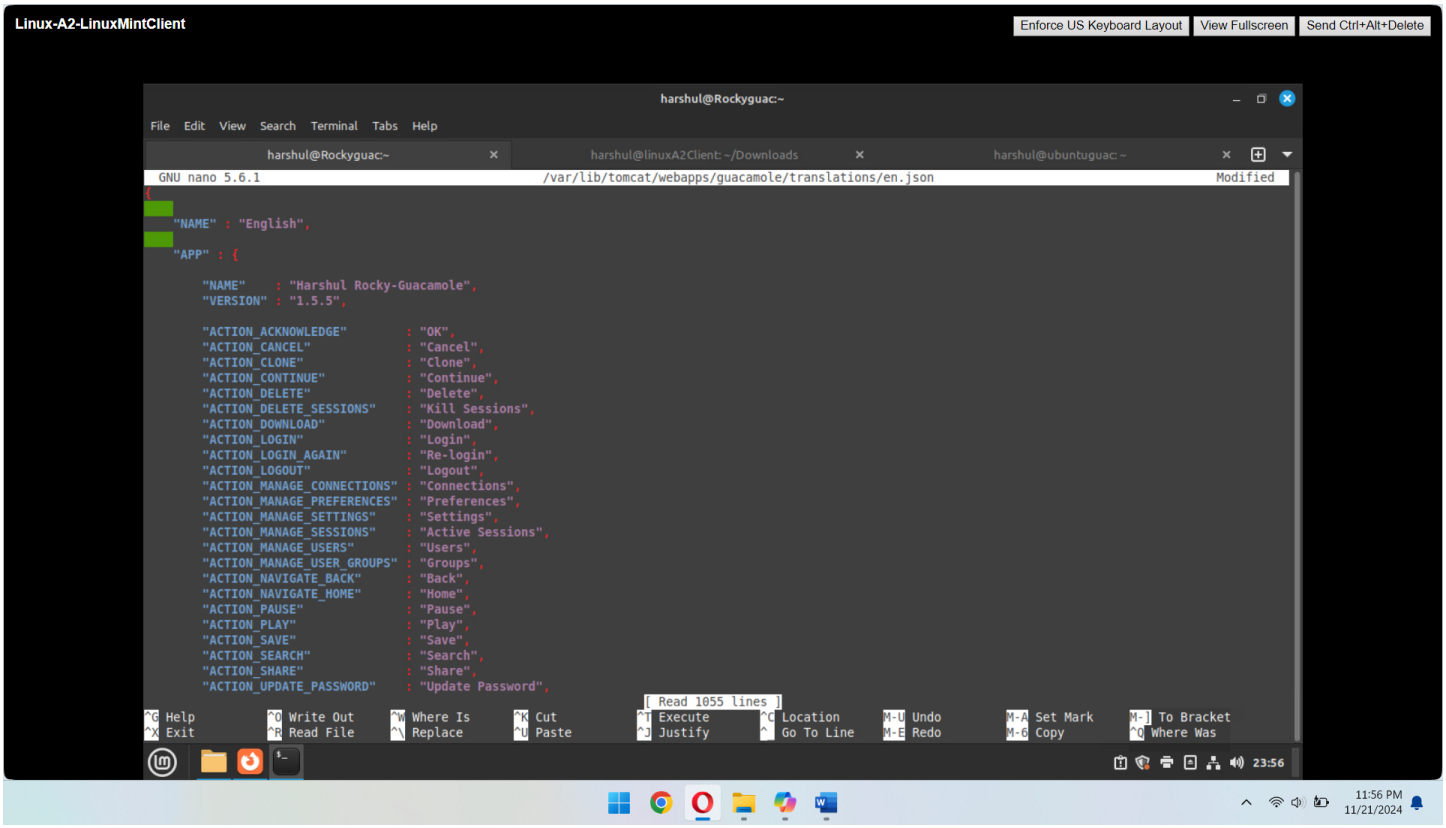


Changing the Web Page Appearance for Guacamole on Rocky Linux

Navigate to the Webapps Directory:cd /var/lib/tomcat9/webapps/
Open the en.jsonFile: sudo nano /var/lib/tomcat9/webapps/guacamole/translations/en.json

Change the title name to:"NAME": "Harshul Rocky-Guacamole"

Save and Exit: Ctrl + O , Ctrl + X



Database Setup for Guacamole on Rocky Linux

Install MariaDB Server

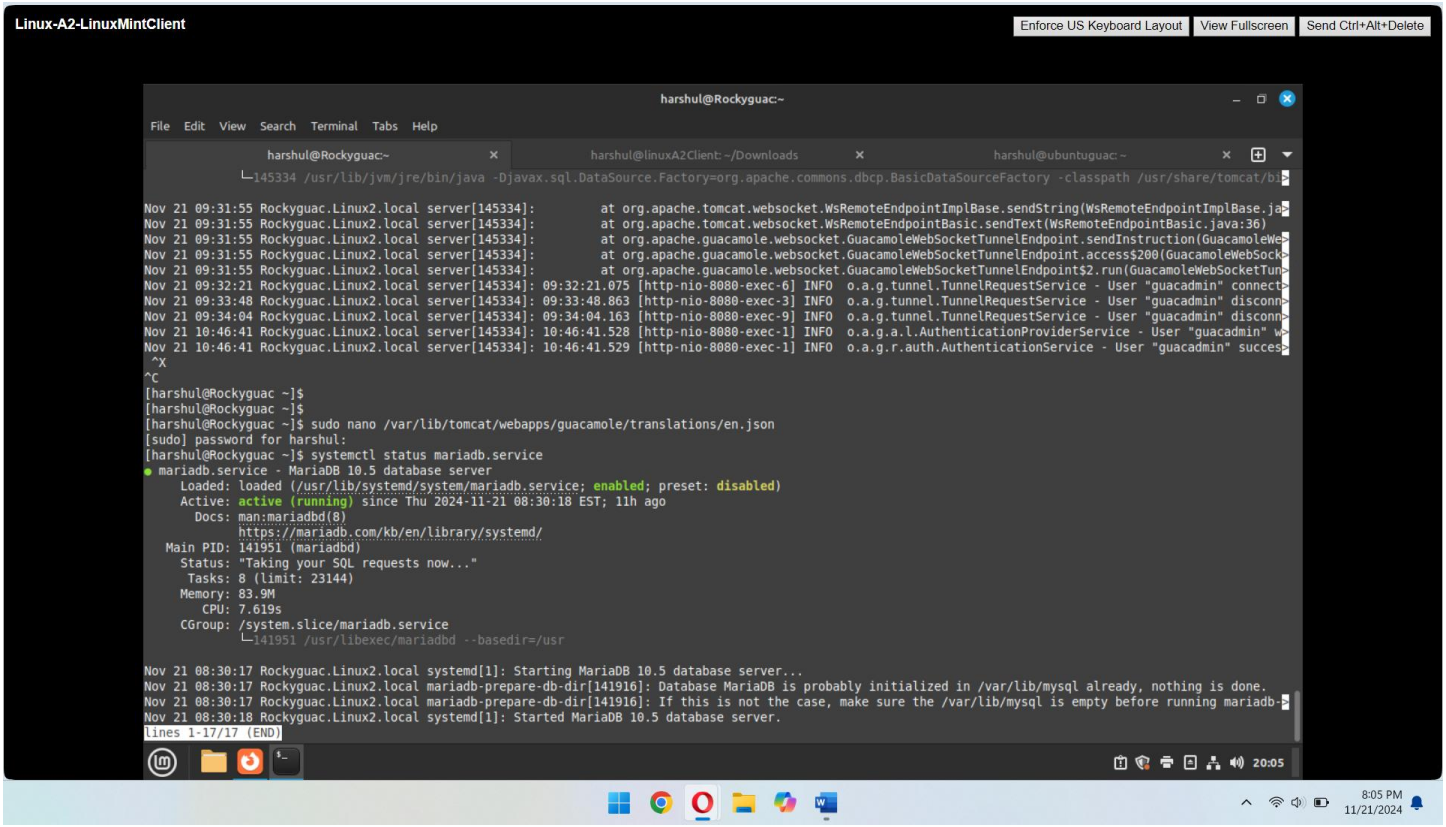
Database Install :sudo dnf install mariadb-server

