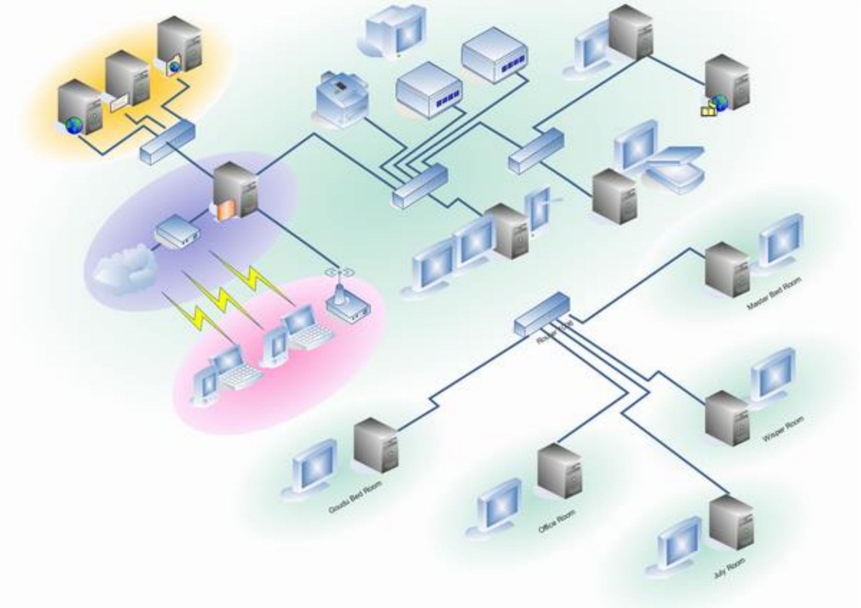
Linux For Embedded Systems

For Arabs

Course 102:

Understanding Linux

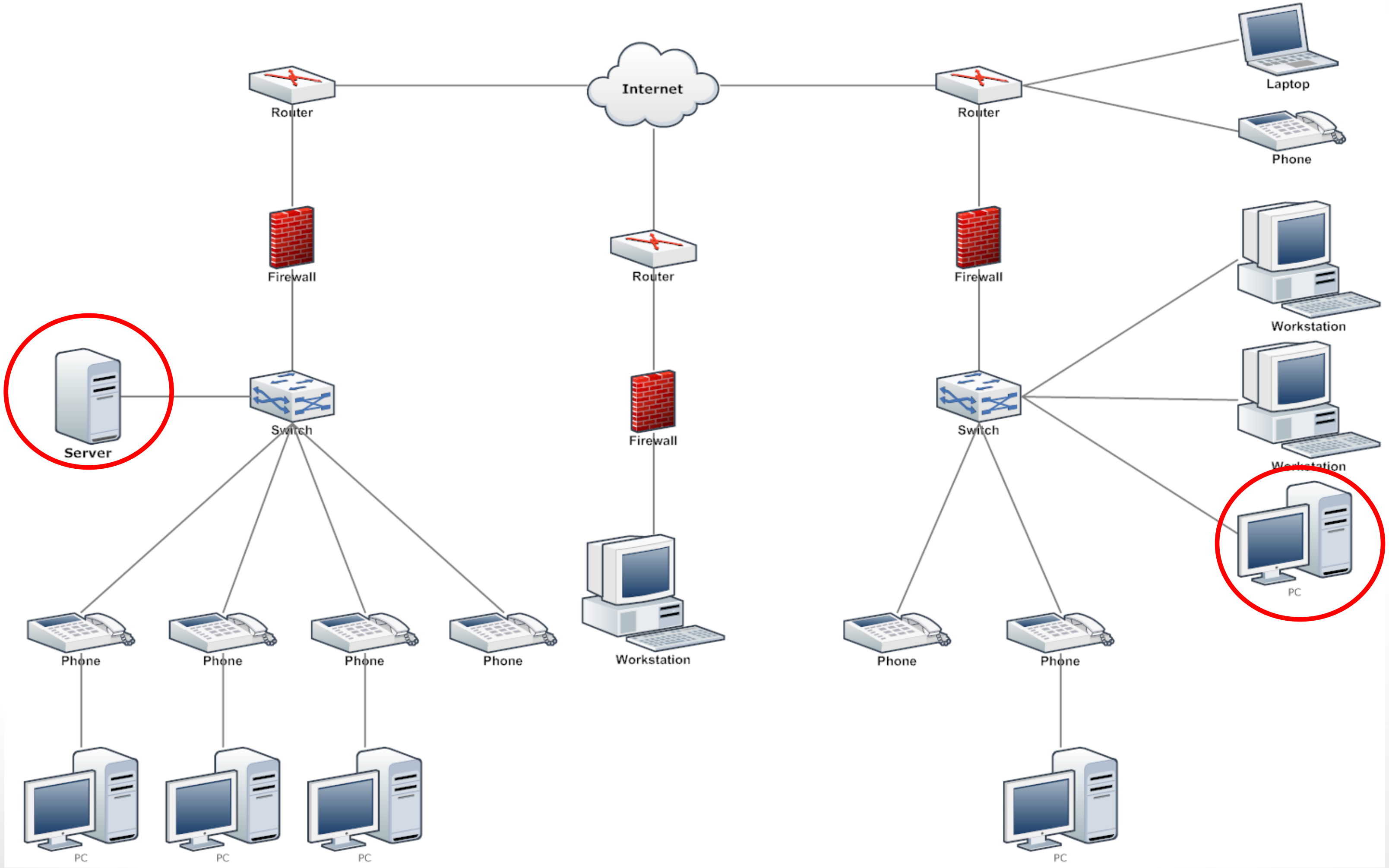
Ahmed ElArabawy



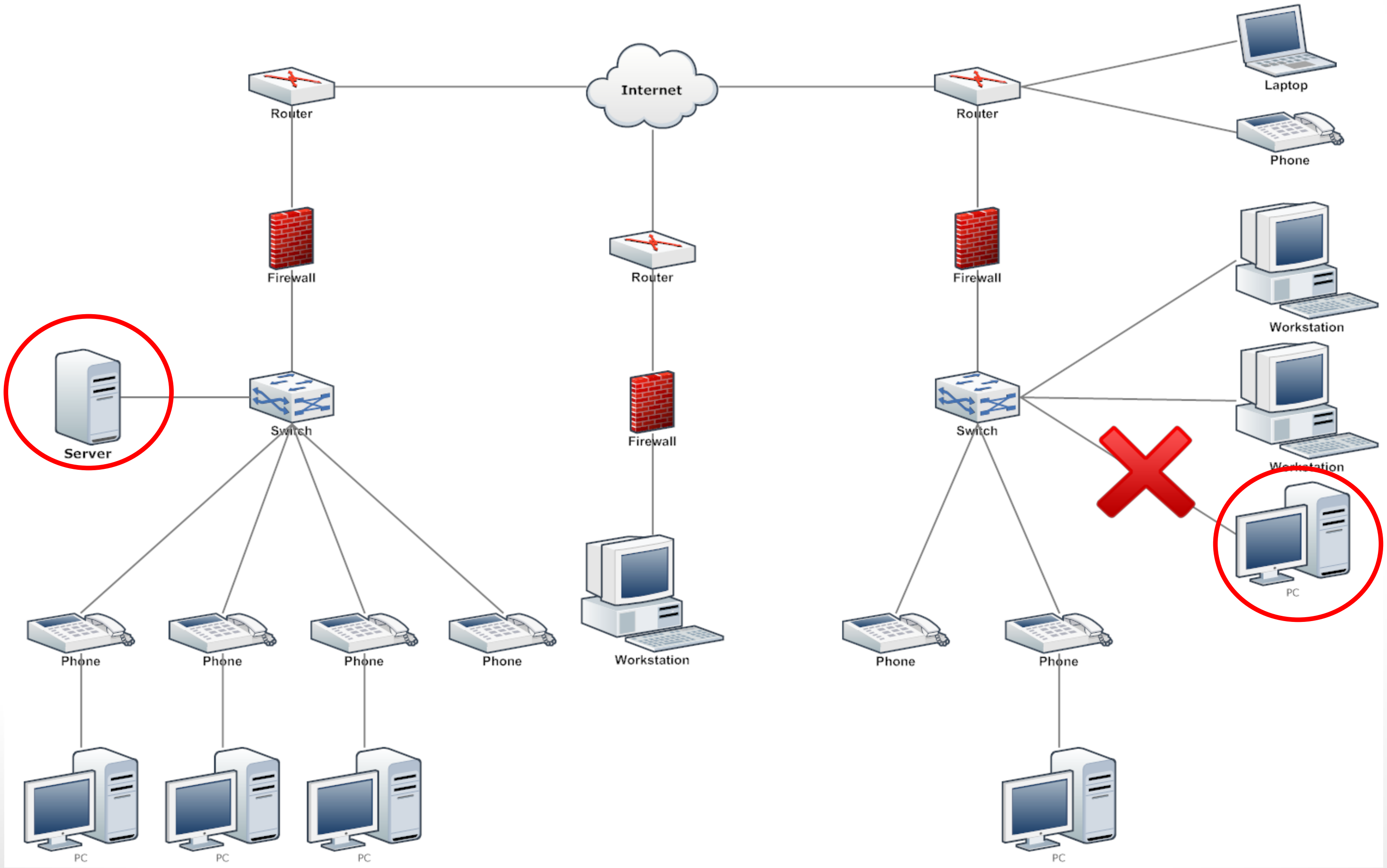
Lecture 21:
Networking in Linux (Applications)

Utility Applications

Check Network Connectivity (ping Command)



Check Network Connectivity (ping Command)



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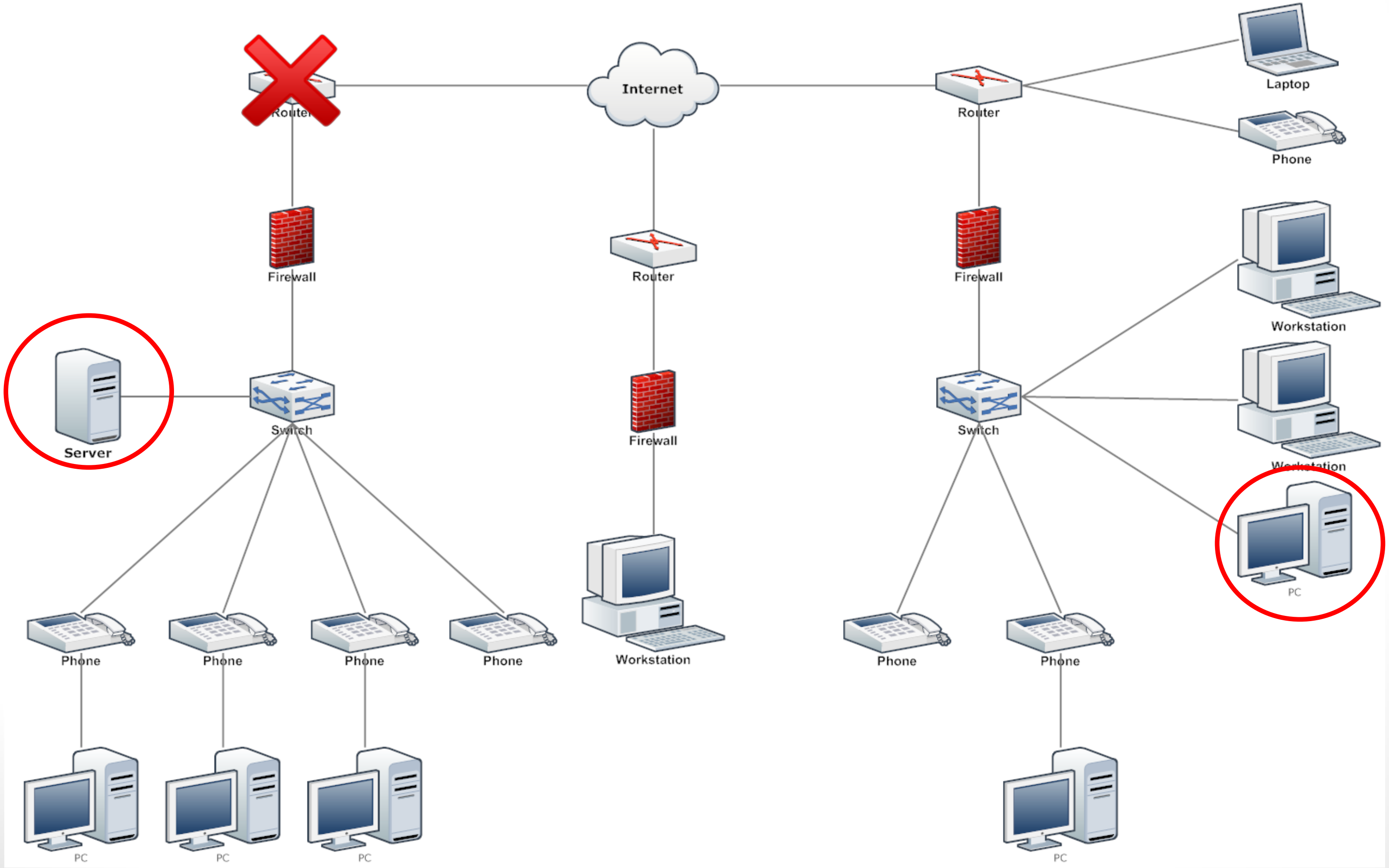

