TCP RESET ATTACK ON SSH

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TCP RESET ATTACK

TCP connections can be closed if the RST bit in the header of a TCP packet is set. RST is one of the six code bits in the TCP header. If PC A is connected to PC B, the connection can be closed by any one of the connected nodes sending a reset packet to the other one. This approach is mainly used in emergency situations when some errors are detected.

Since a single packet can close a TCP connection, this can be used as an attack mechanism to close an established connection between two nodes. In order to break up a TCP connection between A and B, the attacker needs to spoof a TCP RST packet from A to B or from B to A.

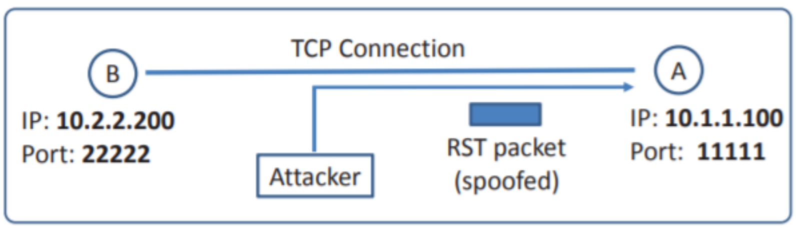


Figure: Attack Diagram of TCP Reset

The diagram above shows the attack diagram for TCP Reset for two PCs connected via a normal TCP connection.

The secure shell (SSH) protocol

The SSH protocol (also referred to as Secure Shell) is a method for secure remote login from one computer to another. It provides several alternative options for strong authentication, and it protects the communications security and integrity with strong encryption. However, the encryption is done in the transport layer, which means only the data in the TCP packets are encrypted. TCP Reset attack only needs to access the header of the packets, which are not encrypted. So the attack can be launched on an SSH connection.

The SSH protocol works in the client-server model. This means that the connection is established by the SSH client connecting to the SSH server. The SSH client drives the connection setup process and uses public key cryptography to verify the identity of the SSH server. After the setup phase the SSH protocol uses strong symmetric encryption and hashing algorithms to ensure the privacy and integrity of the data that is exchanged between the client and server.

The standard TCP port 22 has been assigned for contacting SSH servers.

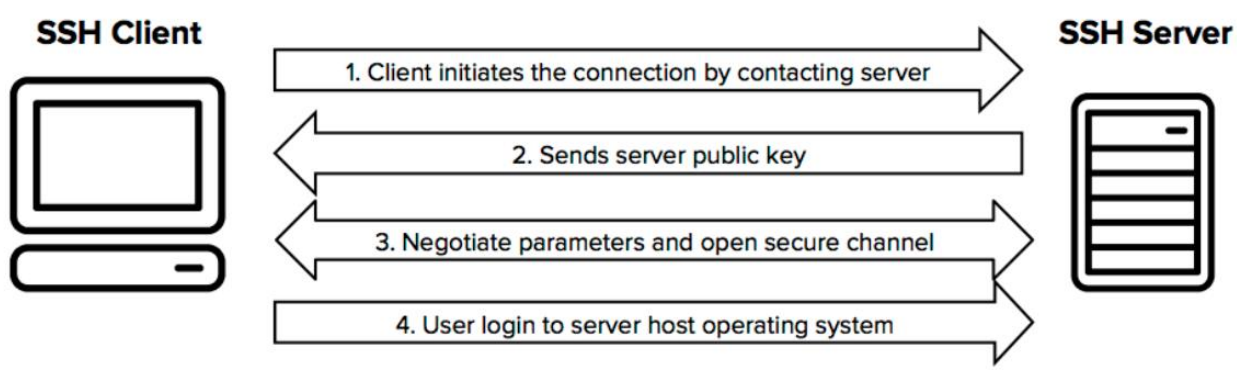


Figure: The SSH client-server model.