Database enable: sudo systemctl enable mariadb.service

Database start: sudo systemctl start mariadb.service

Database status: sudo systemctl status mariadb.service

If you have already installed it with dependencies, then check the status of database



Now, we are going to create database and add user to database and give permissions

Open database as the root user: sudo mysql -u root -p

Enter password and then create a database

Create database : Create database guacdb;

Create user and give password: create user gca@localhost identified by ‘Secret55!’;

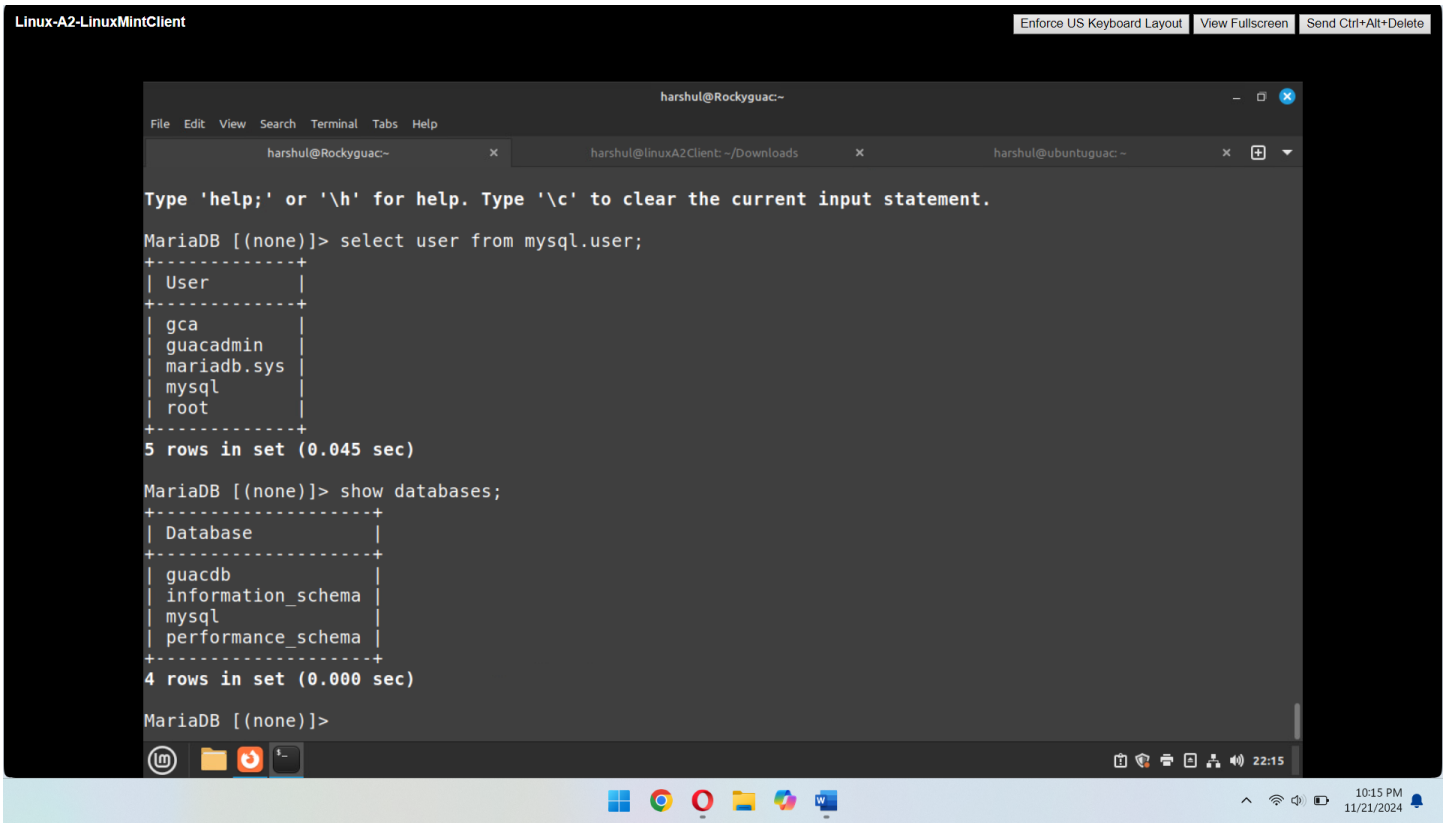
Grant permissions: grant SELECT,UPDATE,INSERT,DELETE on guacdb.* to gca@localhost;

Apply: flush privileges;

Check the user and database:

SELECT user FROM mysql.user;

show databases;



Adding JDBC Authentication for Guacamole on Rocky Linux

Use wget to download the JDBC file:
wget https://guacamole.apache.org/releases/1.5.5/guacamole-auth-jdbc-1.5.5.tar.gz

Extract the File:tar -xzf guacamole-auth-jdbc-1.5.5.tar.gz

Once it is extracted go to the file and go to sql folder: cd guacamole-auth-jdbc-1.5.5/mysql

Move the JAR file to the extensions directory: sudo cp guacamole-auth-jdbc-1.5.5.jar /etc/guacamole/extensions

Add Schema Files to the Database: check you are in the sql directory then run:
sudo mysql -u root -p guacdb < schema/001-createschema.sql
sudo mysql -u root -p guacdb < schema/002-createadmin-user.sql

Download and Install MySQL Connector

Download MySQL Connector: wget https://dev.mysql.com/get/Downloads/Connector-J/mysql-connector-j8.0.31.tar.gz

