

🚀 Assignment 8 — Secure GUI Access via SSH (X11) or VNC

Secure Shell Protocol



📝 Experiment: Basic Linux Data Networking Commands

🎯 Aim

To study and execute basic data networking commands in Linux using the command line interface.

📌 Objectives

- To understand Linux network configuration.
- To test network connectivity.
- To diagnose network-related issues.
- To access and transfer data between systems using networking tools.

📋 Requirements

- Linux Operating System (Ubuntu/Debian/Fedora/Kali etc.)
- Terminal access
- Basic knowledge of Linux commands
- Internet connection (optional)

Theory

Data networking in Linux is performed using built-in terminal commands. These commands help configure systems, test connections, and troubleshoot network problems.

Command	Purpose
<code>ifconfig / ip addr</code>	Shows network interface configuration
<code>ping</code>	Tests connectivity to another host
<code>hostname</code>	Displays system hostname
<code>traceroute</code>	Shows the route packets take
<code>netstat</code>	Displays active connections
<code>nslookup</code>	Queries DNS information
<code>ssh</code>	Secure remote login
<code>scp</code>	Secure file transfer

Case 1 — Same Network (LAN): Friend's Ubuntu ↔ Your Ubuntu

Step 1: Enable SSH on Ubuntu

```
sudo apt update
sudo apt install openssh-server
sudo systemctl enable ssh
sudo systemctl start ssh
```

```
ujjwaltyagi@ujjwaltyagi:~$ sudo useradd -m frienduser || true
[sudo] password for ujjwaltyagi:
useradd: user 'frienduser' already exists
ujjwaltyagi@ujjwaltyagi:~$ sudo systemctl enable --now ssh
Synchronizing state of ssh.service with SysV service script with /usr/lib/systemd/systemd-sysv-install.
Executing: /usr/lib/systemd/systemd-sysv-install enable ssh
```

Step 2: Find Ubuntu's local IP address

```
hostname -I
```

```
ujjwaltyagi@ujjwaltyagi:~$ hostname -I  
10.0.2.15 fd17:625c:f037:2:8b91:9627:6829:959b fd17:625c:f037:2:a00:27ff:fe34:53  
ac
```

Step 3: Connect from friend's Ubuntu

```
ssh username@192.168.1.42
```

```
ujjwaltyagi@ujjwaltyagi:~$ ssh vaibahvg@10.0.2.15  
Enter passphrase for key '/home/ujjwaltyagi/.ssh/id_ed25519':  
vaibahvg@10.0.2.15's password:  
Welcome to Ubuntu 24.04.3 LTS (GNU/Linux 6.14.0-29-generic x86_64)  
  
* Documentation: https://help.ubuntu.com  
* Management: https://landscape.canonical.com  
* Support: https://ubuntu.com/pro  
  
Expanded Security Maintenance for Applications is enabled.  
  
132 updates can be applied immediately.  
76 of these updates are standard security updates.  
To see these additional updates run: apt list --upgradable  
  
Last login: Mon Nov  3 17:08:14 2025 from 10.0.2.15  
vaibahvg@ujjwaltyagi:~$ whoami  
vaibahvg
```