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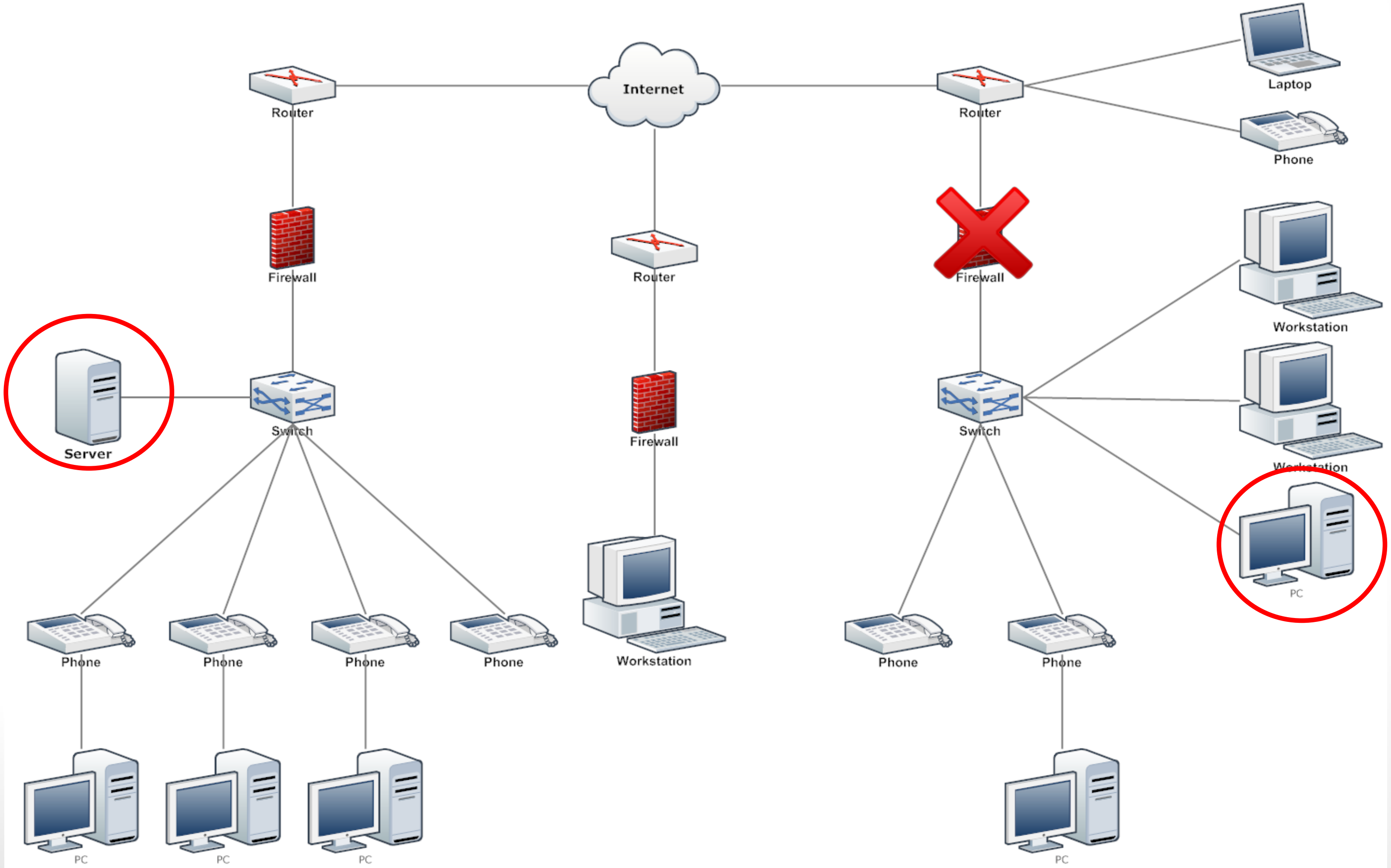
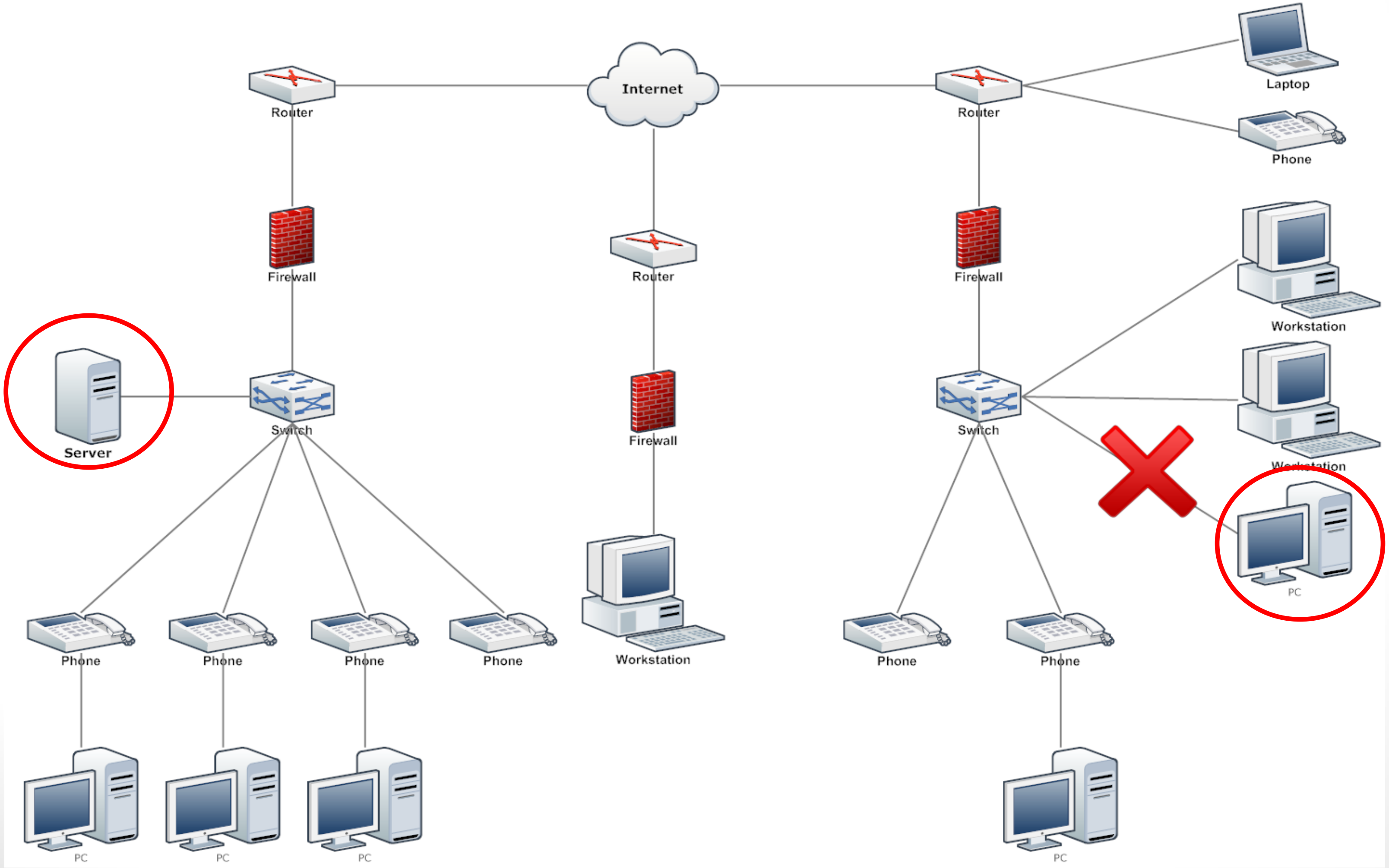


Check Network Connectivity (ping Command)



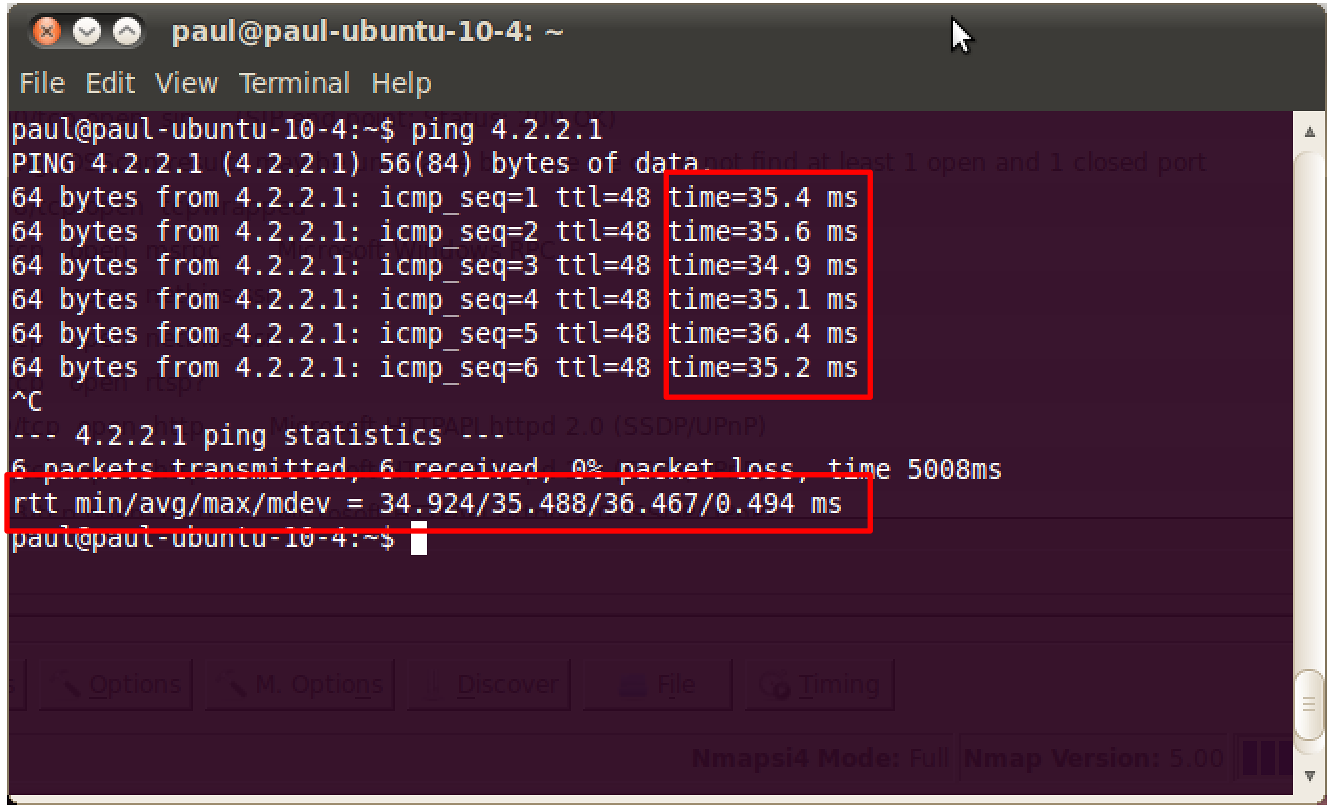
Check Network Connectivity (ping Command)

$ ping <remote machine Address>

This command is used to check connectivity to the remote machine

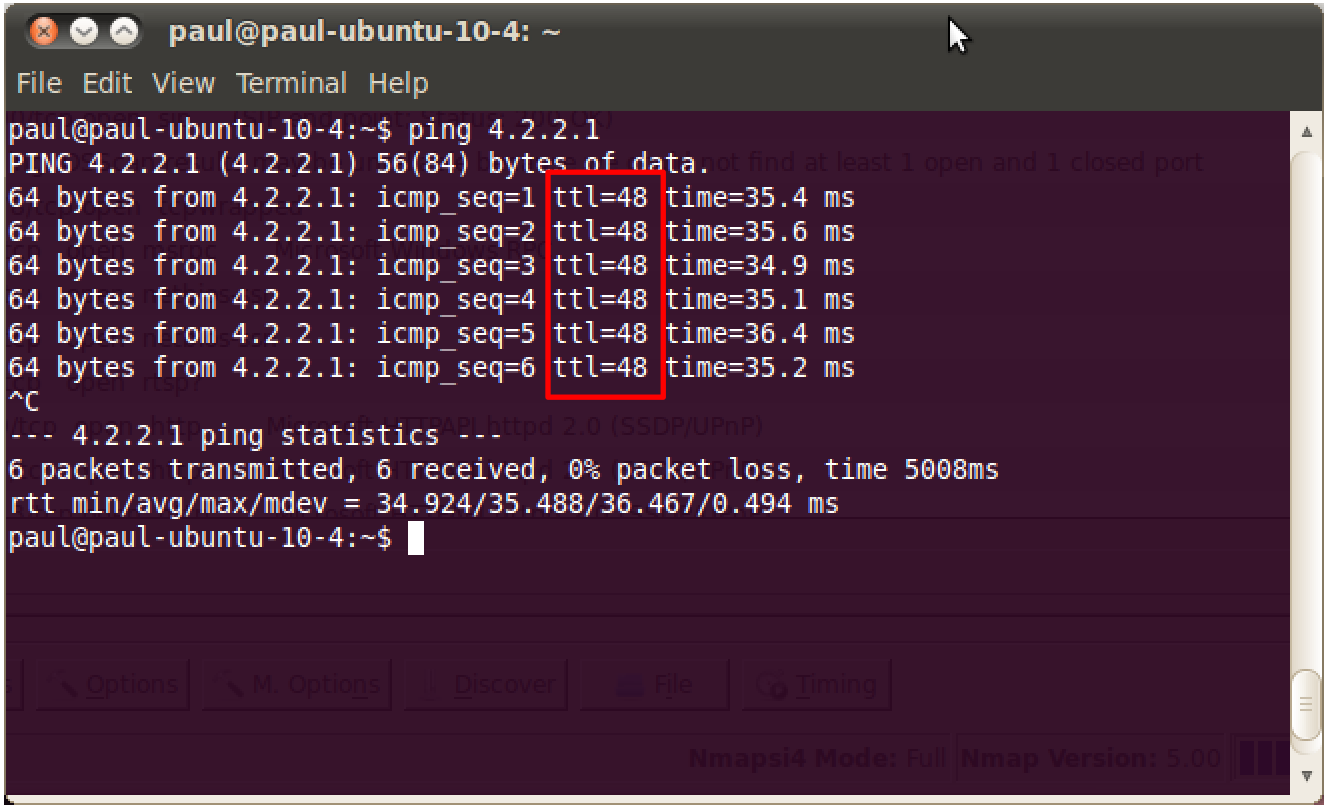
- When you ping a destination,
  - A message ***ICMP_ECHO_REQUEST*** is sent to this destination
  - And a reply ***ICMP_ECHO_RESPONSE*** should be received from the remote destination
- This continues every N second period for a number of times, or until it is interrupted with a Ctrl-C
- Ping can also be used if you want to check the round trip delay to the destination
- You can specify destination by the IP address or by the Domain name
- If you have a network problem, check the following
  - Ping the gateway to make sure it is accessible
  - Ping the DNS Server
  - Ping the destination by name and/or by address

Check Network Connectivity (ping Command)



```
paul@paul-ubuntu-10-4:~$ ping 4.2.2.1
PING 4.2.2.1 (4.2.2.1) 56(84) bytes of data.
64 bytes from 4.2.2.1: icmp_seq=1 ttl=48 time=35.4 ms
64 bytes from 4.2.2.1: icmp_seq=2 ttl=48 time=35.6 ms
64 bytes from 4.2.2.1: icmp_seq=3 ttl=48 time=34.9 ms
64 bytes from 4.2.2.1: icmp_seq=4 ttl=48 time=35.1 ms
64 bytes from 4.2.2.1: icmp_seq=5 ttl=48 time=36.4 ms
64 bytes from 4.2.2.1: icmp_seq=6 ttl=48 time=35.2 ms
^C
--- 4.2.2.1 ping statistics ---
6 packets transmitted, 6 received, 0% packet loss, time 5008ms
rtt min/avg/max/mdev = 34.924/35.488/36.467/0.494 ms
paul@paul-ubuntu-10-4:~$ 
```