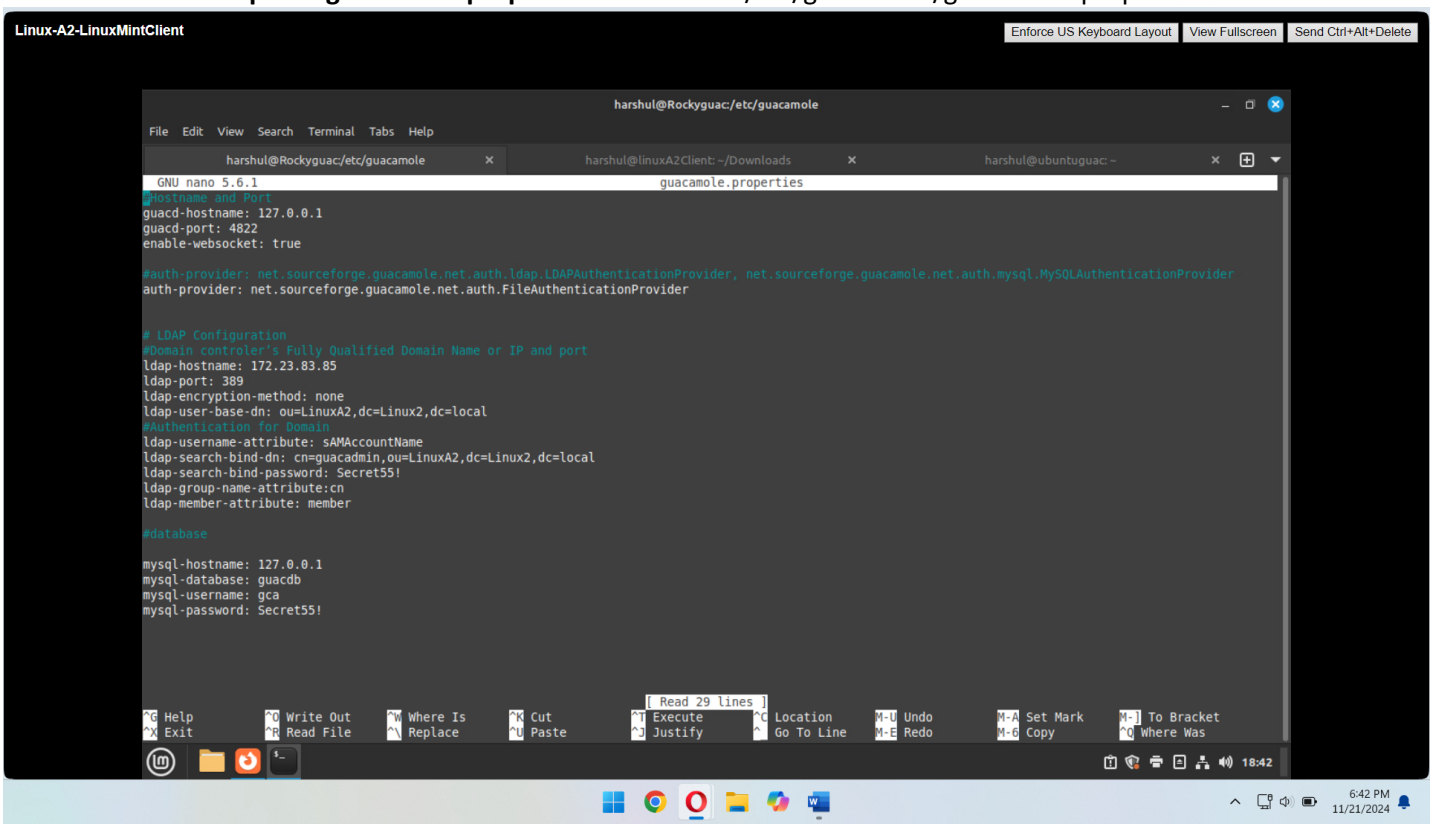
extract it : tar xzvf mysql-connector-j-8.0.31.tar.gz

Copy MySQL Connector to lib Directory:

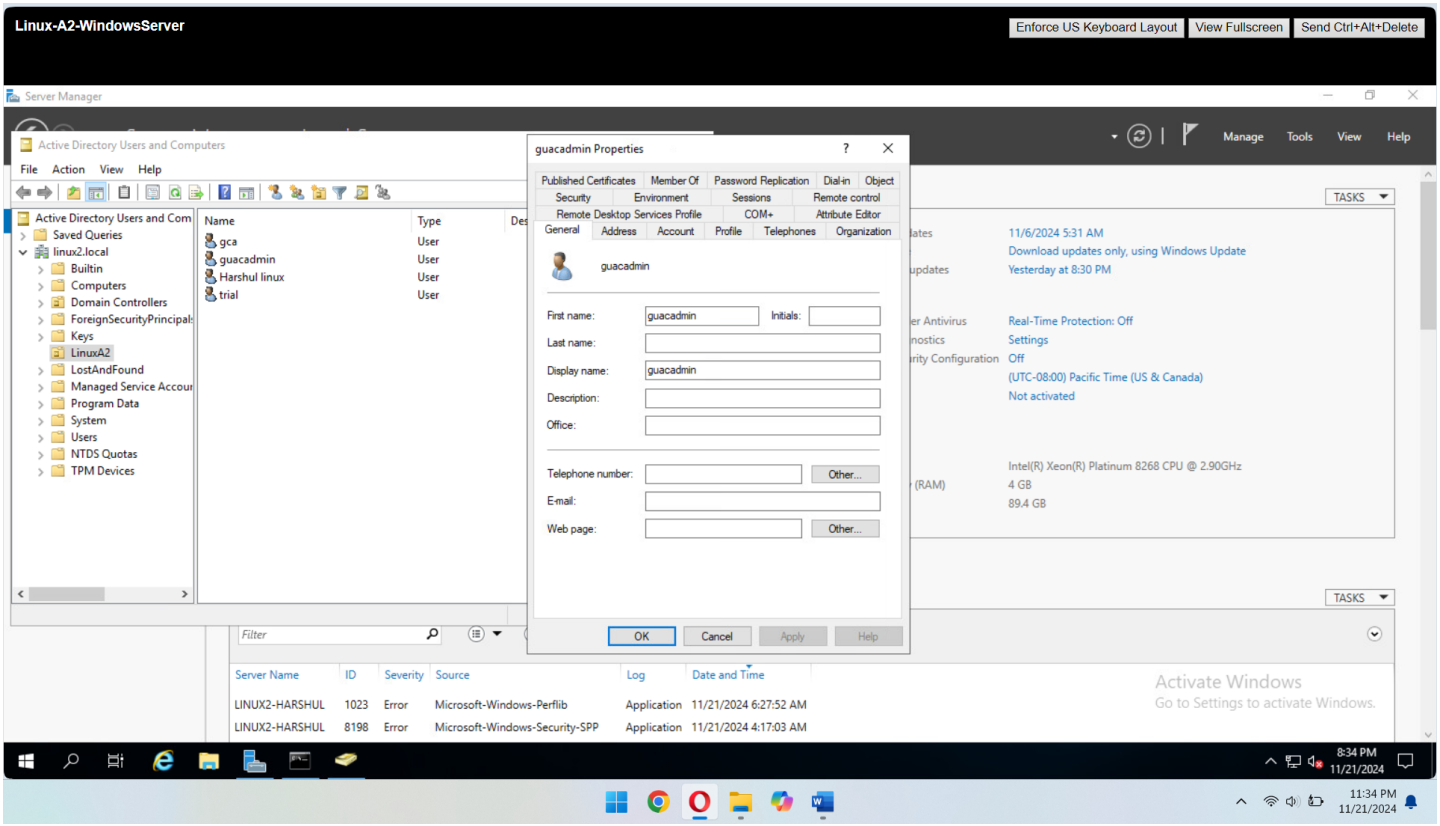
Go to directory : cd /path/to/extracted/mysql-connector-j-8.0.31/

Copy the JAR File to lib Directory: sudo cp mysql-connector-j-8.0.31.jar /etc/guacamole/lib/