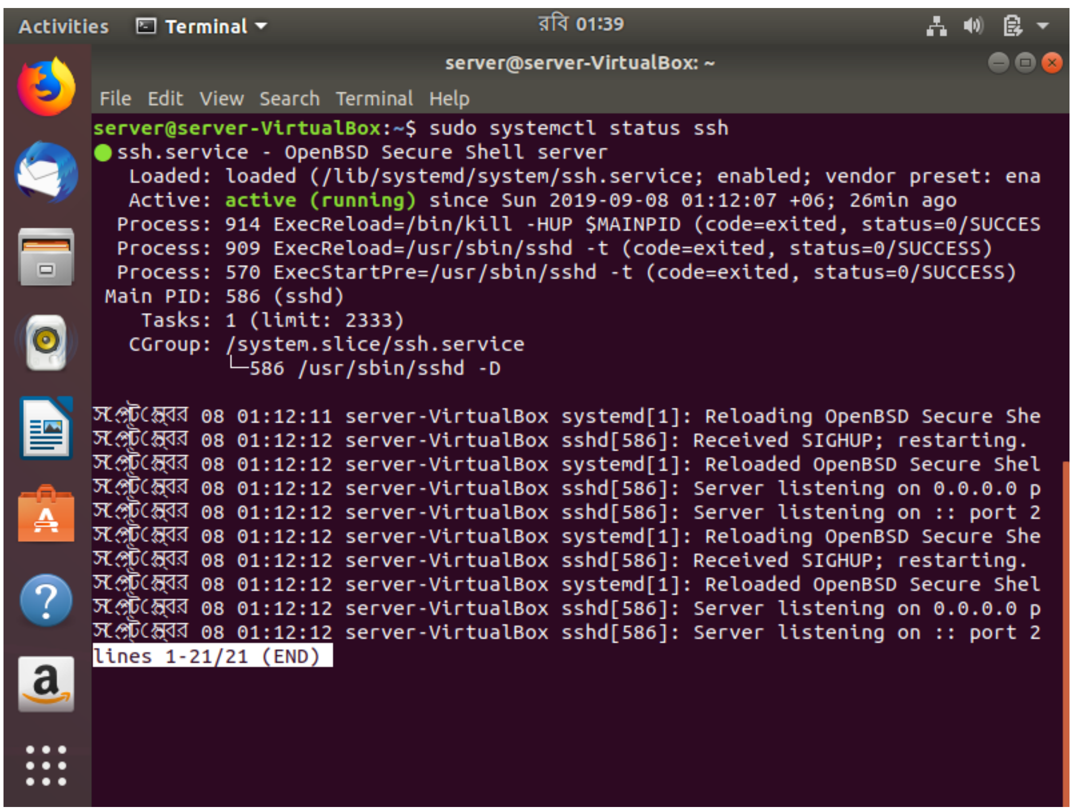
The figure above shows the steps by which a SSH client connects to an SSH server.

<u>Steps of the attack</u>

The steps that have been followed to demonstrate the attack are as follows:

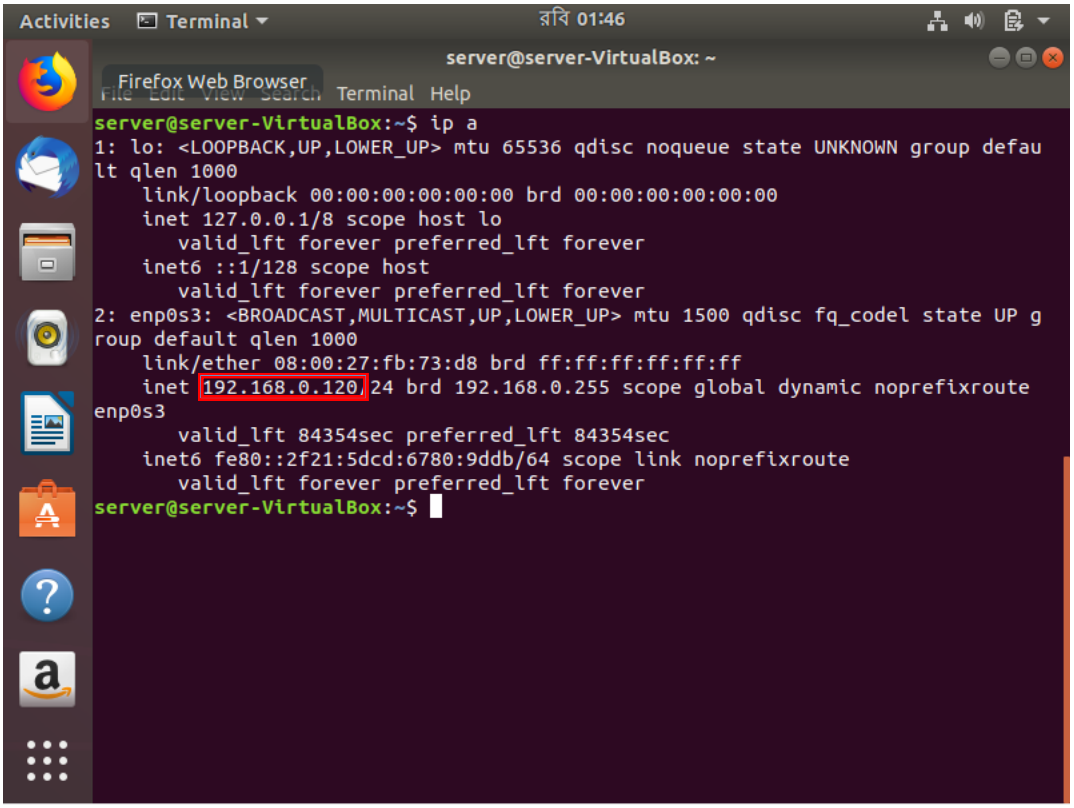
1. Three Ubuntu PCs have been set up using **Oracle VM VirtualBox**. The three PCs were connected to the same LAN via the same router. This was ensured by enabling **promiscuous mode** in all of the three machines. The three PCs have been referred to as **attacker, server** and **client** for the rest of this report.