Check Network Connectivity (ping Command)



```
paul@paul-ubuntu-10-4:~$ ping 4.2.2.1
PING 4.2.2.1 (4.2.2.1) 56(84) bytes of data.
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64 bytes from 4.2.2.1: icmp_seq=4 ttl=48 time=35.1 ms
64 bytes from 4.2.2.1: icmp_seq=5 ttl=48 time=36.4 ms
64 bytes from 4.2.2.1: icmp_seq=6 ttl=48 time=35.2 ms
^C
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paul@paul-ubuntu-10-4:~$ 
```
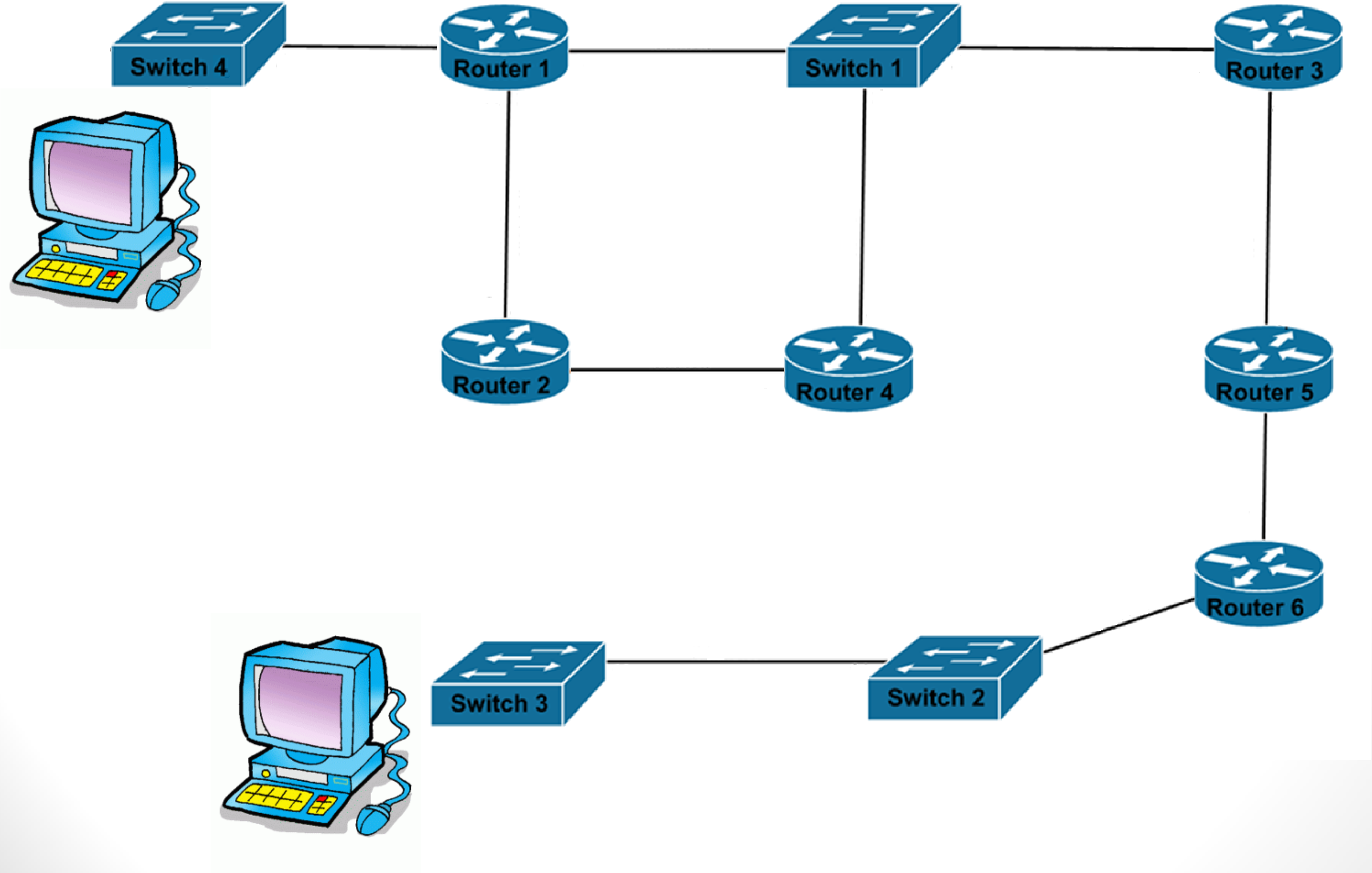
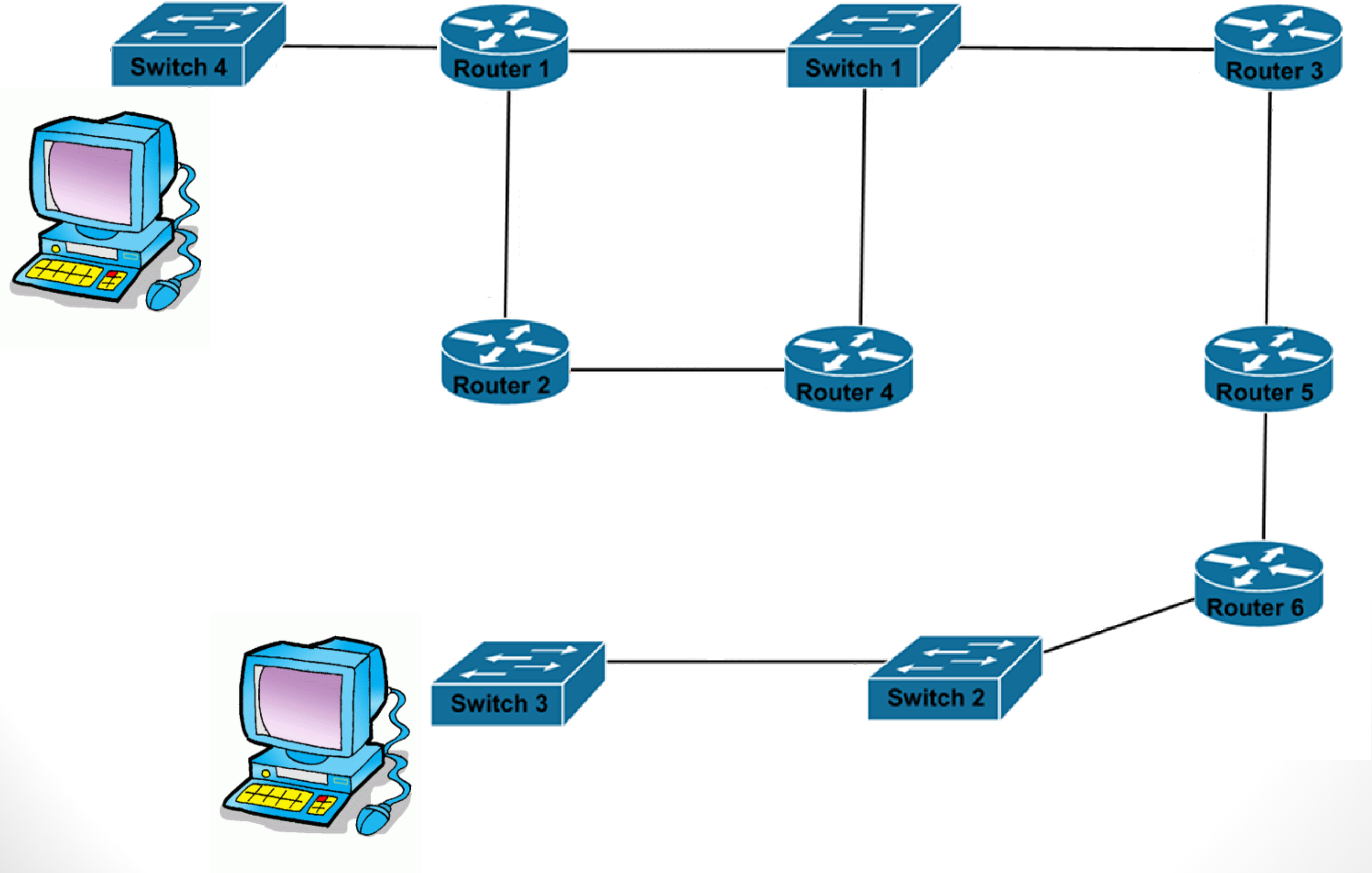

Time To Live (TTL)



Tracing the Route



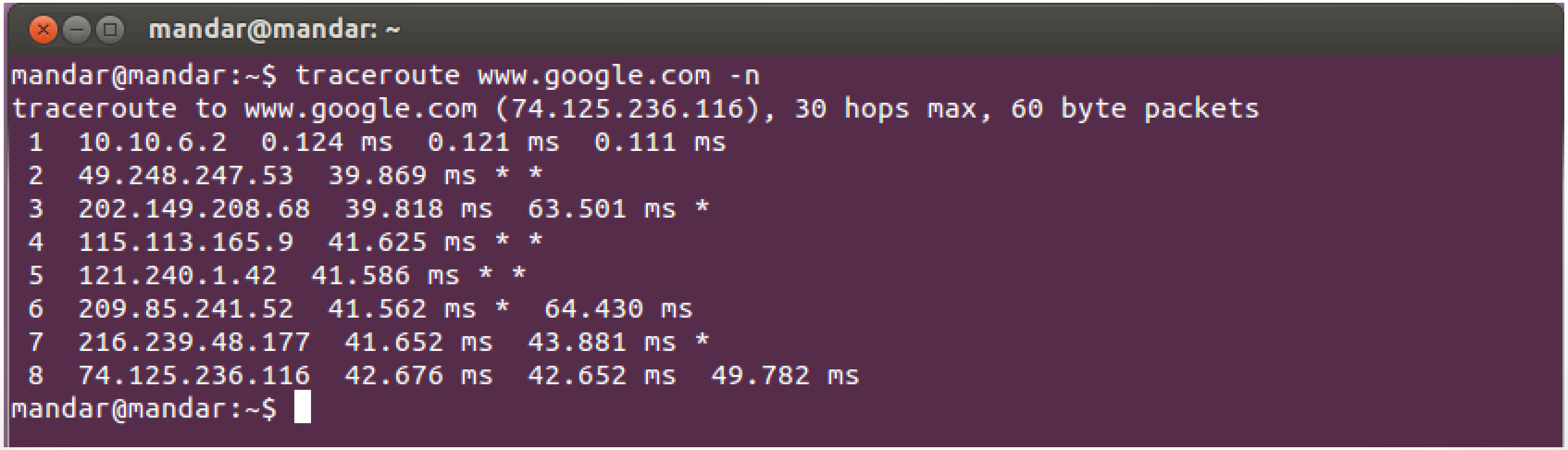
Tracing the Route (traceroute Command)

$ traceroute <destination Address>

- Same as ping, but this time, you get the whole route of the packet

  $ traceroute www.google.com

- Sometimes, certain nodes in the route remain hidden



mandar@mandar: ~

```
mandar@mandar:~$ traceroute www.google.com -n
traceroute to www.google.com (74.125.236.116), 30 hops max, 60 byte packets
 1  10.10.6.2  0.124 ms  0.121 ms  0.111 ms
 2  49.248.247.53  39.869 ms * *
 3  202.149.208.68  39.818 ms  63.501 ms *
 4  115.113.165.9  41.625 ms * *
 5  121.240.1.42  41.586 ms * *
 6  209.85.241.52  41.562 ms *  64.430 ms
 7  216.239.48.177  41.652 ms  43.881 ms *
 8  74.125.236.116  42.676 ms  42.652 ms  49.782 ms
mandar@mandar:~$ 
```

Collecting Network Statistics (netstat Command)

$ netstat [Options]

This command displays various network related information such as network connections, routing tables, interface statistics, etc.,

- To display the routing table information

  ```
  $ netstat -r
  ```

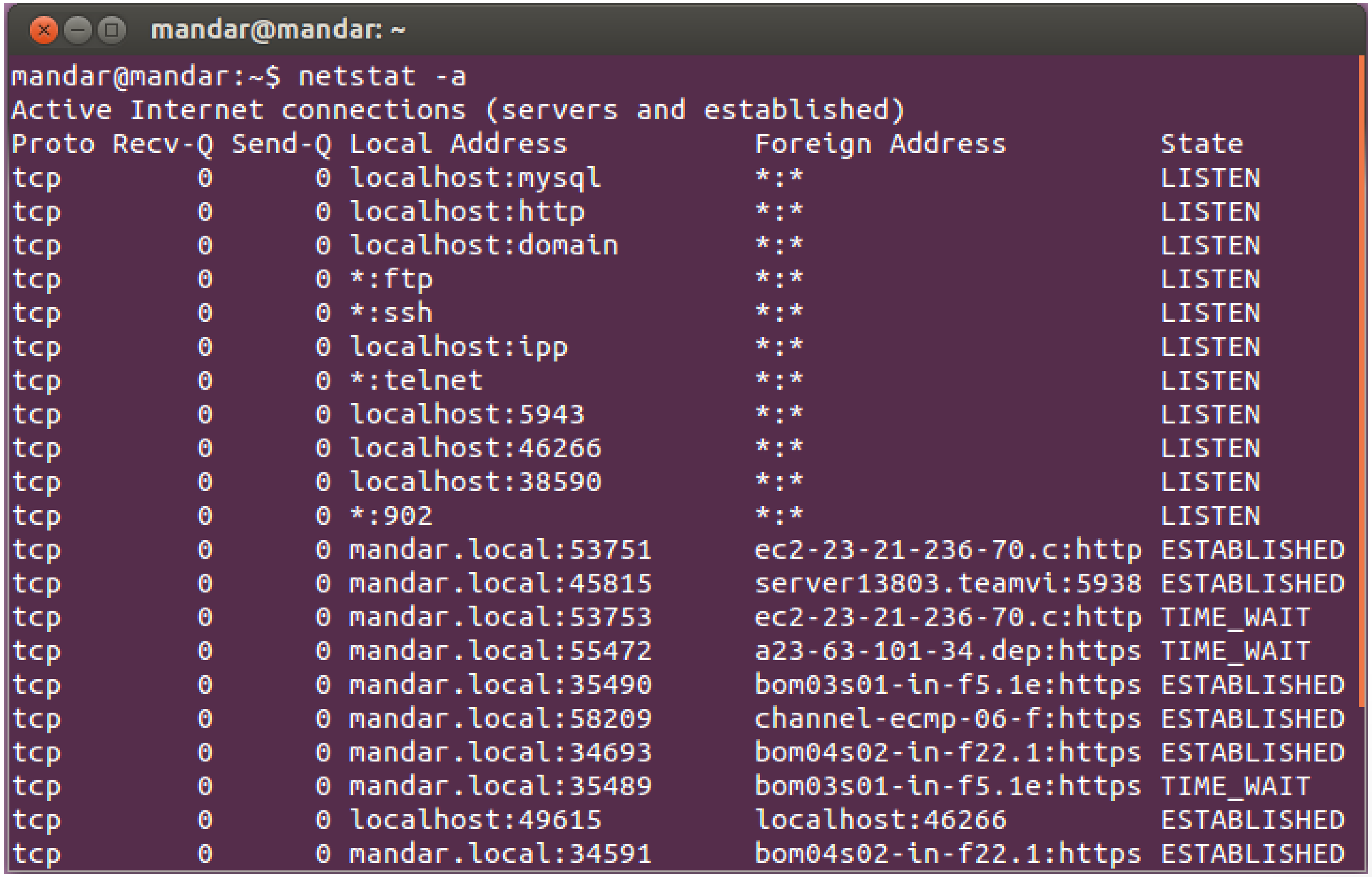
- To list network interfaces on the machine

  ```
  $ netstat -i
  $ netstat -ie    (output similar to ifconfig)
  ```