Step 4–7: Create, verify, delete file & exit

```
echo "This file was created remotely using SSH" > ~/ssh_test.txt  
cat ~/ssh_test.txt  
rm ~/ssh_test.txt  
exit
```

```
vaibahvg@ujjwaltyagi:~$ cat ~/.ssh/authorized_keys  
ssh-ed25519 AAAAC3NzaC1lZDI1NTE5AAAIIF2VoISW9box0H9etpllHkPwkz0KyysCxt9f04bbXDu  
ujjwaltyagi@ujjwaltyagi  
ssh-rsa AAAAB3NzaC1yc2EAAAQABAAQCrj9pWlhK52jqKxYIwGZTR202UUPI0DzUXzvrb3Ua  
hTBzy7oBbj2w0e7dTqaFojwf0s4xR39o3hy8mIUvU8S4cZs26R8iGwz/c0dDFYzhSYJOW8WofsdXfnwf  
4N6PDcYgKFHHkHu/kI1e1k54xkjYgK+5z0ja55K+YVCn6uhdFTlB+yC5JaFG0v8B8fltuuvkseepE5/  
Tevg1D+MjzD9Z+XLxUEgP+N/MGwdcsHohmz3ezuKtTVIc0Kwc2N9ykwT0z6xsnXE1m9CY/hfhtgBz2gV  
oujFsGgZ7BBG7Tk0IAp4QLBFXAeVq62U9/WWEldku6nV2qhyH5sy1UZ14k5B vaibahvg@ujjwaltyag  
i  
vaibahvg@ujjwaltyagi:~$ exit  
logout  
Connection to 10.0.2.15 closed.  
ujjwaltyagi@ujjwaltyagi:~$
```

🌐 Case 2 — Different Networks (WAN): Remote Server / Cloud VM

◊ Step 1: View IP Address & Interfaces

```
ip addr show
```

```
ujjwaltyagi@ujjwaltyagi:~$ 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 noprefixroute
        valid_lft forever preferred_lft forever
2: enp0s3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000
    link/ether 08:00:27:34:53:ac brd ff:ff:ff:ff:ff:ff
    inet 10.0.2.15/24 brd 10.0.2.255 scope global dynamic noprefixroute enp0s3
        valid_lft 74084sec preferred_lft 74084sec
    inet6 fd17:625c:f037:2:8b91:9627:6829:959b/64 scope global temporary dynamic
        valid_lft 86232sec preferred_lft 14232sec
    inet6 fd17:625c:f037:2:a00:27ff:fe34:53ac/64 scope global dynamic mngtmpaddr
        valid_lft 86232sec preferred_lft 14232sec
    inet6 fe80::a00:27ff:fe34:53ac/64 scope link
        valid_lft forever preferred_lft forever
ujjwaltyagi@ujjwaltyagi:~$
```

◊ Step 2: Display hostname

```
hostname
```

```
ujjwaltyagi@ujjwaltyagi:~$ hostname
ujjwaltyagi
[1]+ 14777 Stopped                  hostname
```

◊ Step 3–6: Connectivity tests & diagnostics

```
ping google.com -c 4
traceroute google.com
netstat -tulnp
nslookup google.com
```

```
ujjwaltyagi@ujjwaltyagi:~$ ping google.com -c 4
PING google.com (142.250.76.78) 56(84) bytes of data.
64 bytes from tzdela-aq-in-f14.1e100.net (142.250.76.78): icmp_seq=1 ttl=255 time=55.6 ms
64 bytes from tzdela-aq-in-f14.1e100.net (142.250.76.78): icmp_seq=2 ttl=255 time=20.2 ms
64 bytes from tzdela-aq-in-f14.1e100.net (142.250.76.78): icmp_seq=3 ttl=255 time=18.4 ms
64 bytes from tzdela-aq-in-f14.1e100.net (142.250.76.78): icmp_seq=4 ttl=255 time=29.2 ms

--- google.com ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3510ms
rtt min/avg/max/mdev = 18.406/30.845/55.581/14.850 ms
```

```
ujjwaltyagi@ujjwaltyagi:~$ traceroute google.com
traceroute to google.com (142.250.76.78), 30 hops max, 60 byte packets
 1 _gateway (10.0.2.2)  8.226 ms  1.374 ms  1.060 ms

 2 * * *
 3 * * *
 4 * * *
 5 * * *
 6 * * *
 7 * * *
 8 * * *
 9 * * *
10 * * *
11 * * *
12 * * *
13 * * *
14 * * *
15 * * *
16 * * *
17 * * *
18 * * *
19 * * *
20 * * *
21 * * *
22 * * *
```

```
ujjwaltyagi@ujjwaltyagi:~$ netstat -tulnp
(Not all processes could be identified, non-owned process info
 will not be shown, you would have to be root to see it all.)
Active Internet connections (only servers)
Proto Recv-Q Send-Q Local Address          Foreign Address        State      PID/Program name
tcp      0      0 127.0.0.54:53          0.0.0.0:*            LISTEN     -
tcp      0      0 0.0.0.0:22            0.0.0.0:*            LISTEN     -
tcp      0      0 127.0.0.53:53          0.0.0.0:*            LISTEN     -
tcp      0      0 127.0.0.1:631           0.0.0.0:*            LISTEN     -
tcp6     0      0 :::22                 :::*                  LISTEN     -
tcp6     0      0 ::1:631                :::*                  LISTEN     -
udp      0      0 127.0.0.54:53          0.0.0.0:*            LISTEN     -
udp      0      0 127.0.0.53:53          0.0.0.0:*            LISTEN     -
udp      0      0 0.0.0.0:58272          0.0.0.0:*            LISTEN     -
udp      0      0 0.0.0.0:5353           0.0.0.0:*            LISTEN     -
udp6     0      0 :::39957               :::*                  LISTEN     -
udp6     0      0 ::::5353              :::*                  LISTEN     -
```

```
ujjwaltyagi@ujjwaltyagi:~$ nslookup google.com
Server:      127.0.0.53
Address:     127.0.0.53#53

Non-authoritative answer:
Name:   google.com
Address: 142.250.76.78
Name:   google.com
Address: 2404:6800:4002:830::200e
```