Update guacamole.properties : sudo nano /etc/guacamole/guacamole.properties

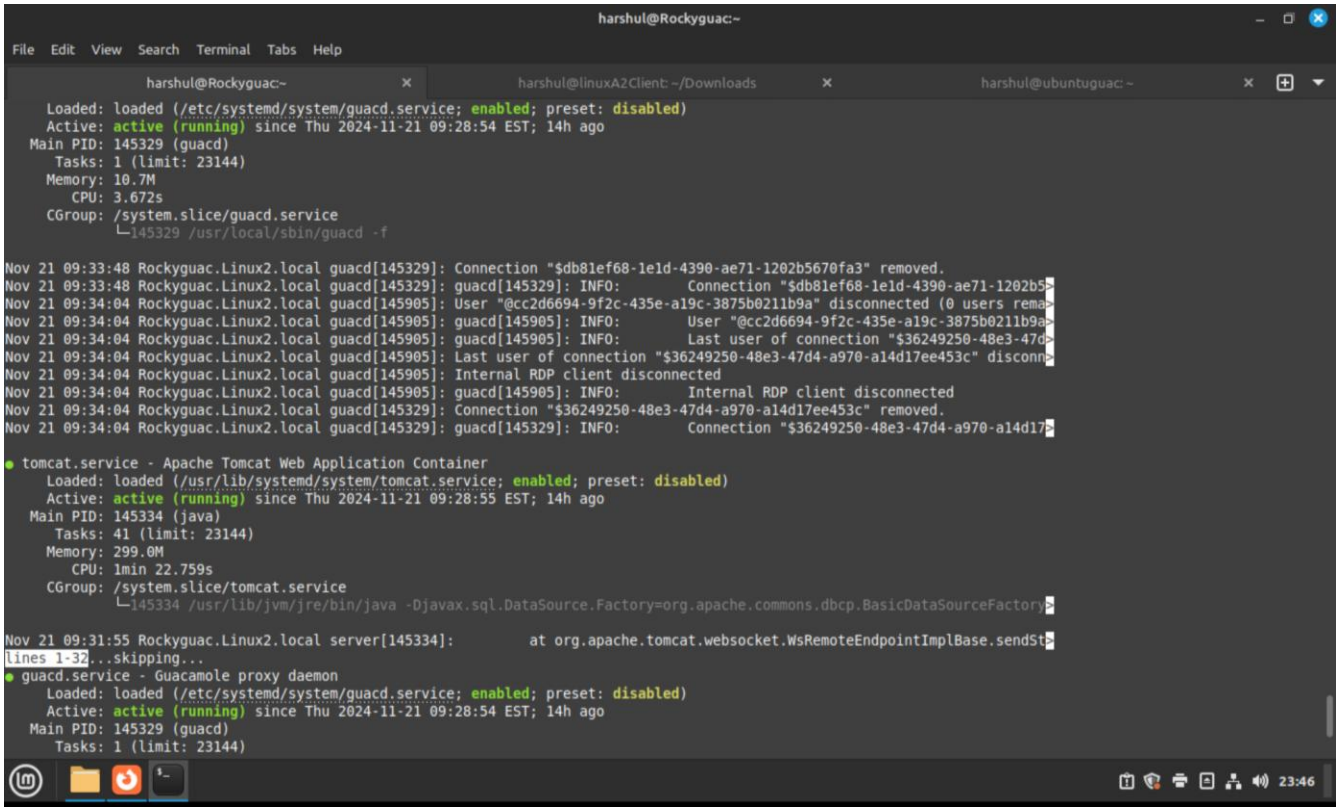


We need to create guacadmin in AD in Domain controller as default username is guacadmin in database so we can log in and make it work.