- To list statistics on sockets of different protocols

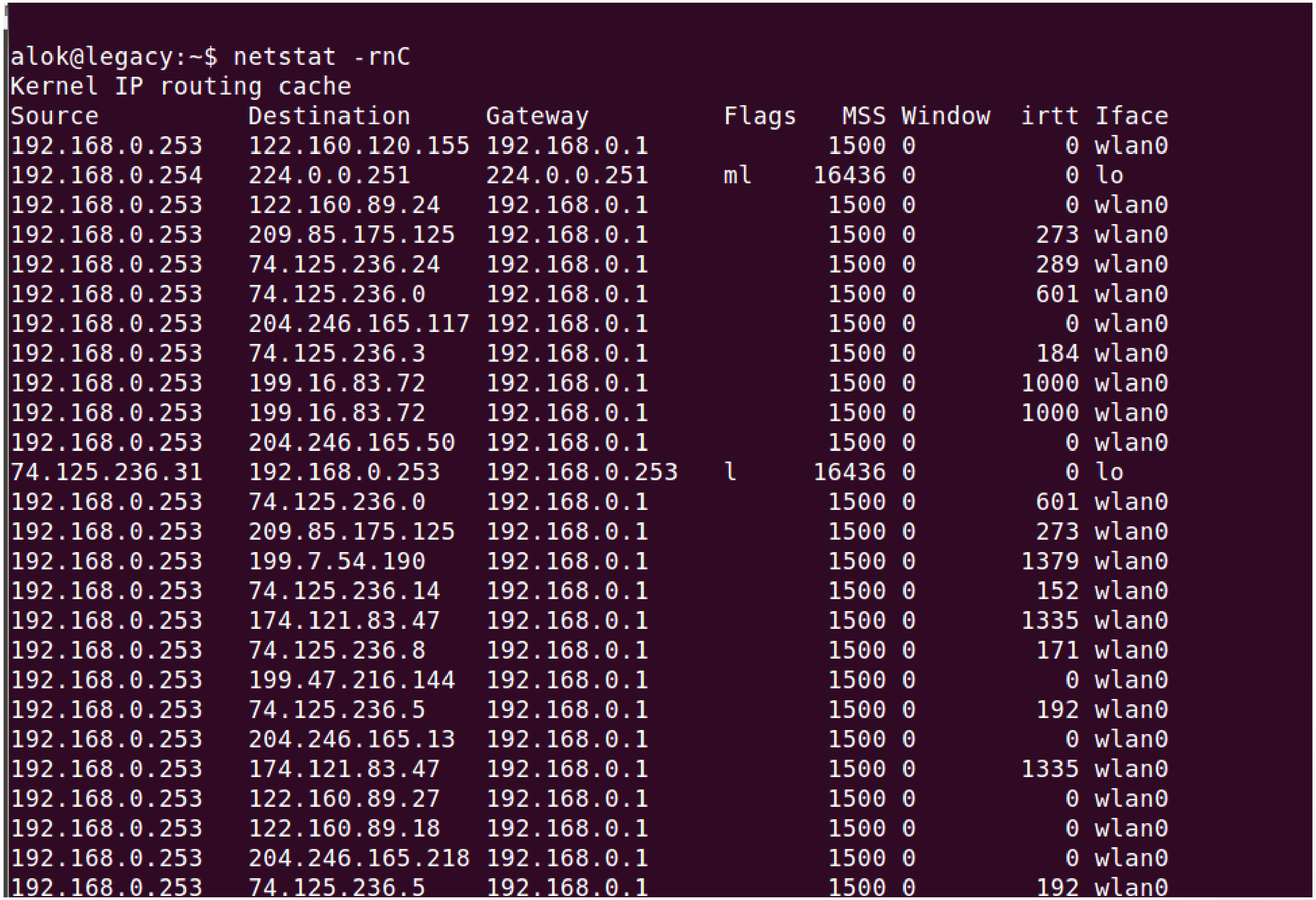
  ```
  $ netstat -s
  $ netstat -st     (only for TCP Protocol)
  $ netstat -su    (only for UDP Protocol)
  ```

Collecting Network Statistics (netstat Command)



```
mandar@mandar:~$ netstat -a
Active Internet connections (servers and established)
Proto Recv-Q Send-Q Local Address           Foreign Address         State
tcp        0      0 localhost:mysql         *:*                     LISTEN
tcp        0      0 localhost:http          *:*                     LISTEN
tcp        0      0 localhost:domain        *:*                     LISTEN
tcp        0      0 *:ftp                   *:*                     LISTEN
tcp        0      0 *:ssh                   *:*                     LISTEN
tcp        0      0 localhost:ipp           *:*                     LISTEN
tcp        0      0 *:telnet                *:*                     LISTEN
tcp        0      0 localhost:5943          *:*                     LISTEN
tcp        0      0 localhost:46266         *:*                     LISTEN
tcp        0      0 localhost:38590         *:*                     LISTEN
tcp        0      0 *:902                   *:*                     LISTEN
tcp        0      0 mandar.local:53751      ec2-23-21-236-70.c:http ESTABLISHED
tcp        0      0 mandar.local:45815      server13803.teamvi:5938 ESTABLISHED
tcp        0      0 mandar.local:53753      ec2-23-21-236-70.c:http TIME_WAIT
tcp        0      0 mandar.local:55472      a23-63-101-34.dep:https TIME_WAIT
tcp        0      0 mandar.local:35490      bom03s01-in-f5.1e:https ESTABLISHED
tcp        0      0 mandar.local:58209      channel-ecmp-06-f:https ESTABLISHED
tcp        0      0 mandar.local:34693      bom04s02-in-f22.1:https ESTABLISHED
tcp        0      0 mandar.local:35489      bom03s01-in-f5.1e:https TIME_WAIT
tcp        0      0 localhost:49615         localhost:46266         ESTABLISHED
tcp        0      0 mandar.local:34591      bom04s02-in-f22.1:https ESTABLISHED
```

Collecting Network Statistics (netstat Command)



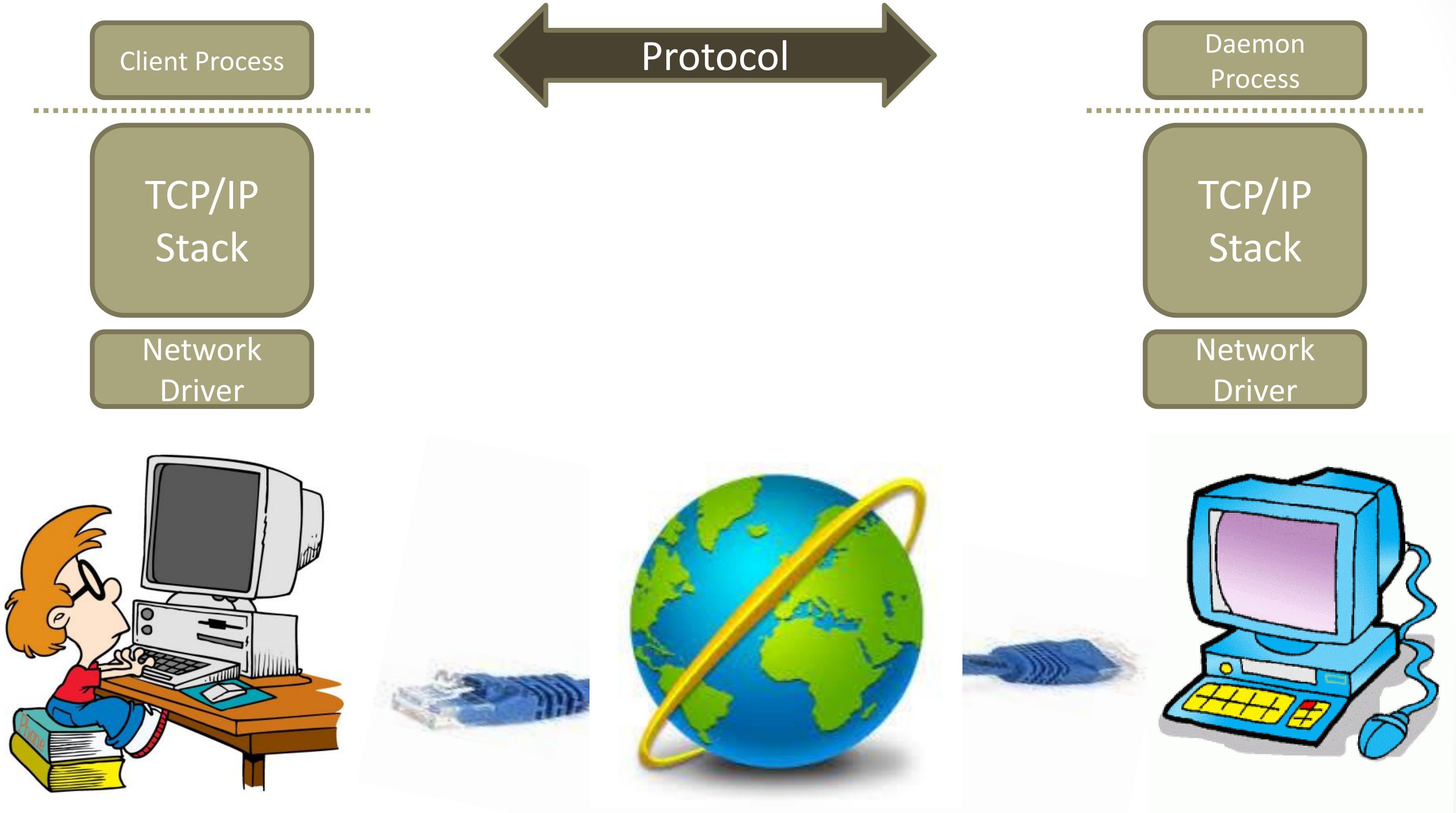
```
alok@legacy:~$ netstat -rnC
Kernel IP routing cache
Source          Destination     Gateway         Flags   MSS Window  irtt Iface
192.168.0.253   122.160.120.155 192.168.0.1            1500 0          0 wlan0
192.168.0.254   224.0.0.251     224.0.0.251     ml    16436 0          0 lo
192.168.0.253   122.160.89.24   192.168.0.1            1500 0          0 wlan0
192.168.0.253   209.85.175.125  192.168.0.1            1500 0        273 wlan0
192.168.0.253   74.125.236.24   192.168.0.1            1500 0        289 wlan0
192.168.0.253   74.125.236.0    192.168.0.1            1500 0        601 wlan0
192.168.0.253   204.246.165.117 192.168.0.1            1500 0          0 wlan0
192.168.0.253   74.125.236.3    192.168.0.1            1500 0        184 wlan0
192.168.0.253   199.16.83.72    192.168.0.1            1500 0       1000 wlan0
192.168.0.253   199.16.83.72    192.168.0.1            1500 0       1000 wlan0
192.168.0.253   204.246.165.50  192.168.0.1            1500 0          0 wlan0
74.125.236.31   192.168.0.253   192.168.0.253   l     16436 0          0 lo
192.168.0.253   74.125.236.0    192.168.0.1            1500 0        601 wlan0
192.168.0.253   209.85.175.125  192.168.0.1            1500 0        273 wlan0
192.168.0.253   199.7.54.190    192.168.0.1            1500 0       1379 wlan0
192.168.0.253   74.125.236.14   192.168.0.1            1500 0        152 wlan0
192.168.0.253   174.121.83.47   192.168.0.1            1500 0       1335 wlan0
192.168.0.253   74.125.236.8    192.168.0.1            1500 0        171 wlan0
192.168.0.253   199.47.216.144  192.168.0.1            1500 0          0 wlan0
192.168.0.253   74.125.236.5    192.168.0.1            1500 0        192 wlan0
192.168.0.253   204.246.165.13  192.168.0.1            1500 0          0 wlan0
192.168.0.253   174.121.83.47   192.168.0.1            1500 0       1335 wlan0
192.168.0.253   122.160.89.27   192.168.0.1            1500 0          0 wlan0
192.168.0.253   122.160.89.18   192.168.0.1            1500 0          0 wlan0
192.168.0.253   204.246.165.218 192.168.0.1            1500 0          0 wlan0
192.168.0.253   74.125.236.5    192.168.0.1            1500 0        192 wlan0
```

Network Applications

General Structure

- The different network applications described in this lecture share the following structure
  - The user accesses a remote machine for different purposes
    - Copy files to/from the remote machine
    - Access a terminal in the remote machine
    - Access the GUI of the remote machine
  - In all cases, the user runs a client application on his local machine
  - The remote machine will be running a server application
  - The server application will be running on a Daemon process waiting for a connection from the client side
  - Both the Client and the Daemon are user plane applications that communicate with the TCP/IP stack residing in the kernel

General Structure



Client Process

TCP/IP Stack

Network Driver

Protocol

Daemon Process

TCP/IP Stack

Network Driver

Remote Access of a Machine (telnet Protocol)

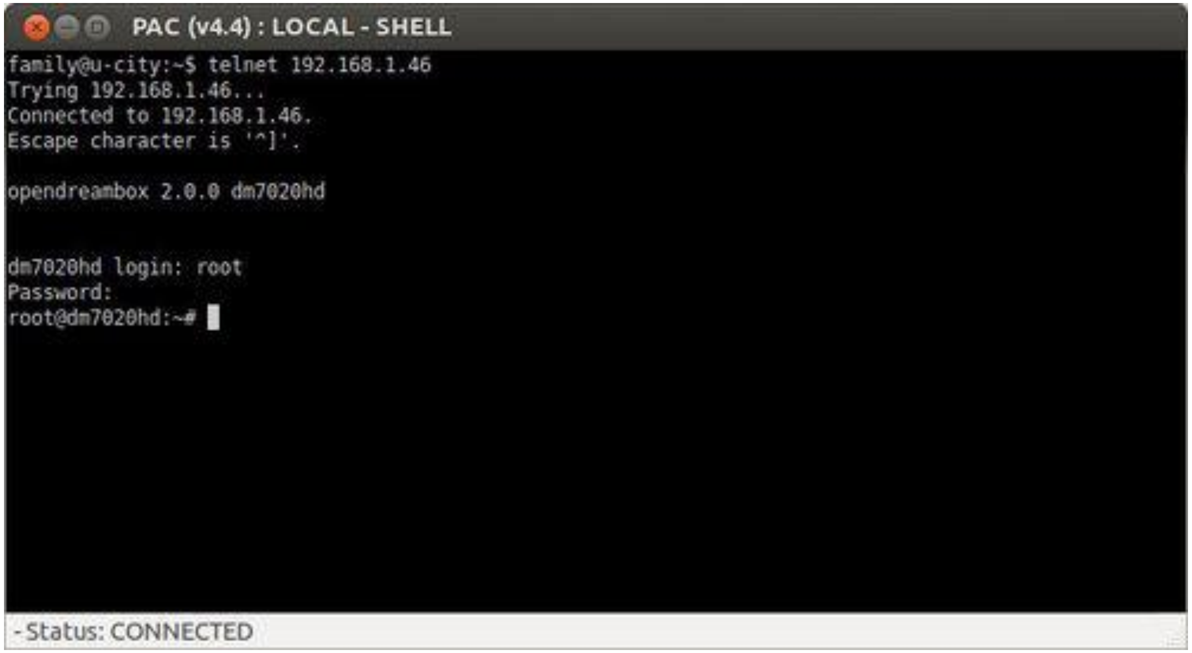
$ telnet <destination Address>

- The telnet is a protocol to enable the user at the client side to access a remote machine by opening a terminal on it

```
$ telnet 192.168.101.27
$ telnet bob@192.168.101.27
```

- The User will need to enter his login info
- A server application must be running on the destination machine to accept client connections
- Once connection is established, a **tty terminal** will be established on the remote machine that is controlled via the **Telnet session**
- Anything the user types is sent to the remote machine as if the user is using it