◊ Step 7-8: Remote login & SCP transfer

```
ssh user@192.168.1.10
scp test.txt user@192.168.1.10:/home/user/
```

```
ujjwaltyagi@ujjwaltyagi:~$ ssh vaibahvg@10.0.2.15
Enter passphrase for key '/home/ujjwaltyagi/.ssh/id_ed25519':
vaibahvg@10.0.2.15's password:
Welcome to Ubuntu 24.04.3 LTS (GNU/Linux 6.14.0-29-generic x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:    https://landscape.canonical.com
 * Support:        https://ubuntu.com/pro
```

Expanded Security Maintenance for Applications is enabled.

132 updates can be applied immediately.
 76 of these updates are standard security updates.
 To see these additional updates run: apt list --upgradable

```
Last login: Mon Nov  3 17:23:09 2025 from 10.0.2.15
```

```
ujjwaltyagi@ujjwaltyagi:~$ echo "Hello from ujjwal" >test2.txt
ujjwaltyagi@ujjwaltyagi:~$ scp test2.txt vaibahvg@10.0.2.15:/home/vaibahvg/
sign_and_send_pubkey: signing failed for ED25519 "/home/ujjwaltyagi/.ssh/id_ed25519" from agent: agent refused operation
vaibahvg@10.0.2.15's password:
test2.txt                                100%   18      3.0KB/s   00:00
ujjwaltyagi@ujjwaltyagi:~$
```

GUI — Secure Remote Desktop & X11

- 1) Prepare & secure the remote machine (friend's laptop)

```
sudo apt update
sudo apt install -y openssh-server tigervnc-standalone-server
```

```

sudo useradd -m frienduser || true
sudo systemctl enable --now ssh
sudo -u frienduser mkdir -p /home/frienduser/.ssh
echo "" | sudo tee -a /home/frienduser/.ssh/authorized_keys
sudo chmod 700 /home/frienduser/.ssh
sudo chmod 600 /home/frienduser/.ssh/authorized_keys
sudo chown -R frienduser:frienduser /home/frienduser/.ssh
sudo systemctl status ssh --no-pager
ss -tlnp | grep :22