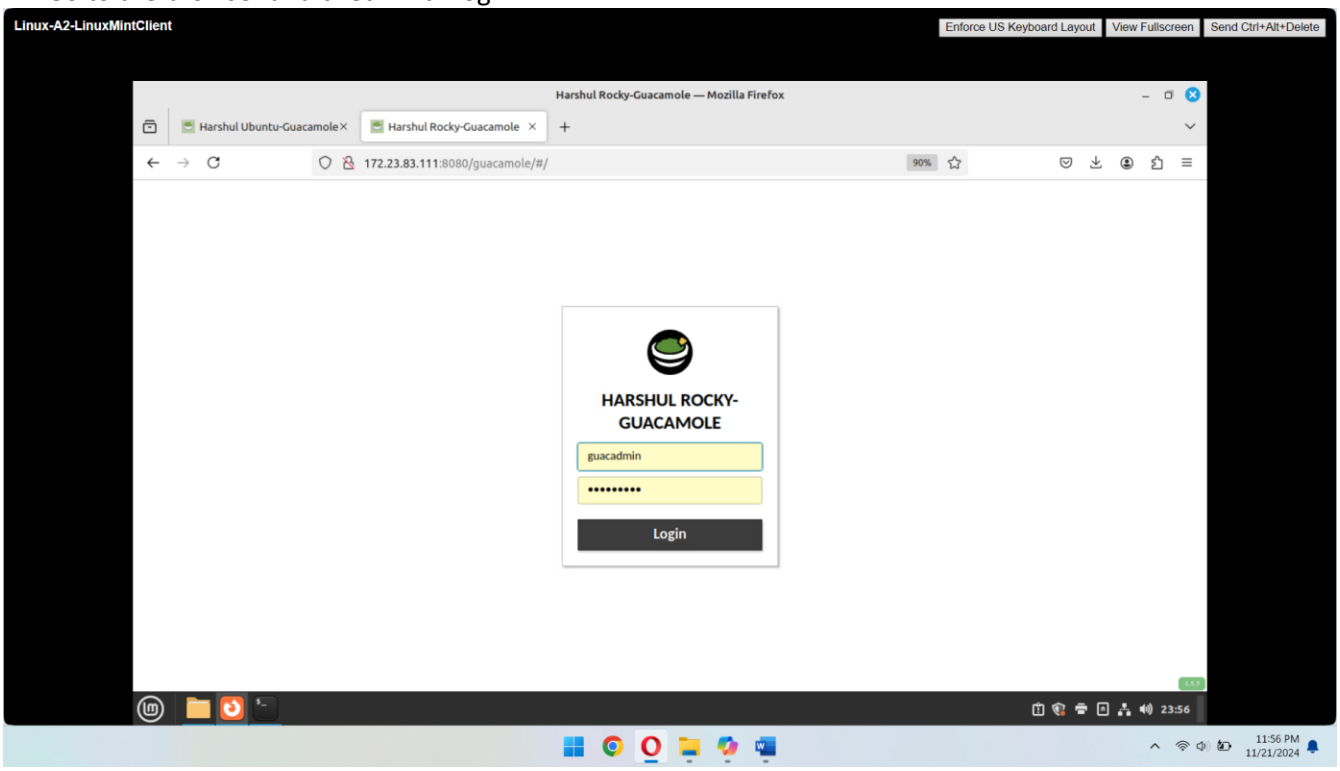


Restart all the services and check the status of all services

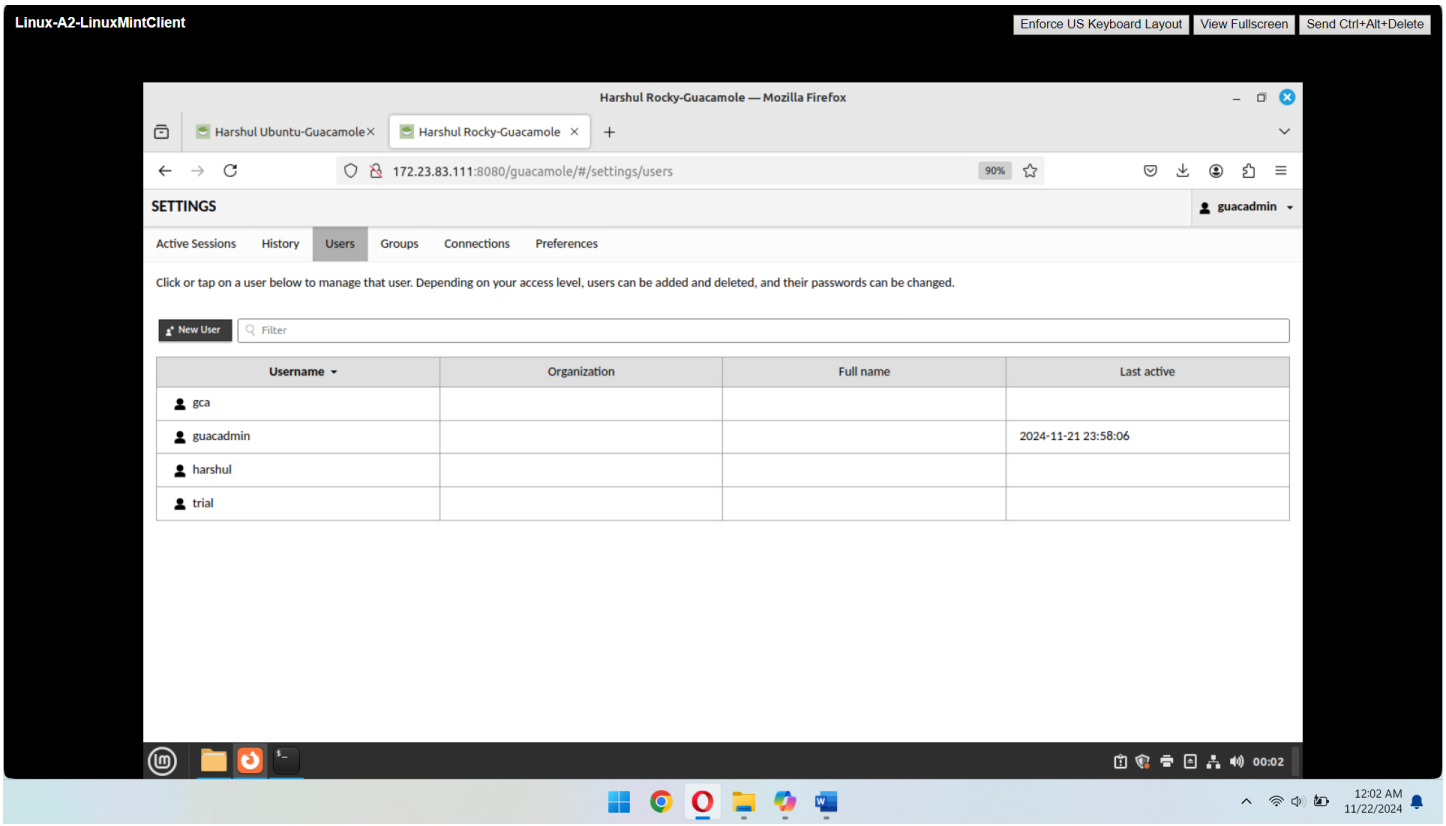
Sudo systemctl restart tomcat.service mariadb.service guacd.service
Sudo systemctl status tomcat.service mariadb.service guacd.service



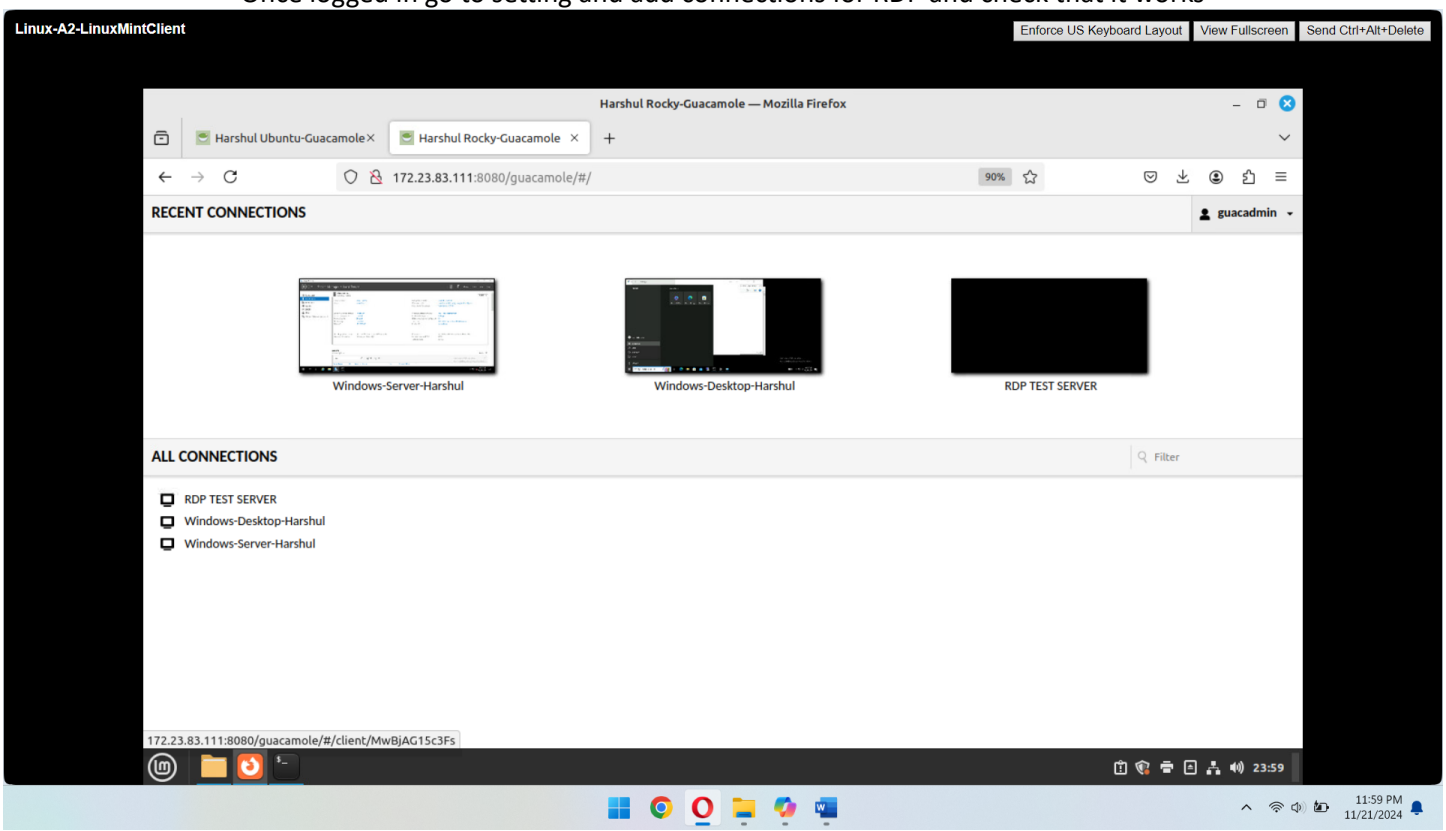
Go to the browser and check with login



We can see our users



Once logged in go to setting and add connections for RDP and check that it works



8.Loadballancer and Reverse Proxy

install the apache2 server and other dependencies for load balancing

Install Apache2:sudo apt install apache2
Install Additional Apache2 Modules:sudo apt install apache2-dev apache2-utils apache2-data

Enable required modules.