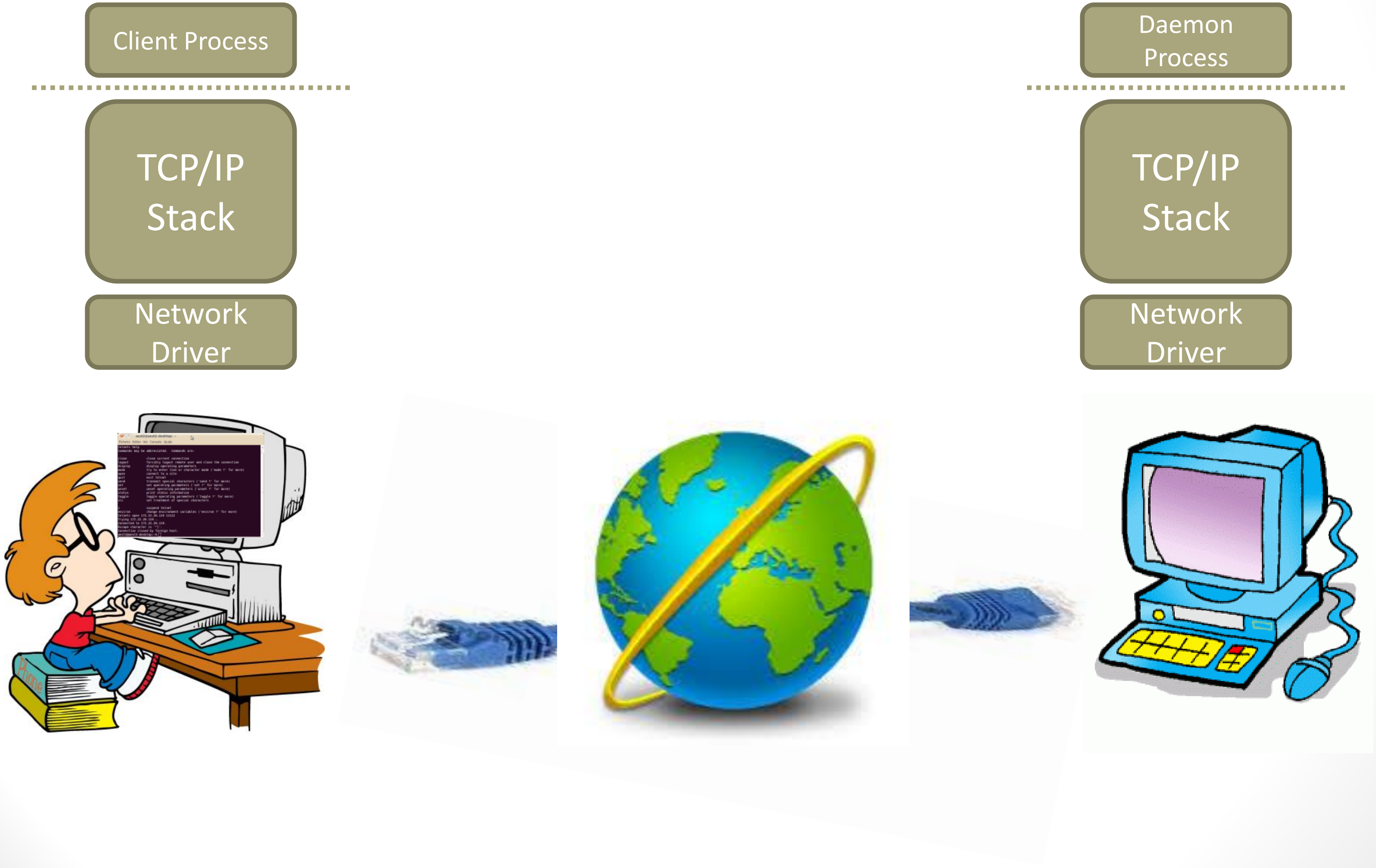
Remote Access of a Machine (telnet Protocol)



```
family@u-city:~$ telnet 192.168.1.46
Trying 192.168.1.46...
Connected to 192.168.1.46.
Escape character is '^]'.

opendreambox 2.0.0 dm7020hd


dm7020hd login: root
Password:
root@dm7020hd:~#
```

- After log-in is complete successfully, the user can perform any action that is done on normal terminal

Telnet



Client Process

TCP/IP Stack

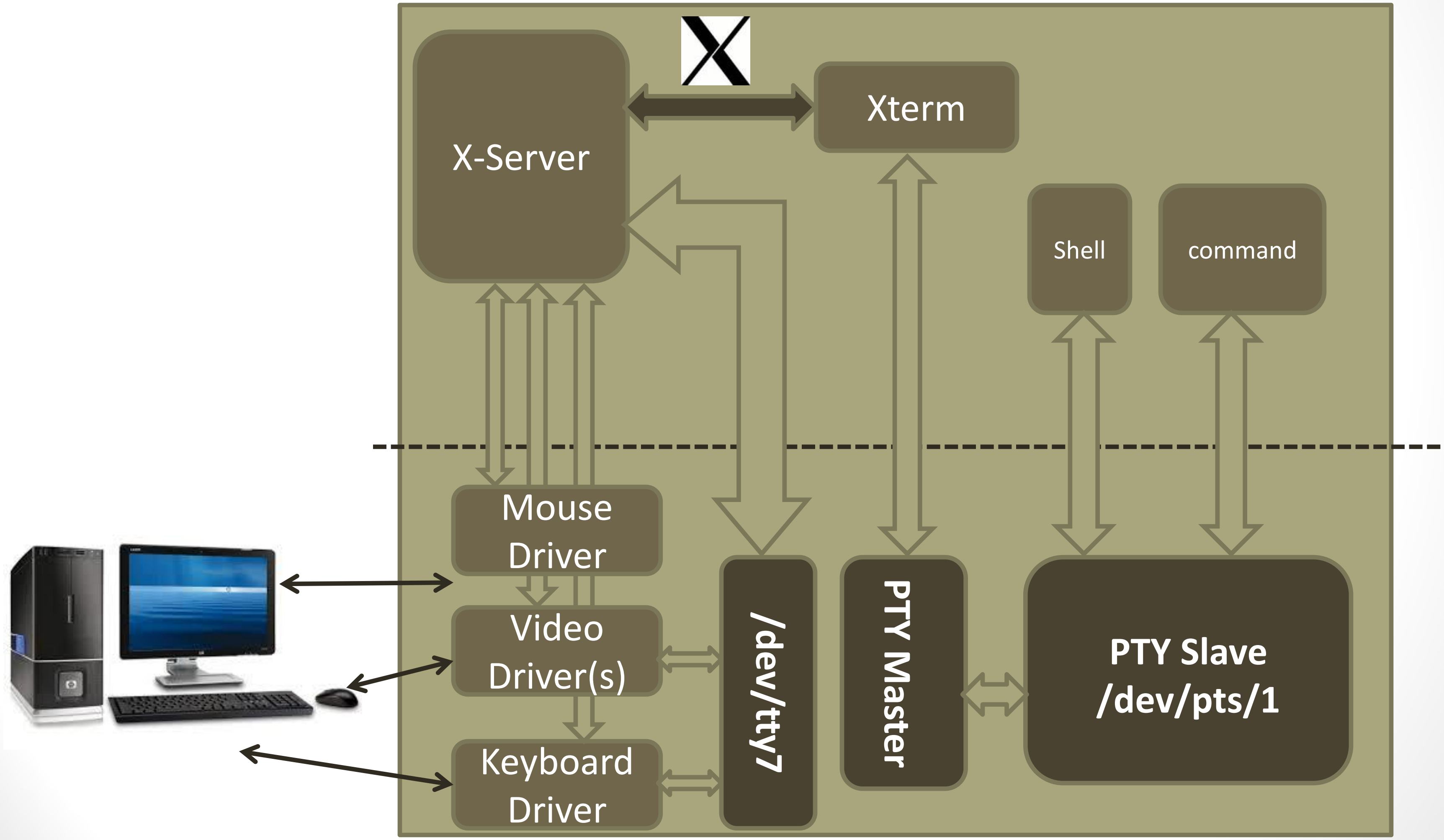
Network Driver

Daemon Process

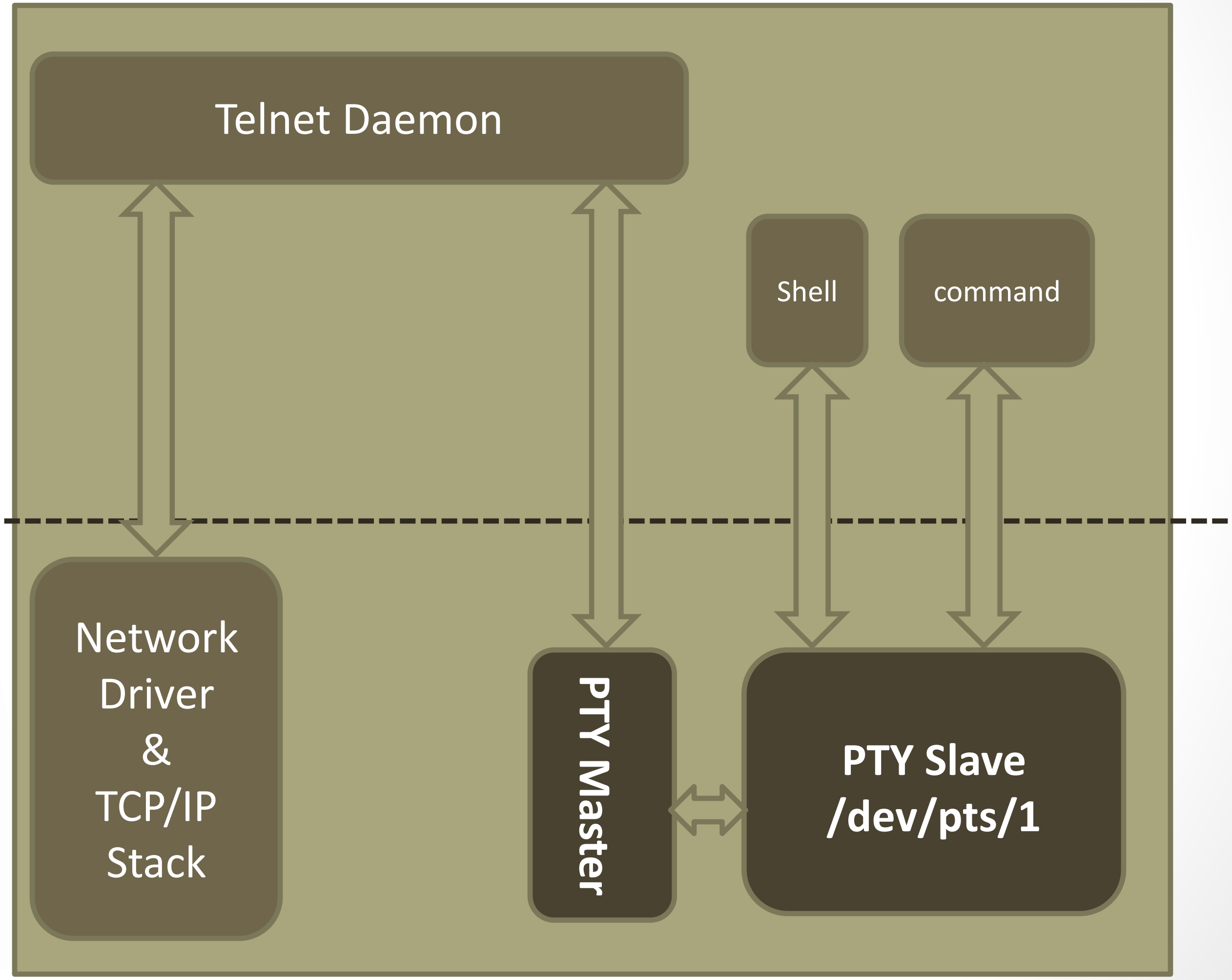
TCP/IP Stack

Network Driver

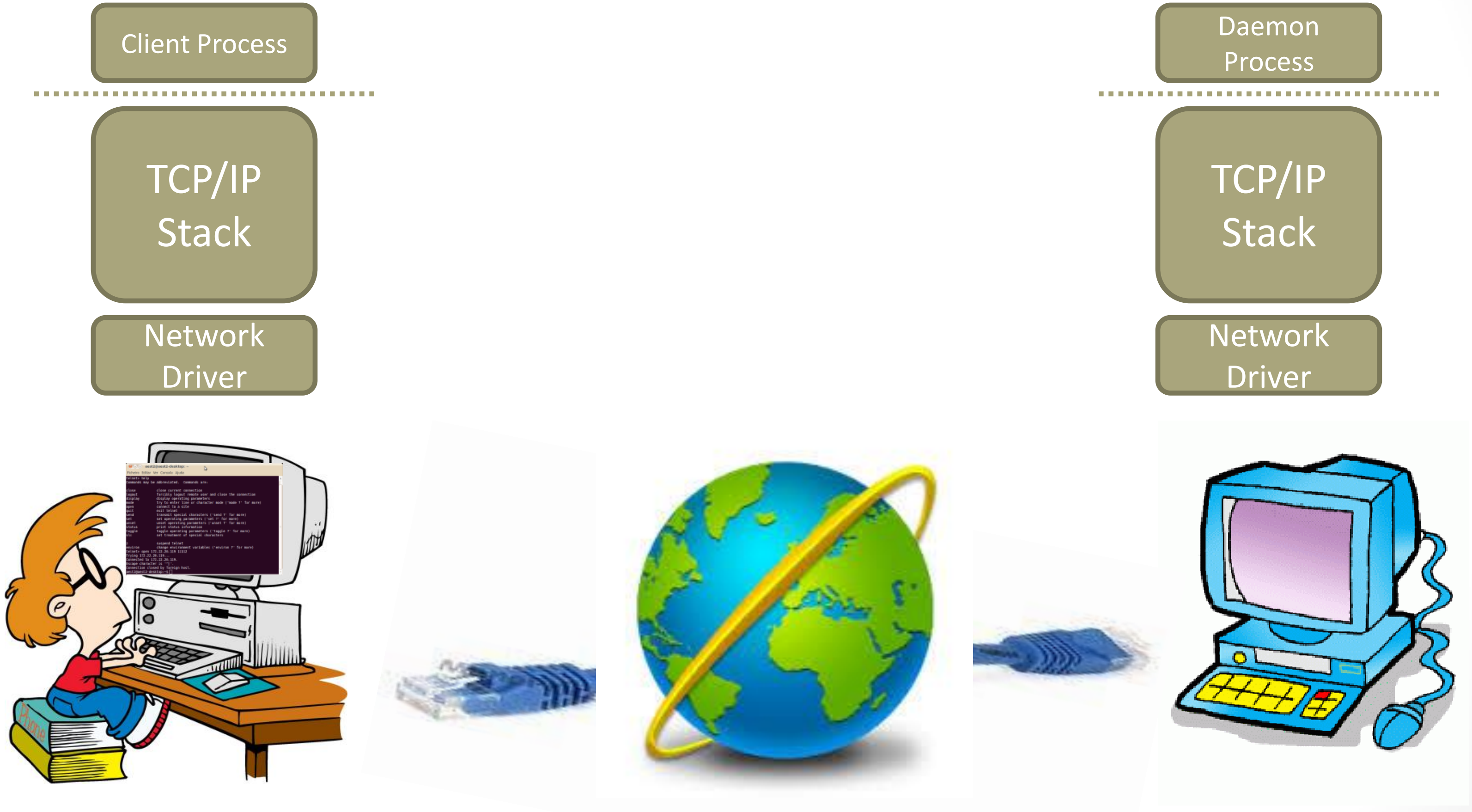
Logging in Using a Telnet Session…



Logging in Using a Telnet Session…



Transporting files (ftp protocol)



Client Process

TCP/IP Stack

Network Driver

Daemon Process

TCP/IP Stack

Network Driver

Transporting files (ftp protocol)

$ ftp <Remote Machine Addrress>

- This protocol enables the client to move files from/to the remote machine

```
$ ftp 192.168.101.12
$ ftp bob@192.168.101.12
```