```

```

ujjwaltyagi@ujjwaltyagi:~$ sudo apt install tightvncserver xfce4 xfce4-goodies -y
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
tightvncserver is already the newest version (1:1.3.10-8).
The following package was automatically installed and is no longer required:
 libl11vm19
Use 'sudo apt autoremove' to remove it.
The following additional packages will be installed:
 7zip accountsservice-ubuntu-schemas avahi-utils bamfdaemon bzip2 desktop-base elementary-xfce-icon-theme exo-utils
 fonts-quicksand gir1.2-dbusmenu-glib-0.4 gnome-bluetooth gnome-screensaver greybird-gtk-theme indicator-applet
 indicator-application indicator-appmenu indicator-bluetooth indicator-common indicator-datetime indicator-keyboard
 indicator-messages indicator-power indicator-printers indicator-session indicator-sound jayatana libaccounts-glib0
 libasound2-plugins libatkmm-1.6-1v5 libbamf3-2t64 libburn4t64 libcairomm-1.0-1v5 libexo-2-0 libexo-common
 libfcitx-config4 libfcitx-gclient1 libfcitx-utils0 libgarcon-1-0 libgarcon-common libgarcon-gtk3-1-0
 libglibmm-2.4-1t64 libgnome-panel3 libgtk-layer-shell0 libgtkmm-3.0-1t64 libgtksourceview-4-0
 libgtksourceview-4-common libido3-0.1-0 libindicator3-7 libisofs6t64 libjack-jackd2-0 libkeybinder-3.0-0
 liblightdm-gobject-1-0 libmessaging-menu0 libmousepad0 libpangomm-1.4-1v5 libqrencode4 libsigc++-2.0-0v5 libtagc0
 libthunarx-3-0 libtumbler-1-0t64 libunity-gtk2-parser0 libunity-gtk3-parser0 libunity-settings-daemon1 libutempter0
 libxfce4panel-2.0-4 libxfce4ui-2-0 libxfce4ui-common libxfce4ui-utils libxfce4util-bin libxfce4util-common
 libxfce4util7 libxfconf-0-3 libxnvctrl0 libxpresent1 light-locker light-locker-settings lightdm lm-sensors mousepad
 p7zip-full pavucontrol policykit-1-gnome pulseaudio-utils python3-psutil ristretto system-config-printer
 tango-icon-theme thunar thunar-archive-plugin thunar-data thunar-media-tags-plugin thunar-volman tumbler
 tumbler-common ubuntu-touch-sounds unity-greeter unity-gtk2-module-common unity-gtk3-module
 unity-settings-daemon unity-settings-daemon-schemas xarchiver xfburn xfce4-appfinder xfce4-battery-plugin

```

```

ujjwaltyagi@ujjwaltyagi:~$ sudo adduser vaibahvg
info: Adding user `vaibahvg' ...
info: Selecting UID/GID from range 1000 to 59999 ...
info: Adding new group `vaibahvg' (1002) ...
info: Adding new user `vaibahvg' (1002) with group `vaibahvg (1002)' ...
info: Creating home directory `/home/vaibahvg' ...
info: Copying files from `/etc/skel' ...
New password:
BAD PASSWORD: The password fails the dictionary check - it is too simplistic/systematic
Retype new password:
passwd: password updated successfully
Changing the user information for vaibahvg
Enter the new value, or press ENTER for the default
      Full Name []: vaibhavg
      Room Number []: 34
      Work Phone []:
      Home Phone []:
      Other []:
Is the information correct? [Y/n] y
info: Adding new user `vaibahvg' to supplemental / extra groups `users' ...
info: Adding user `vaibahvg' to group `users' ...

```

```
ujjwaltyagi@ujjwaltyagi:~$ sudo systemctl status ssh
[sudo] password for ujjwaltyagi:
● ssh.service - OpenBSD Secure Shell server
    Loaded: loaded (/usr/lib/systemd/system/ssh.service; disabled; preset: enabled)
      Active: inactive (dead)
TriggeredBy: ● ssh.socket
    Docs: man:sshd(8)
          man:sshd_config(5)
ujjwaltyagi@ujjwaltyagi:~$
```

```
ujjwaltyagi@ujjwaltyagi:~$ mkdir -p ~/.ssh
ujjwaltyagi@ujjwaltyagi:~$ chmod 700 ~/.ssh
ujjwaltyagi@ujjwaltyagi:~$ touch ~/.ssh/authorized_keys
ujjwaltyagi@ujjwaltyagi:~$ chmod 600 ~/.ssh/authorised_keys
chmod: cannot access '/home/ujjwaltyagi/.ssh/authorised_keys': No such file or directory
ujjwaltyagi@ujjwaltyagi:~$ chmod 600 ~/.ssh/authorized_keys
```