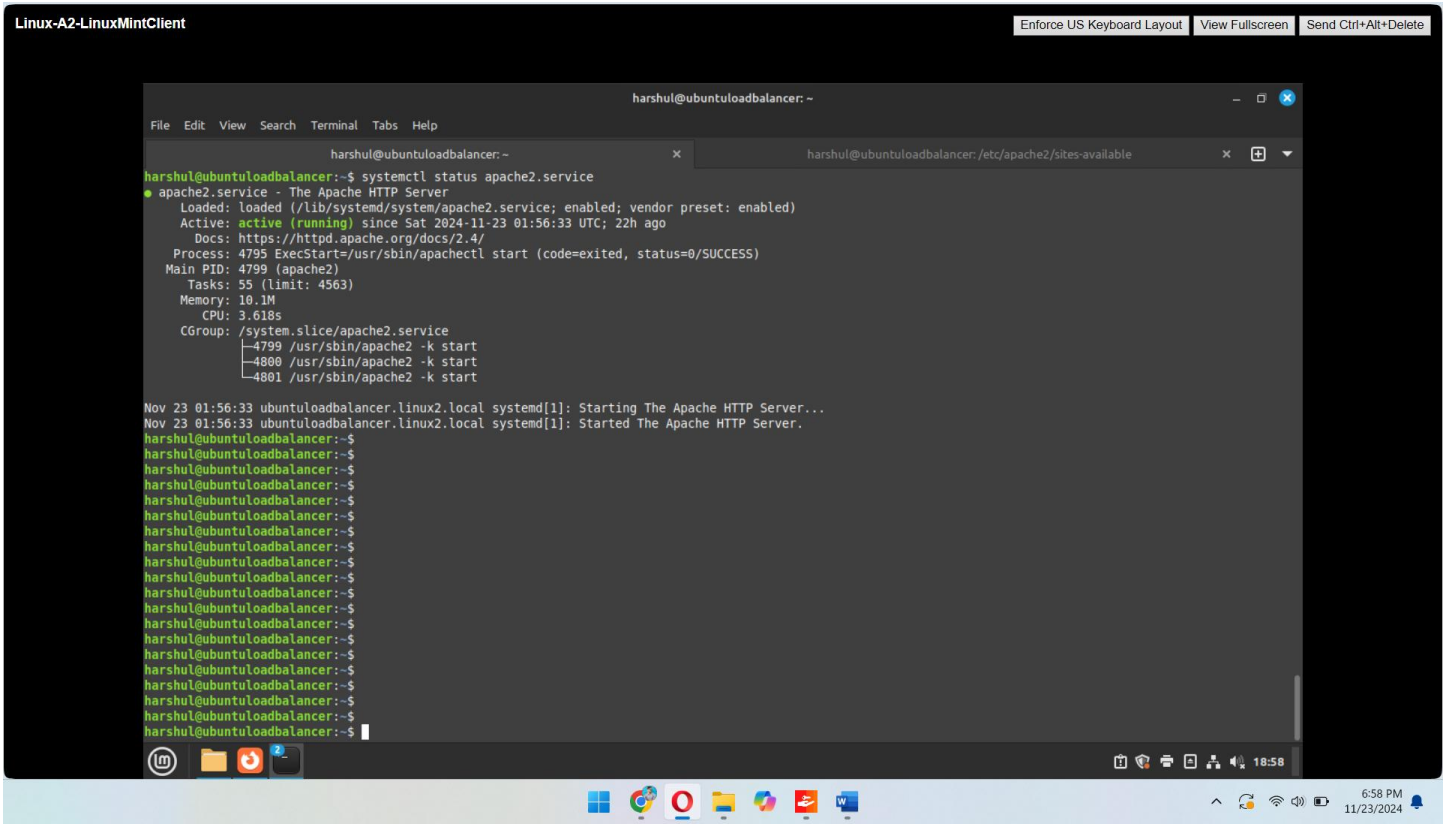
Enable Proxy Module:sudo a2enmod proxy
Enable Proxy HTTP Module:sudo a2enmod proxy_http
Enable Load Balancer Module:sudo a2enmod mod_balancer
Enable Load Balancing Method by Requests Module:sudo a2enmod lbmethod_byrequests

Make sure the firewall is disabled

Disable UFW Service:sudo systemctl disable ufw.service
Stop UFW Service:sudo systemctl stop ufw.service

Now enable and restart the apache2

Enable Apache2 to Start at Boot:sudo systemctl enable apache2
Restart Apache2 Service:sudo systemctl restart apache2.service
Check Apache2 Service Status:sudo systemctl status apache2.service