- Sometimes an FTP server can allow anonymous login. In this case use,

Username: anonymous

Password: your email

- Once you login, you will be able to get/put files

```
$ get myfile.txt
$ mget *.exe
$ put my_picture.png
$ mput *.jpg
```

- To exit

```
$ bye
```

Security Concern

- Both Telnet and FTP do not use a secured connection
- Information travel between the local machine and the remote one in clear text
- This can be a big problem. A hacker can,
  - Listen to the message being sent
  - Modify the messages being sent
  - Send its own messages with false identity
- Sometimes, this is not a problem
  - Connecting to a machine in a secured environment
  - Connecting to an embedded platform within a isolated network
  - You don’t care about security
- Other times, this is not acceptable

Secure login to remote machines (ssh protocol)

$ ssh <destination Address>

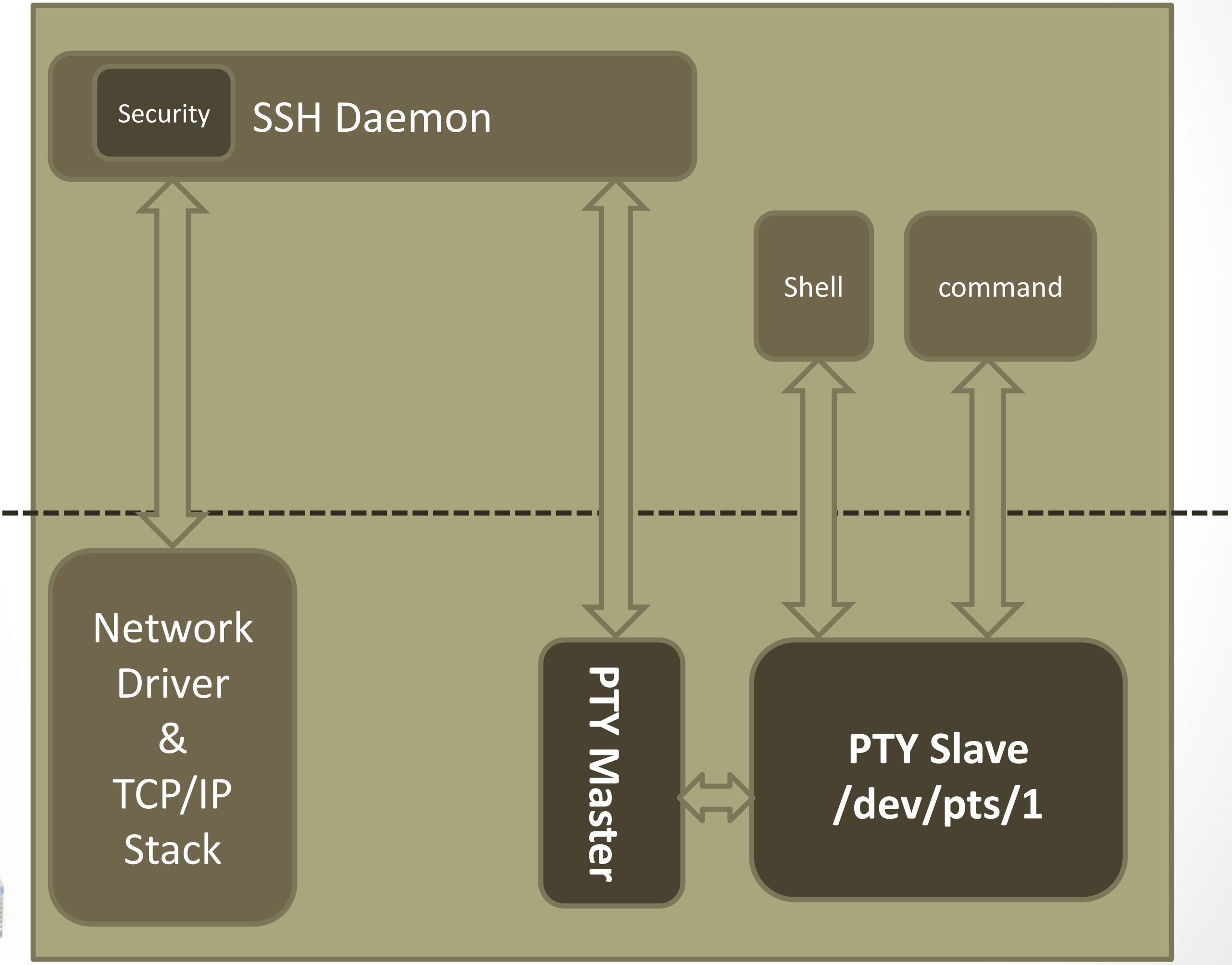
- This is similar to the telnet protocol except for that the connection will be secured (traffic will be encrypted)
- To login securely to a machine,

  $ ssh 192.168.101.100

  $ ssh bob@ 192.168.101.100

  $ ssh bob@tom-machine
- In the first time to connect to this machine, some confirmation will be requested to install the required keys for encryption
- Once connection is established, a **tty terminal** will be established on the remote machine that is controlled via the **SSH session**

Logging in Using a SSH Session…



Secure File Copy (scp Command)

```
$ scp <local filename> <user>@<remoteServer>:<remote-filename>
$ scp <user>@<remoteServer>:<remote-filename> <local filename>
```

- This command copies files from/to a remote machine
- It uses a secure channel similar to that of SSH
- Usage is similar to the ordinary copy command "***cp***" with the exception:
  - Remote filename is preceded by the remote server name, and optionally the user name
  - A username / password may need to be entered to complete the command

- The scp performs secure copy,

```
$ scp 192.168.101.13:my-doc.pdf  ./my-docs/
$ scp bob@192.168.101.13:my-doc.pdf  ./my-docs/
$ scp ./my-docs/*.pdf   bob@remoteServer:.
$ scp -r ./documents bob@202.11.1.20:.
```

Secure File Transfer (sftp Command)

$ sftp <remote Address>

- This command has a similar usage as the normal ***ftp*** command
- However, it uses an SSH connection to secure the file transfer

```
$ sftp 192.168.1.103
$ sftp bob@192.168.1.103
```

- It has the same interface as ftp
- Note that sftp does not require an ftp daemon on the remote machine since it uses the ssh connection

Downloading file from the Web (wget Command)

$ wget <URL of the file>

- Very useful tool for downloading files from the web from the command line

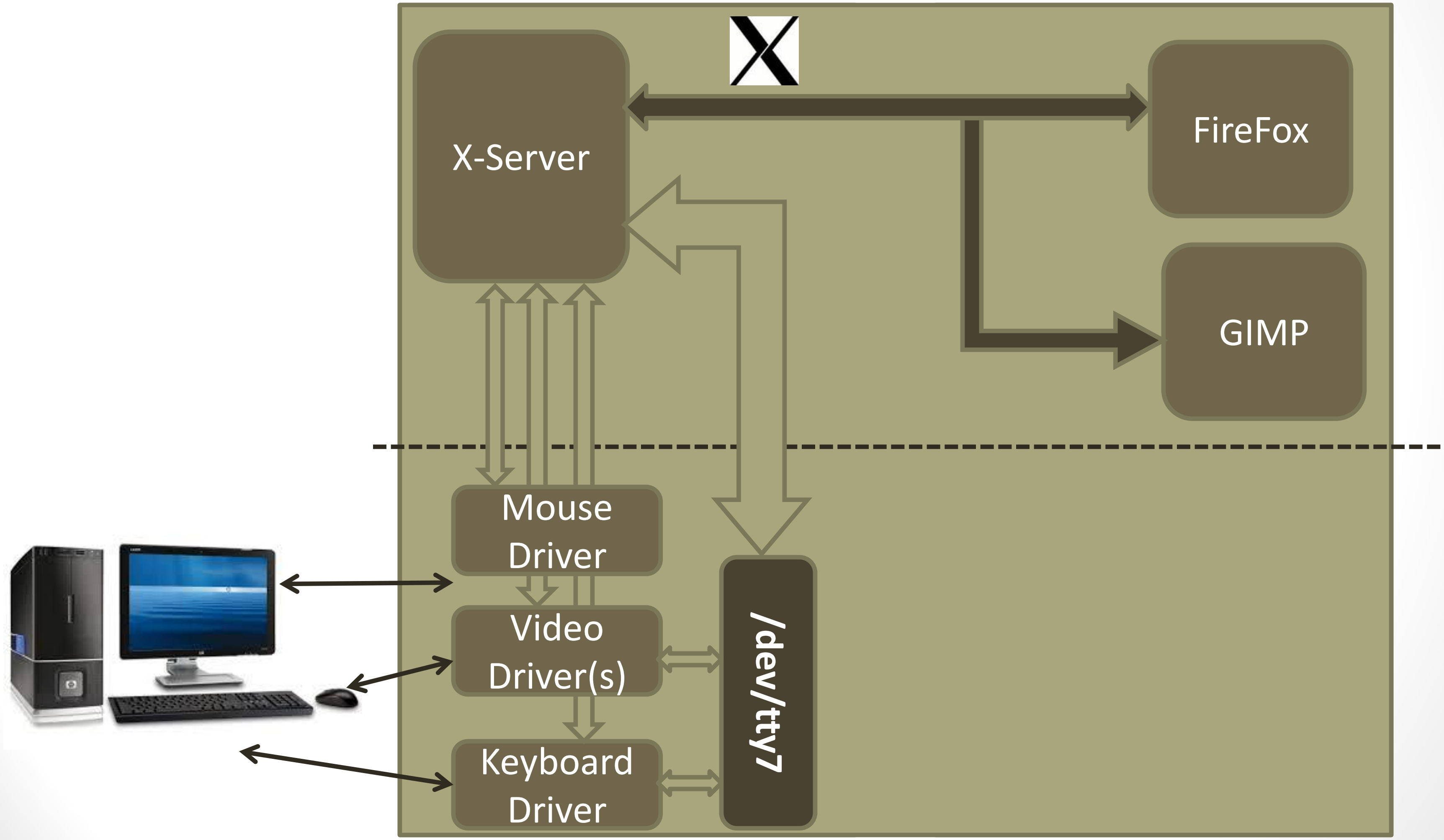
  $ wget http://www.my-web-site.com/file.xml

- Very useful in scripts that perform a download from the web

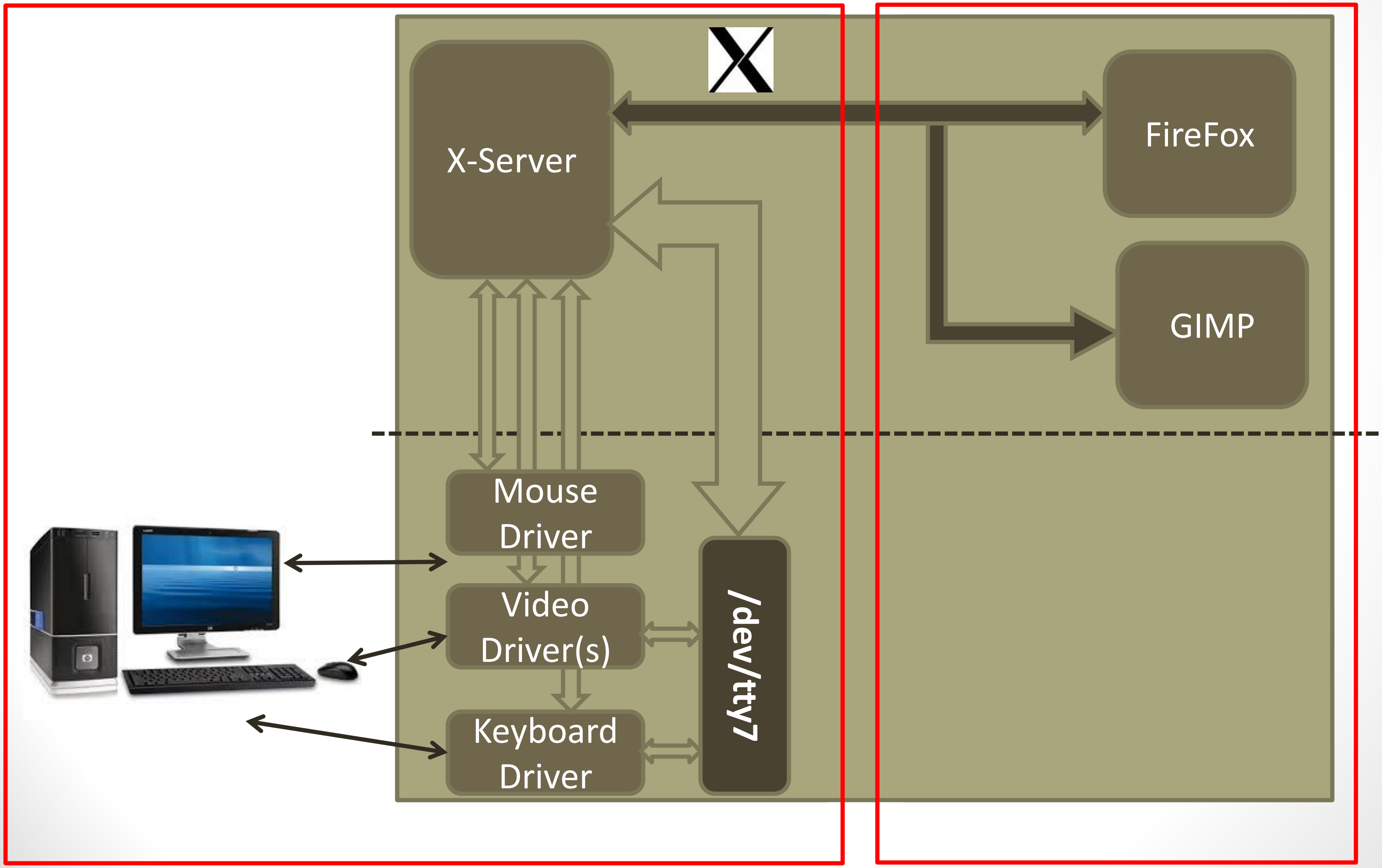
Remote Access the Desktop

- The access methods mentioned so far (Telnet and SSH) provide access to a text terminal in the remote machine
- However, sometimes we need to have remote access to the remote machine GUI
- We will need to access the GUI using our mouse and keyboard
- This can be achieved using two ways,
  - Running the X-server on the local machine, and connecting to the x-clients (applications) on the remote machine
  - Running a VNC Client-Server model