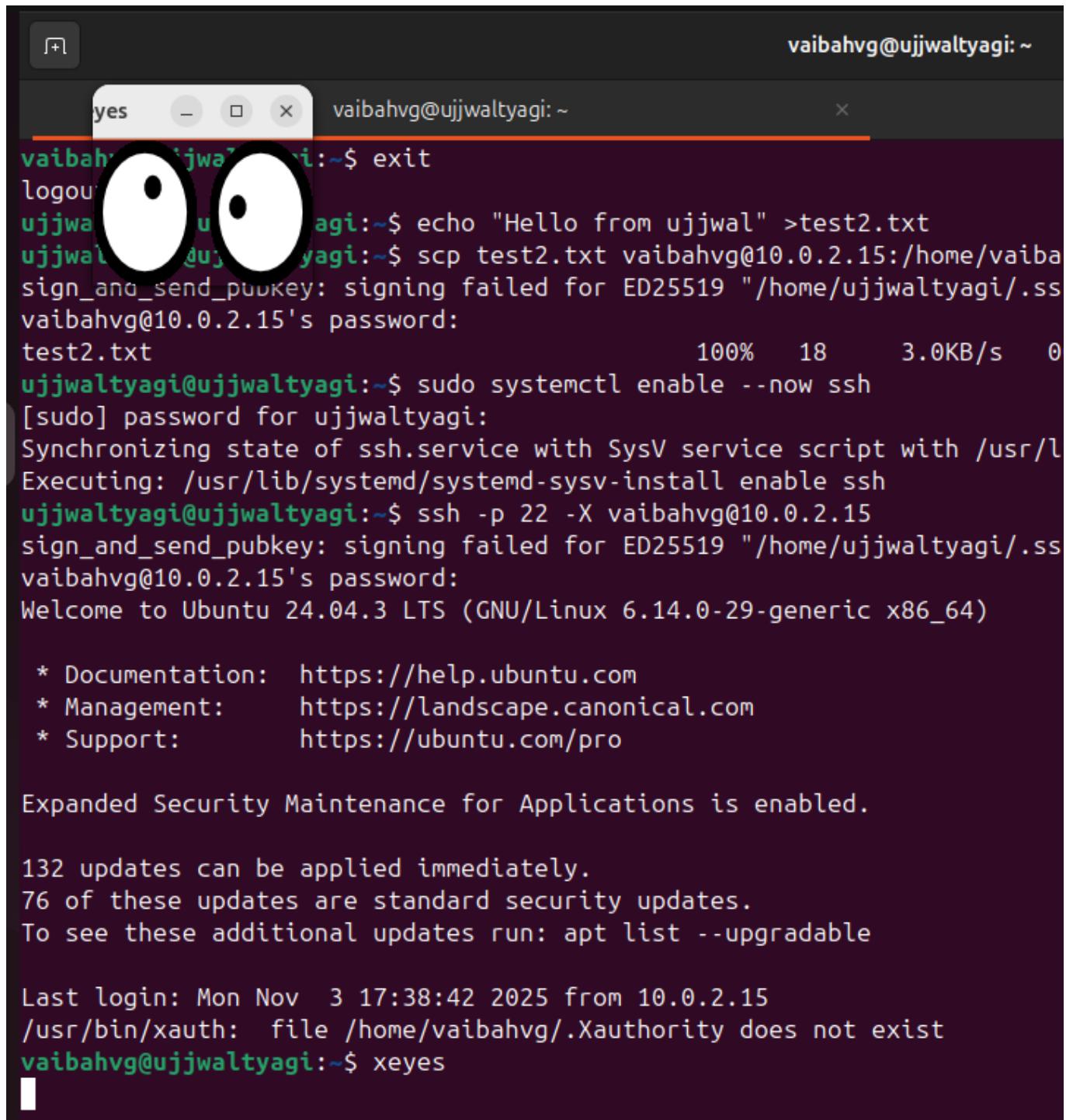
```
ujjwaltyagi@ujjwaltyagi:~$ sudo systemctl enable --now ssh
Synchronizing state of ssh.service with SysV service script with /usr/lib/systemd/systemd-sysv-install.
Executing: /usr/lib/systemd/systemd-sysv-install enable ssh
ujjwaltyagi@ujjwaltyagi:~$ sudo systemctl status ssh --no-pager
● ssh.service - OpenBSD Secure Shell server
    Loaded: loaded (/usr/lib/systemd/system/ssh.service; enabled; preset: enabled)
      Active: active (running) since Mon 2025-11-03 15:33:37 IST; 1h 29min ago
TriggeredBy: ● ssh.socket
    Docs: man:sshd(8)
          man:sshd_config(5)
      Main PID: 1161 (sshd)
        Tasks: 1 (limit: 9659)
       Memory: 4.1M (peak: 20.5M)
         CPU: 828ms
        CGroup: /system.slice/ssh.service
                  └─1161 "sshd: /usr/sbin/sshd -D [listener] 0 of 10-100 startups"

Nov 03 16:52:44 ujjwaltyagi sshd[5669]: pam_unix(sshd:auth): authentication...2.15
Nov 03 16:52:47 ujjwaltyagi sshd[5669]: Failed password for invalid user va...ssh2
Nov 03 16:52:57 ujjwaltyagi sshd[5669]: pam_unix(sshd:auth): check pass; us...nown
Nov 03 16:53:00 ujjwaltyagi sshd[5669]: Failed password for invalid user va...ssh2
Nov 03 16:53:10 ujjwaltyagi sshd[5669]: Failed password for invalid user va...ssh2
Nov 03 16:53:10 ujjwaltyagi sshd[5669]: Connection closed by invalid user v...uth]
Nov 03 16:53:10 ujjwaltyagi sshd[5669]: PAM 1 more authentication failure; ...2.15
Nov 03 16:58:01 ujjwaltyagi sshd[5683]: Failed password for ujjwaltyagi fro...ssh2
Nov 03 16:58:05 ujjwaltyagi sshd[5683]: Accepted password for ujjwaltyagi f...ssh2
Nov 03 16:58:05 ujjwaltyagi sshd[5683]: pam_unix(sshd:session): session ope...d=0)
Hint: Some lines were ellipsized, use -l to show in full.
```