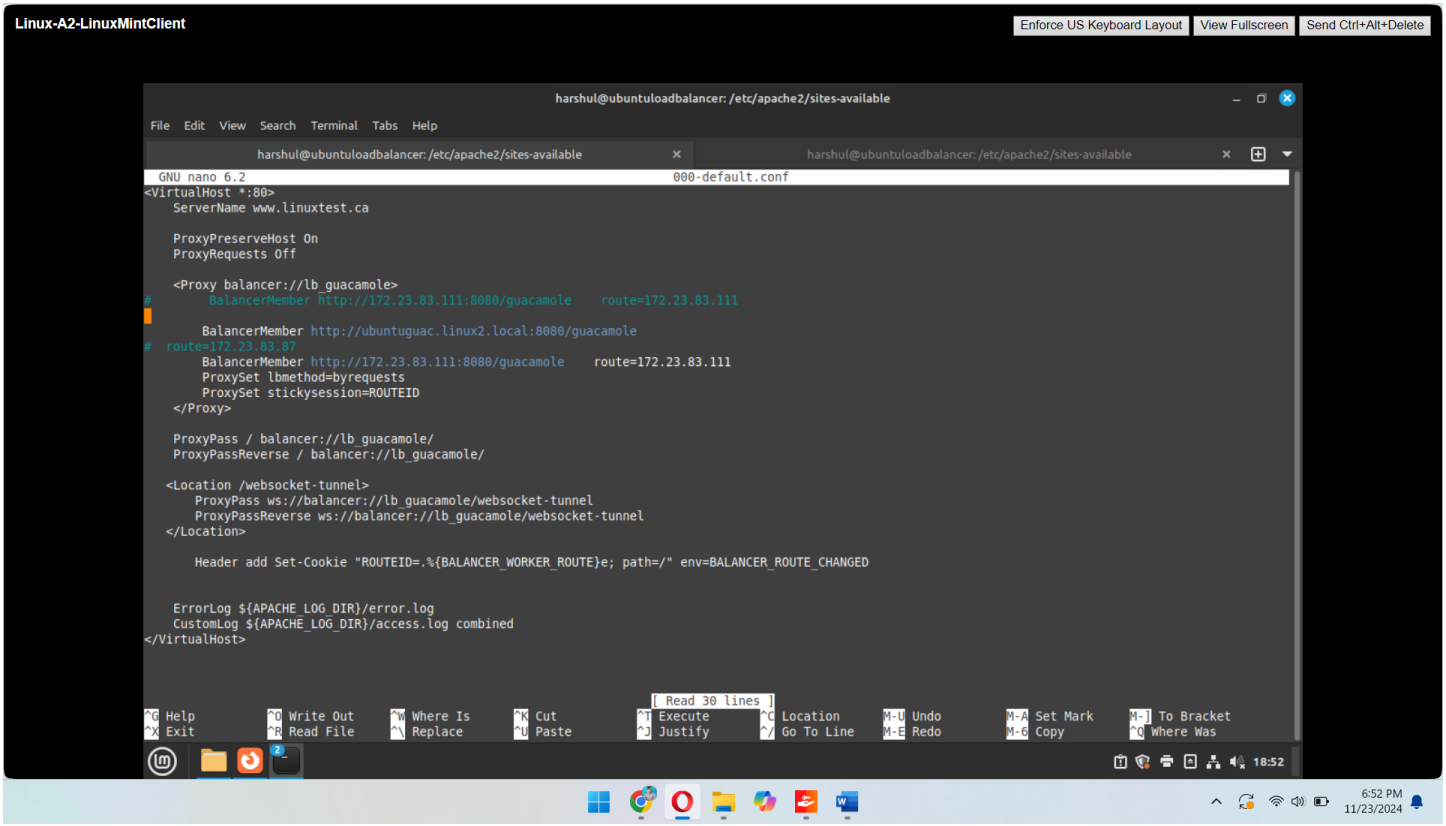


Configure the .conf file for load balancing

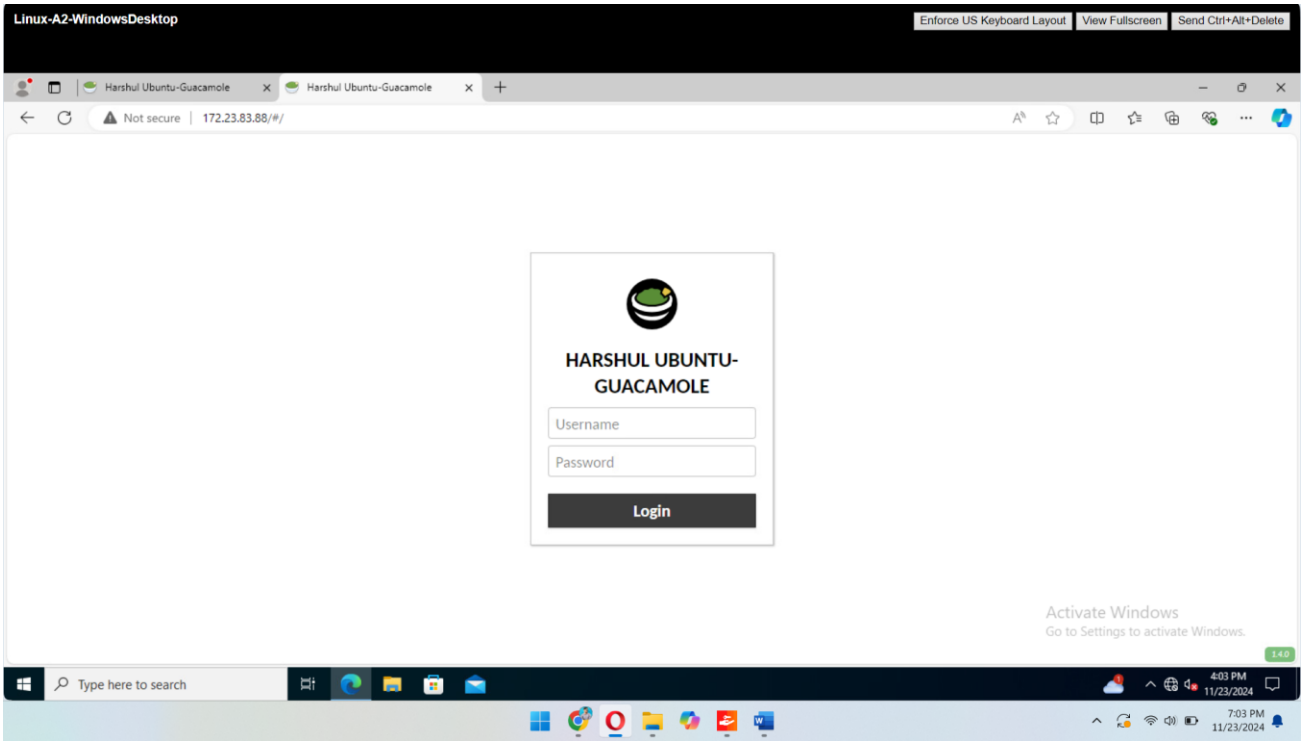
Go to file: cd /etc/apache2/sites-enabled/