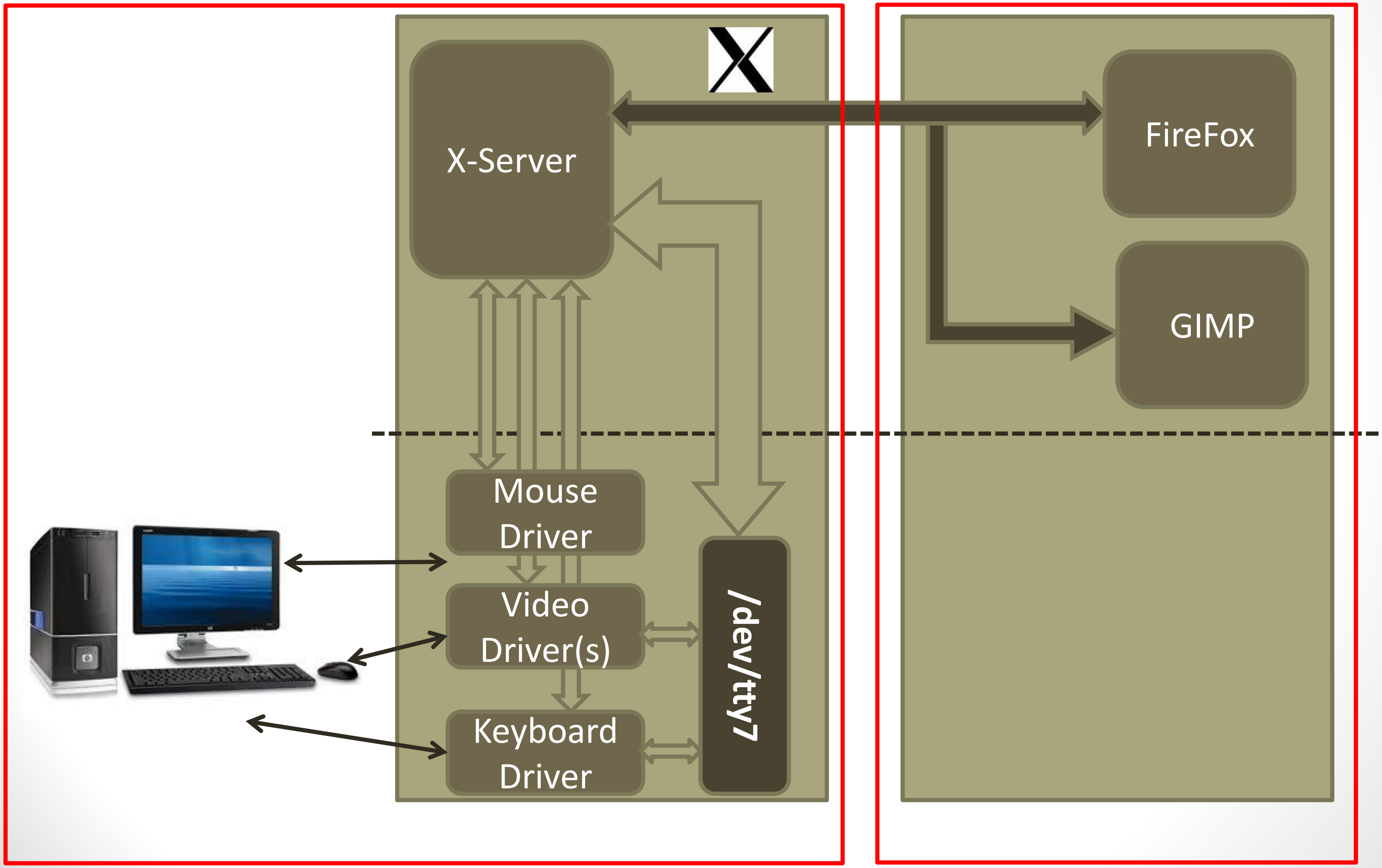
Using X-Server on the Local Machine



Using X-Server on the Local Machine



Using X-Server on the Local Machine



Using X-Server on the Local Machine (ssh –X Command)

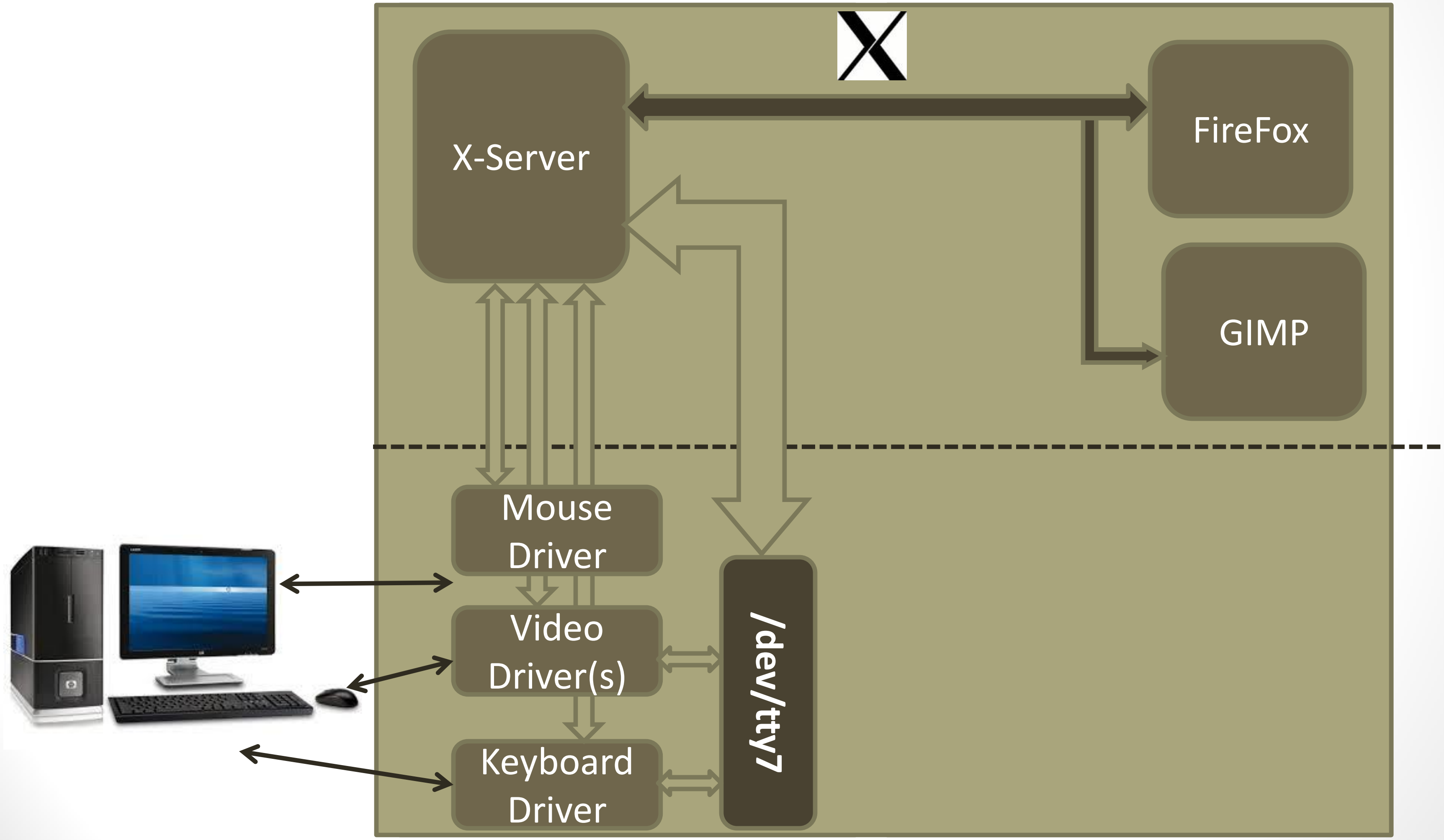
$ ssh -X <remote machine address>

- To establish SSH connection, along with X-Server running on the local machine, and the X-clients (applications) running on the remote machine

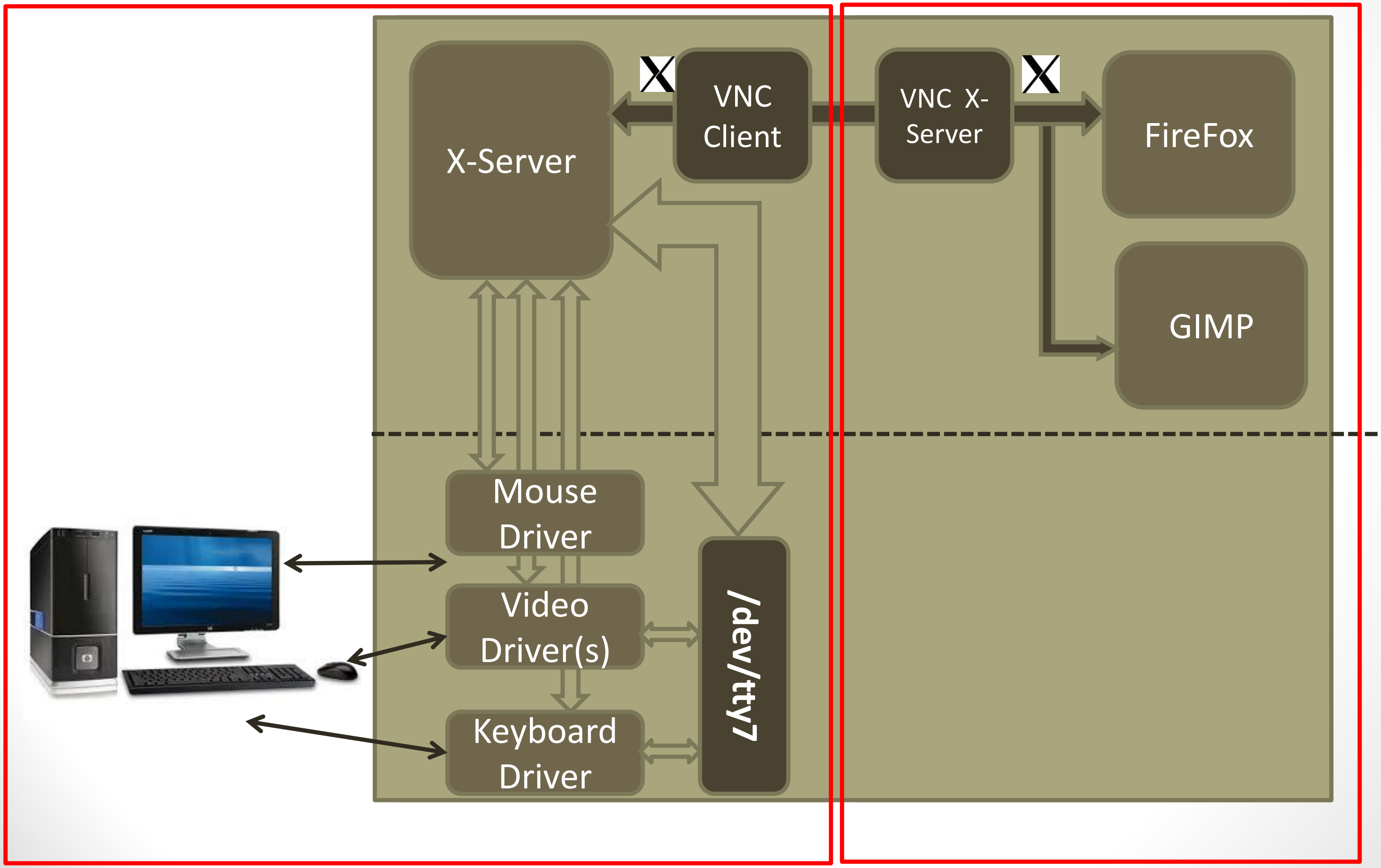
```
$ ssh -X bob@192.168.101.13
```

- This tunnels the X-Protocol massaging between the X-server, and the X-Clients in the SSH connection

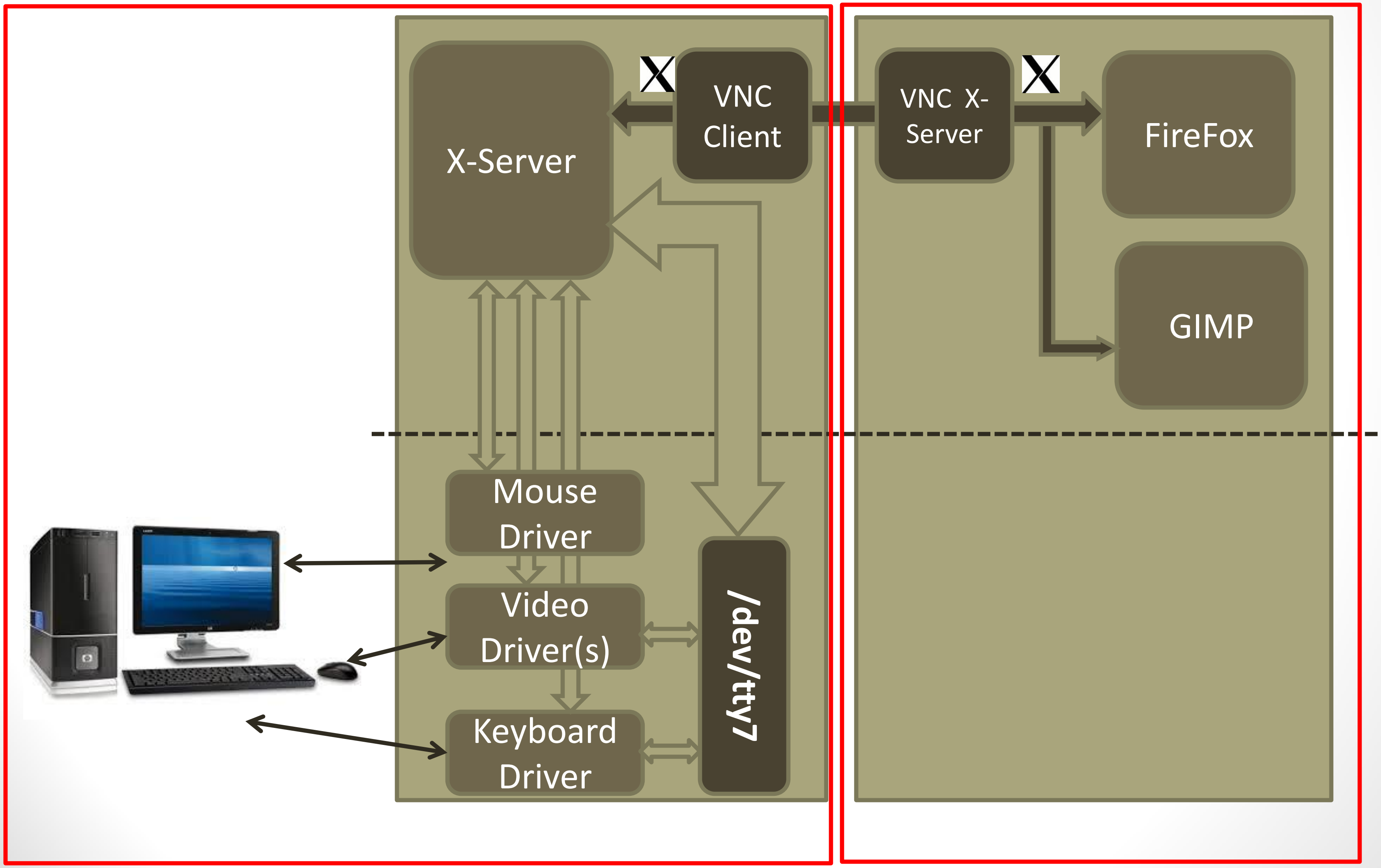
Using VNC


X-Server
FireFox
GIMP
Mouse Driver
Video Driver(s)
Keyboard Driver
/dev/tty7

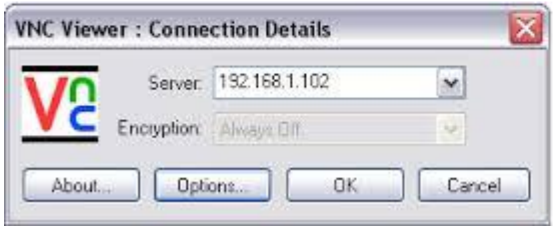
Using VNC


X-Server
X
VNC Client
VNC X-Server
X
FireFox
GIMP
Mouse Driver
Video Driver(s)
Keyboard Driver
/dev/tty7

Using VNC


X-Server
VNC Client
VNC X-Server
FireFox
GIMP
Mouse Driver
Video Driver(s)
Keyboard Driver
/dev/tty7