2) Test X11 forwarding (single GUI app) — from your laptop

Preflight: ensure local X server (Linux desktop, XQuartz on macOS, or VcXsrv/Xming on Windows) is running.

```
ssh -p 22 -X frienduser@FRIEND_IP
# on remote after login:
xeyes & # or gedit & or xclock &
```



vaibahvg@ujjwaltyagi: ~

```

yes - x vaibahvg@ujjwaltyagi: ~
vaibahvg@ujjwaltyagi: ~$ exit
logou
ujjwaltyagi: ~$ echo "Hello from ujjwal" >test2.txt
ujjwaltyagi: ~$ scp test2.txt vaibahvg@10.0.2.15:/home/vaiba
sign_and_send_pubkey: signing failed for ED25519 "/home/ujjwaltyagi/.ss
vaibahvg@10.0.2.15's password:
test2.txt                                100%   18      3.0KB/s  0
ujjwaltyagi@ujjwaltyagi: ~$ sudo systemctl enable --now ssh
[sudo] password for ujjwaltyagi:
Synchronizing state of ssh.service with SysV service script with /usr/l
Executing: /usr/lib/systemd/systemd-sysv-install enable ssh
ujjwaltyagi@ujjwaltyagi: ~$ ssh -p 22 -X vaibahvg@10.0.2.15
sign_and_send_pubkey: signing failed for ED25519 "/home/ujjwaltyagi/.ss
vaibahvg@10.0.2.15's password:
Welcome to Ubuntu 24.04.3 LTS (GNU/Linux 6.14.0-29-generic x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:     https://landscape.canonical.com
 * Support:        https://ubuntu.com/pro

Expanded Security Maintenance for Applications is enabled.

132 updates can be applied immediately.
76 of these updates are standard security updates.
To see these additional updates run: apt list --upgradable

Last login: Mon Nov  3 17:38:42 2025 from 10.0.2.15
/usr/bin/xauth:  file /home/vaibahvg/.Xauthority does not exist
vaibahvg@ujjwaltyagi: ~$ xeyes