Edit it:sudo nano 00-default.conf

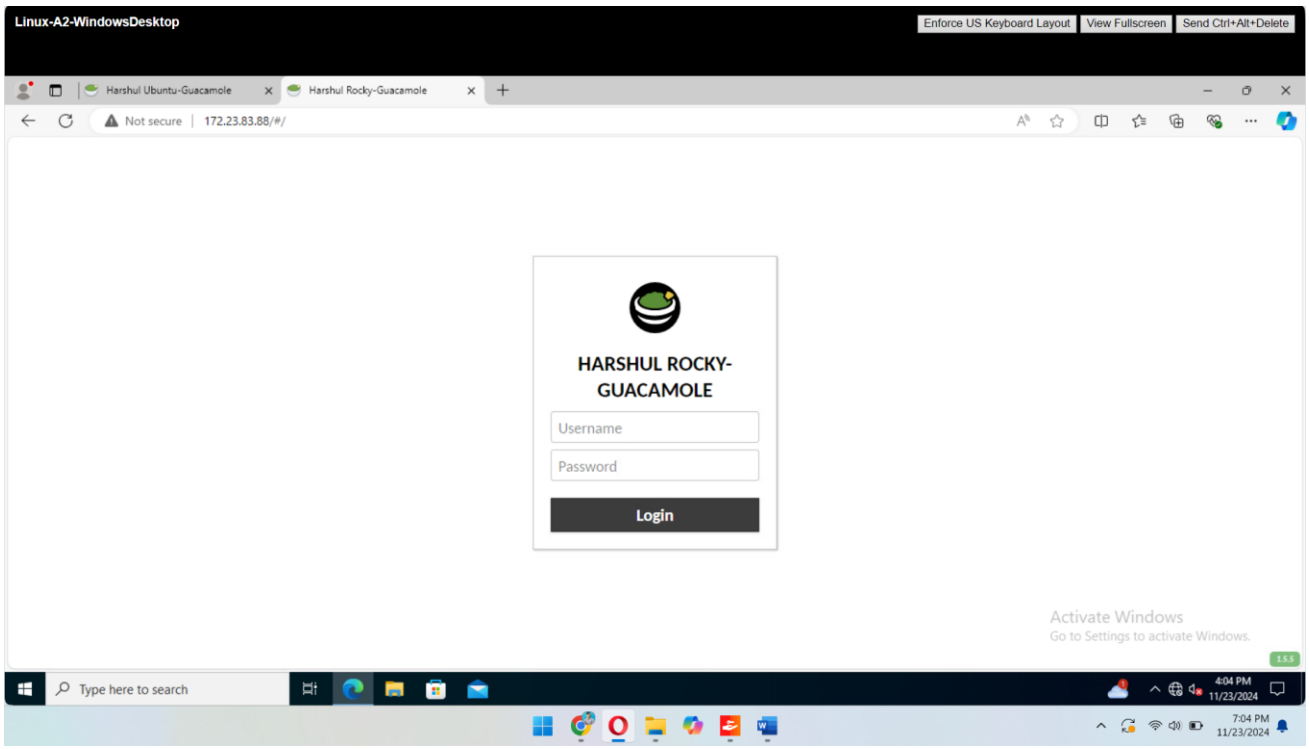
Follow the image below for details



go to browser and type the ip address of the apache2 server : **172.23.83.88**

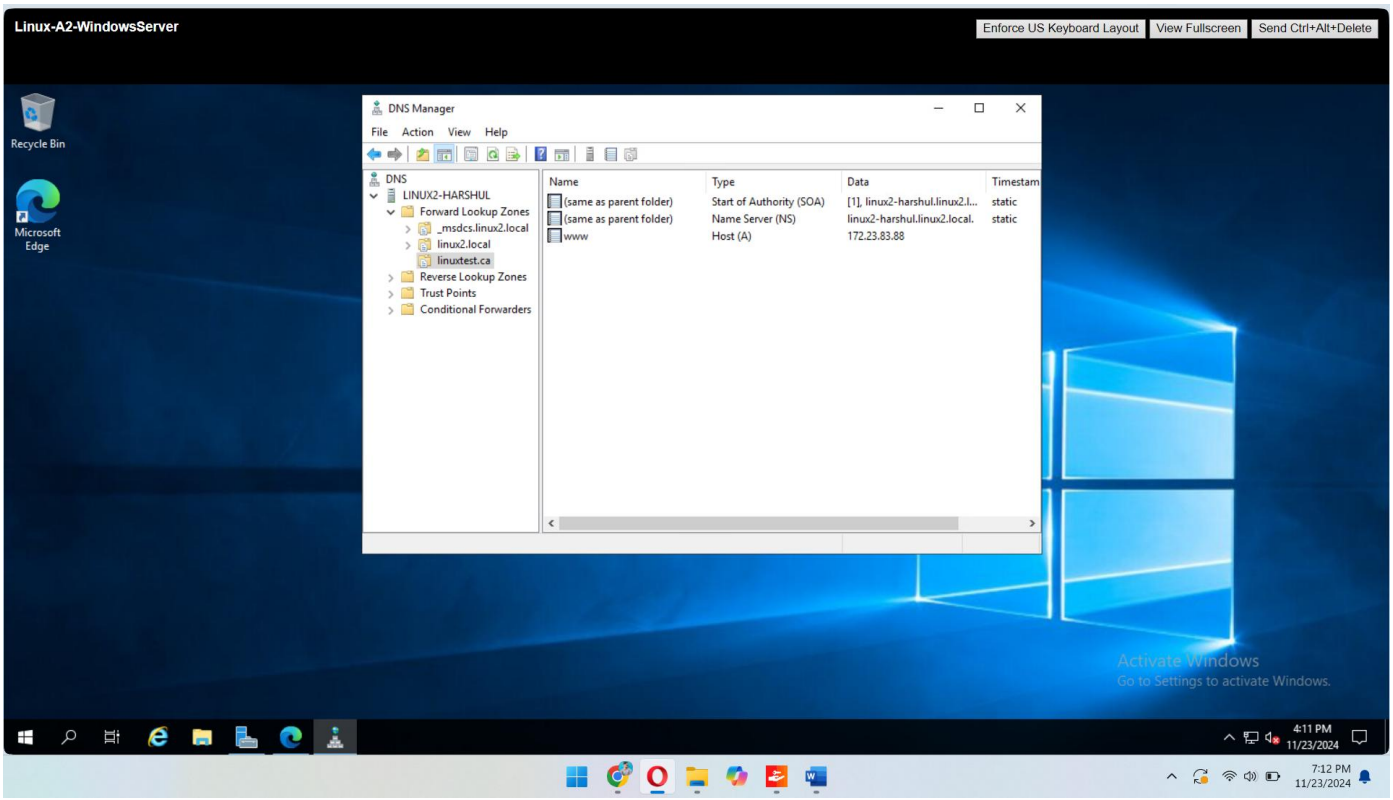


Power down ubuntu guacamole and you should be able to see the Rocky guacamole login page as well



Reverse Proxy Configuration

Go to Domain Controller and check DNS Manager see record is present and make forward lookup zone name linuxtest.ca.



Create Forward Lookup Zone

Right-click on **Forward Lookup Zone**.

Select **New Zone**.

Create **Primary Zone**

Create Host Record for Network Load Balancer

Inside new zone > right-click and select **New Host (A or AAAA)**.

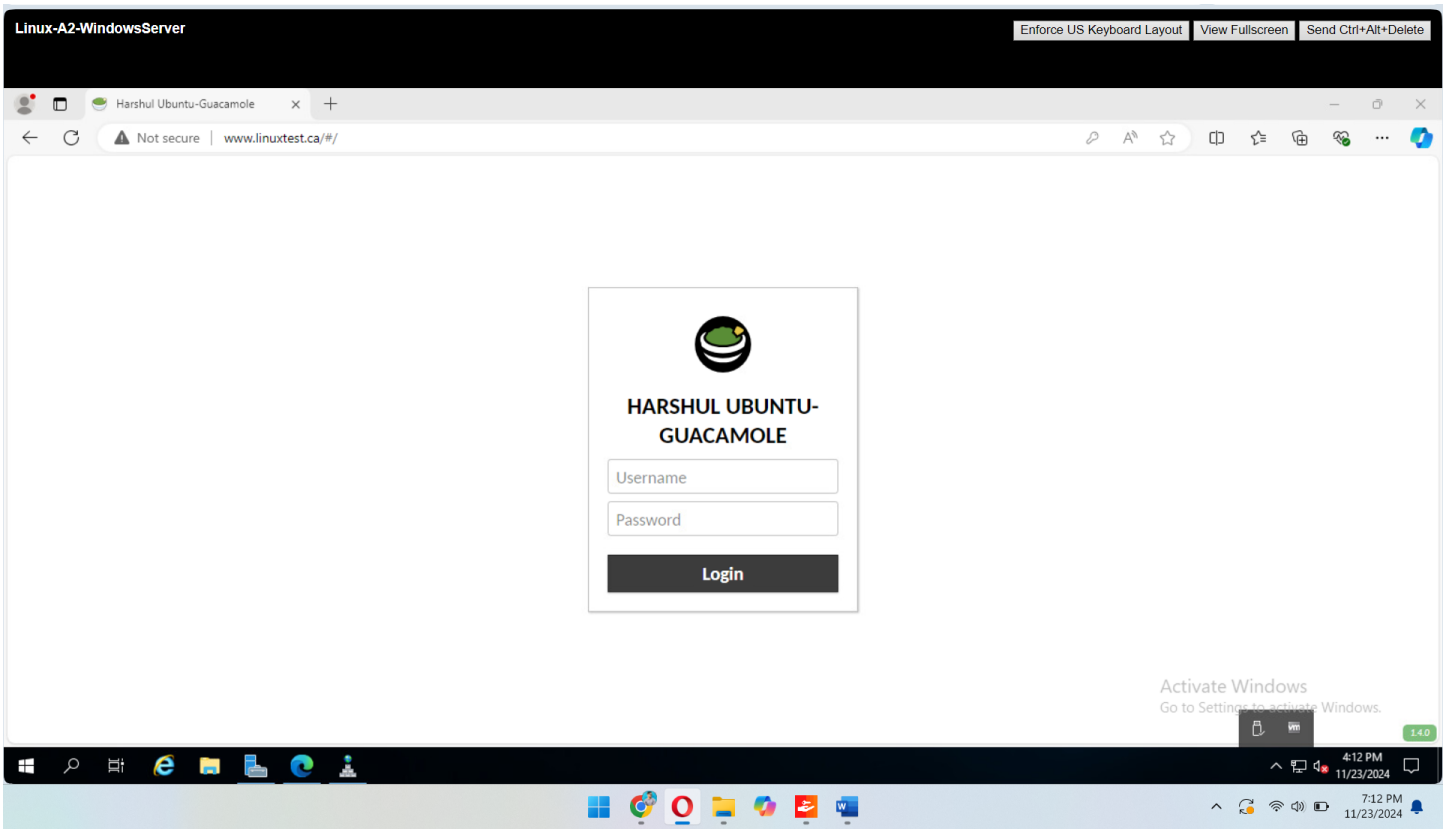
Enter **www** as name and **172.23.83.88** as IP address.

Verify Configuration

go to http://www.linuxtest.ca**.** It will go to one of load balancing servers.

Test Load Balancer

Turn off the Fedora server and verify that load balancer still redirects properly.



References

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Apache GuacamoleTM: 1.5.5. (n.d.). https://guacamole.apache.org/releases/1.5.5/

Installing Guacamole natively — Apache Guacamole Manual v1.5.5. (n.d.). https://guacamole.apache.org/doc/gug/installing-guacamole.html

LDAP authentication — Apache Guacamole Manual v1.5.5. (n.d.). https://guacamole.apache.org/doc/gug/ldap-auth.html

Proxying Guacamole — Apache Guacamole manual V1.5.5. (n.d.). https://guacamole.apache.org/doc/gug/reverse-proxy.html