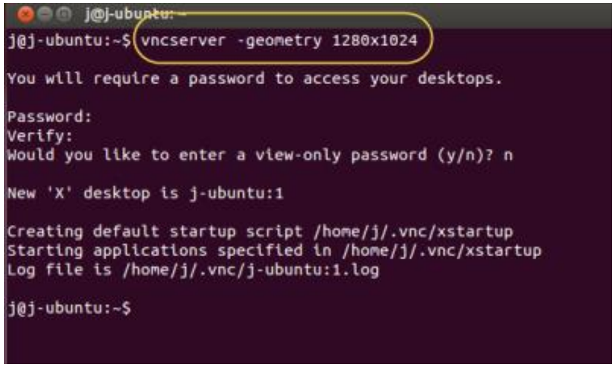
Using VNC



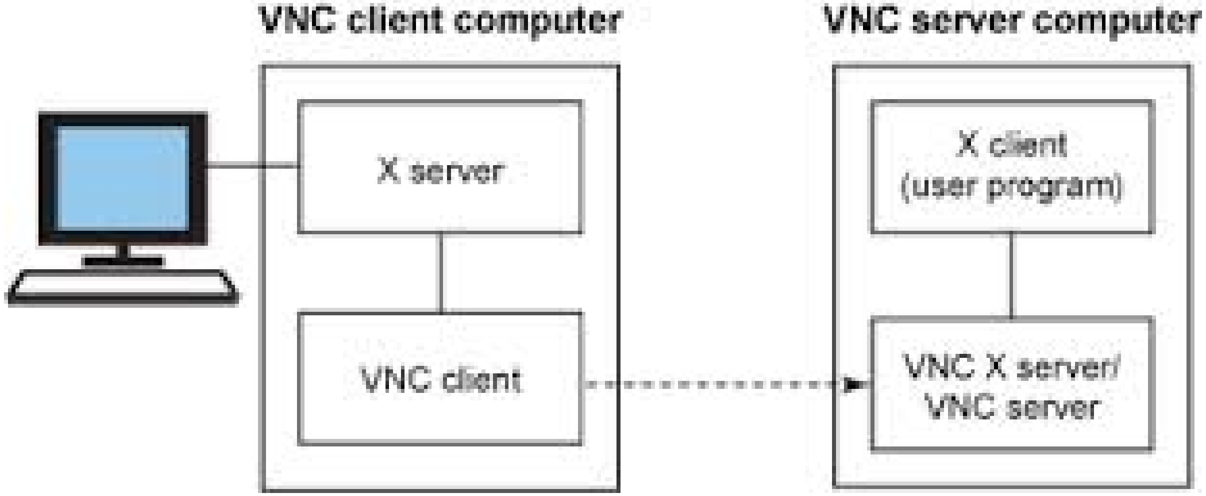
VNC Viewer : Connection Details

Server: 192.168.1.102

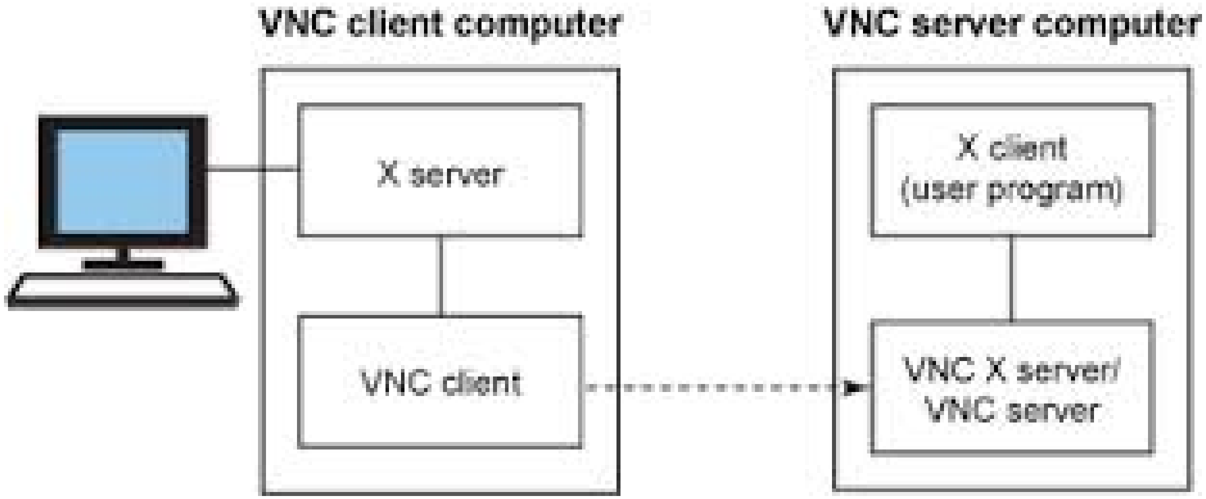
Encryption: Always Off

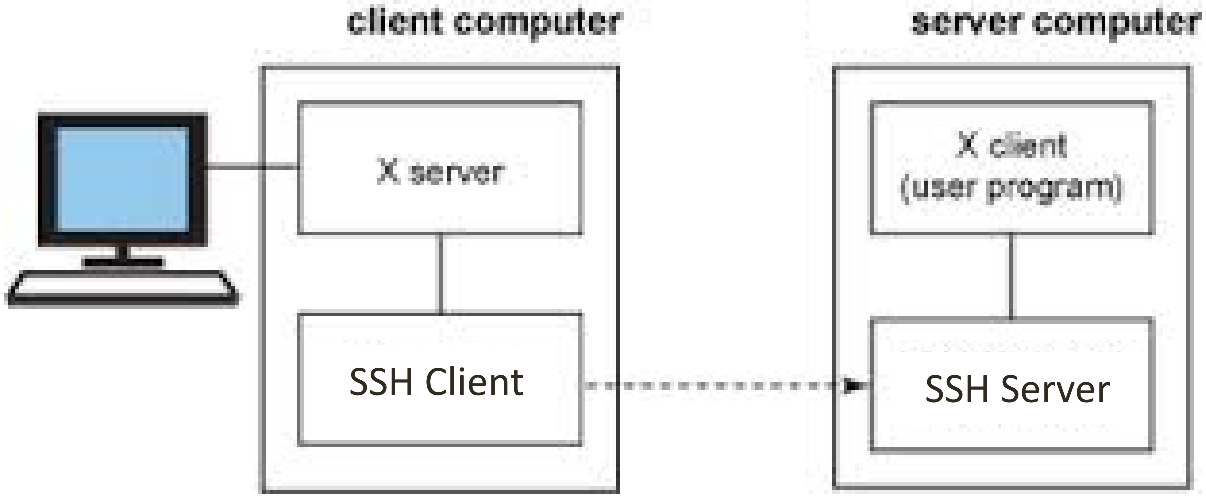


```
j@j-ubuntu: ~
j@j-ubuntu:~$ vncserver -geometry 1280x1024

You will require a password to access your desktops.

Password:
Verify:
Would you like to enter a view-only password (y/n)? n

New 'X' desktop is j-ubuntu:1

Creating default startup script /home/j/.vnc/xstartup
Starting applications specified in /home/j/.vnc/xstartup
Log file is /home/j/.vnc/j-ubuntu:1.log

j@j-ubuntu:~$
```

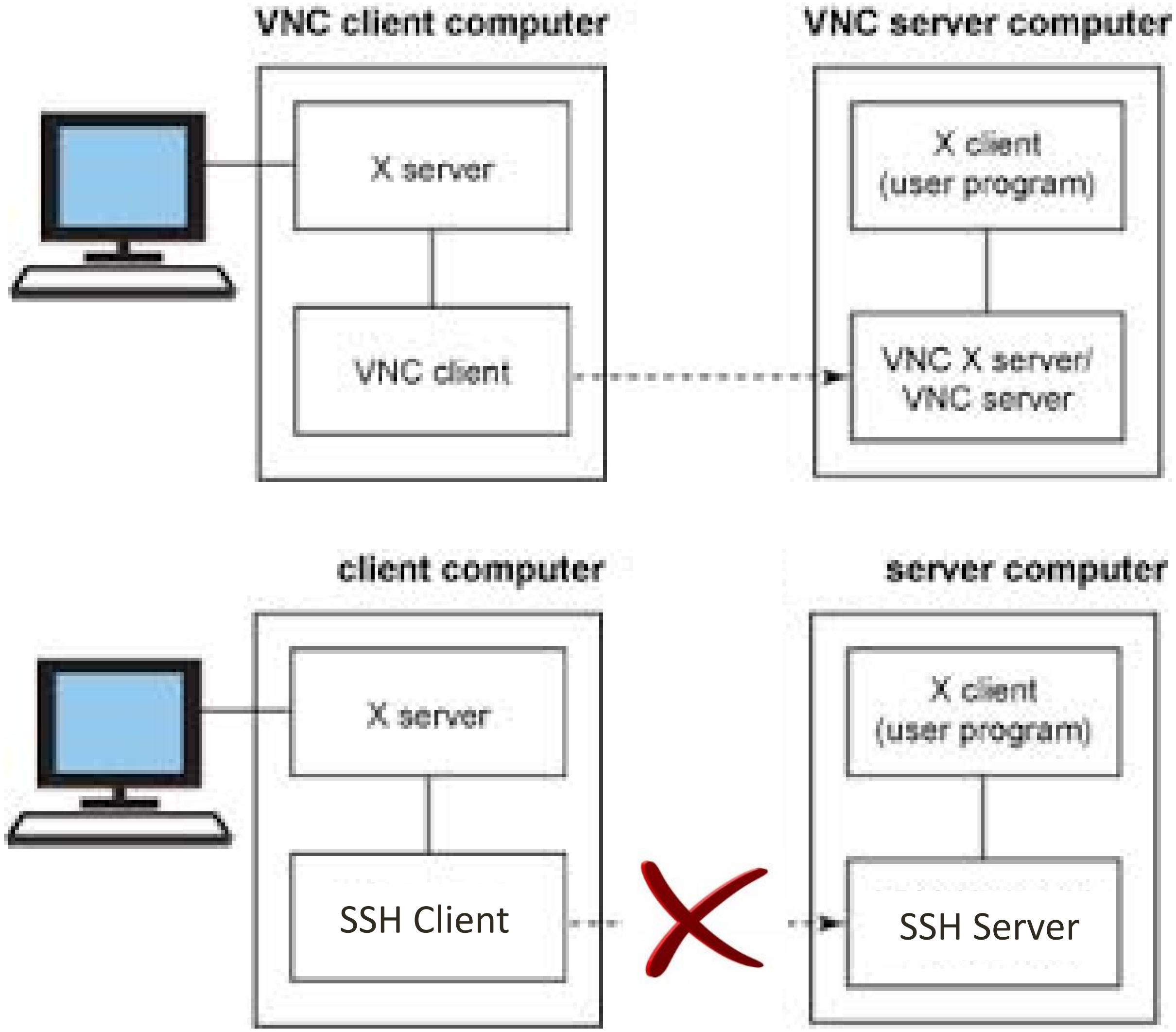


Comparison

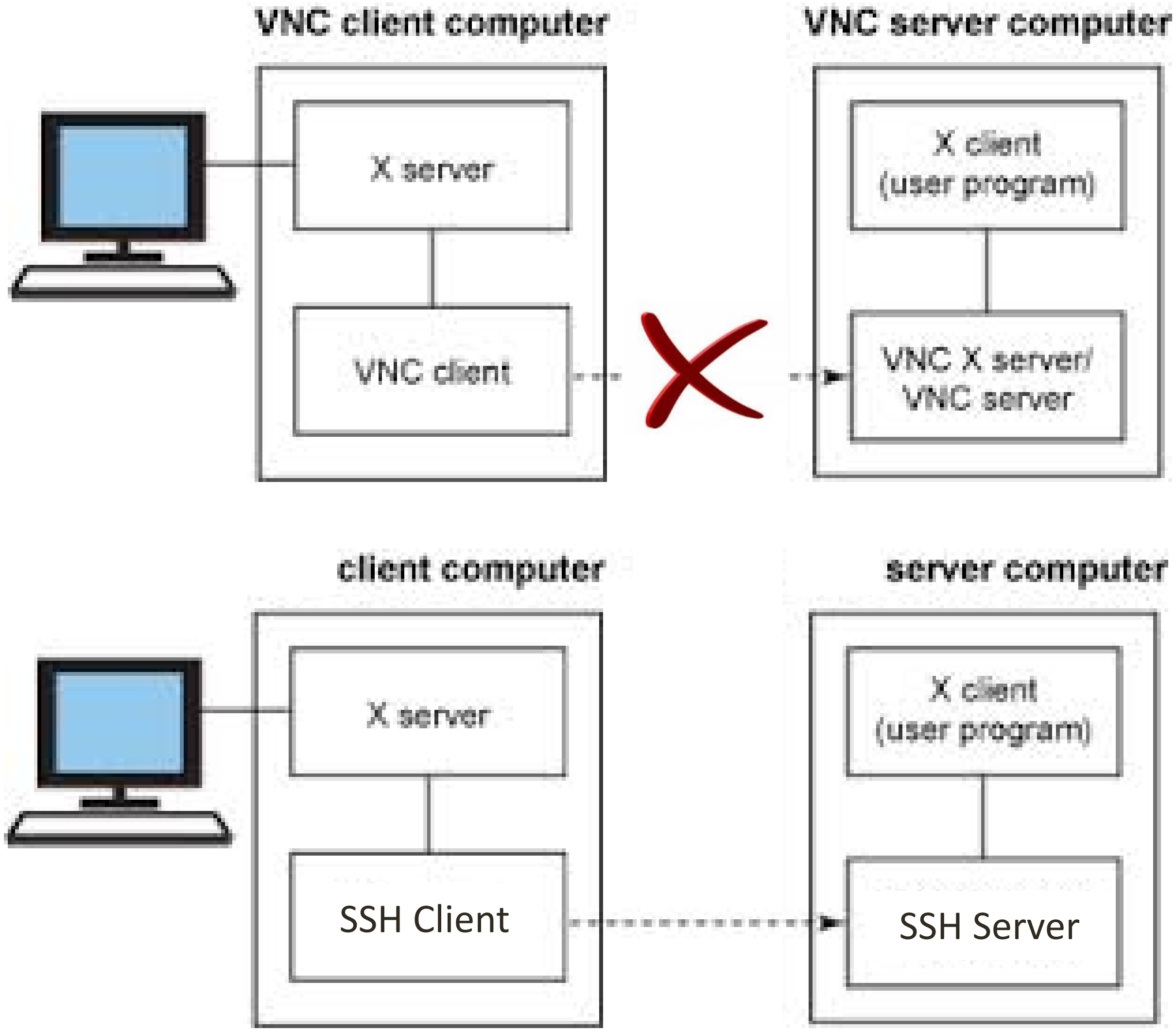

VNC client computer
VNC server computer
X server
VNC client
X client
(user program)
VNC X server/
VNC server


client computer
server computer
X server
SSH Client
X client
(user program)
SSH Server

Comparison


VNC client computer
VNC server computer
X server
X client
(user program)
VNC client
VNC X server/
VNC server
client computer
server computer
X server
X client
(user program)
SSH Client
SSH Server

Comparison


VNC client computer
VNC server computer
X server
VNC client
X client
(user program)
VNC X server/
VNC server
client computer
server computer
X server
SSH Client
X client
(user program)
SSH Server

Linux4

Embedded Systems

http://Linux4EmbeddedSystems.com