```

Success criteria: GUI app window appears on your laptop and is responsive.

- 3) Full desktop: VNC server on friend's laptop + SSH tunnel from your laptop

```
# on friend (as frienduser)
vncserver :1
```

on your laptop (create tunnel)

```
ssh -L 5901:localhost:5901 -p 22 frienduser@FRIEND_IP -N &
```

open VNC client to:

localhost:5901

```
ujjwaltyagi@ujjwaltyagi:~$ ssh -L 5901:localhost:5901 -p 22 vaibahvg@10.0.2.15 -N &
[1] 9487
exit
logout
There are stopped jobs.

[1]+  Stopped                  ssh -L 5901:localhost:5901 -p 22 vaibahvg@10.0.2.15 -N
```

```
ujjwaltyagi@ujjwaltyagi:~$ vncserver :1

New 'X' desktop is ujjwaltyagi:1

Starting applications specified in /home/ujjwaltyagi/.vnc/xstartup
Log file is /home/ujjwaltyagi/.vnc/ujjwaltyagi:1.log
```

```
ujjwaltyagi@ujjwaltyagi:~$ vncviewer

TigerVNC Viewer v1.13.1
Built on: 2024-04-01 08:26
Copyright (C) 1999-2022 TigerVNC Team and many others (see README.rst)
See https://www.tigervnc.org for information on TigerVNC.
```

```
Mon Nov  3 18:51:47 2025
DecodeManager: Detected 5 CPU core(s)
DecodeManager: Creating 4 decoder thread(s)
CConn:         Connected to host localhost port 5901

Mon Nov  3 18:51:52 2025
CConn:         End of stream
CConn:         The connection was dropped by the server before the session could
be established.
DecodeManager: Total: 0 rects, 0 pixels
DecodeManager:          0 B (1:-nan ratio)
```

Output / Observations

Command	Result
ip addr	Lists network interfaces and IP addresses
ping	Replies received indicate connectivity
traceroute	Displays the route path to the destination
nslookup	Shows DNS IP information
ssh	Connects to a remote machine securely
scp	Transfers files securely over SSH

Result & Conclusion

Basic Linux networking commands were successfully executed and network connectivity and configuration were verified. SSH and VNC procedures were demonstrated for both LAN and WAN scenarios.

? Viva Questions (Quick)

What is the purpose of the **ping** command?

The **ping** command is used to test network connectivity by sending ICMP Echo Request packets and measuring replies and round-trip time.

What is the difference between **SSH** and **Telnet**?

Feature	SSH (Secure Shell)	Telnet
Security	Encrypted communication	No encryption
Default Port	22	23
Usage	Secure remote login	Unsecure remote login

How does **traceroute** help?

traceroute shows each hop between source and destination and helps identify delays and routing issues.

Why is **DNS** used?

DNS maps human-friendly hostnames to IP addresses so machines can route network packets correctly.

How to transfer files securely in Linux?

Use **scp** which leverages SSH encryption:

```
scp file.txt user@192.168.1.10:/home/user/
```

Made with ❤ — concise, colorful, and image-preserving overview of Linux Networking & SSH.