2. An SSH connection have been set up between the **server** and the **client.** To do this from scratch, the following needs to be done:
    a. From the **server** PC, SSH needs to be installed. After successful installation, the SSH server should be up and running. This can be checked by executing the following command from the **server:**



The active (running) indicates that the SSH server is running from the **server PC.**

b. The **IP address of the server** needs to be known, as it will be needed by the **client** to connect to the **server.** This can be done by executing the following command from the **server:**



The **IP address** of the server has been shown in a red frame in the above screenshot. As it can be seen, the **IP address** of the **server** is **192.168.0.120.**

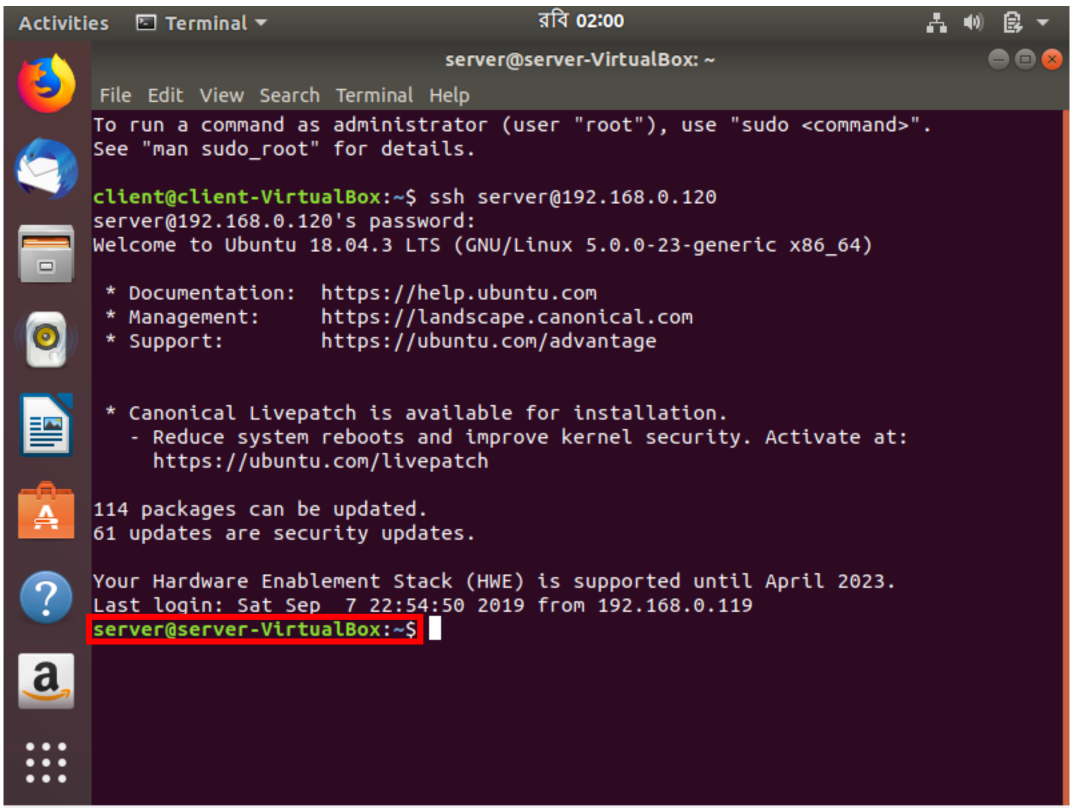
c. SSH clients can connect to SSH servers by using the following command:

```
ssh  server_name@server_ip_address
```

Here, server_name is the name of the server PC. In this case, as seen from the screenshots above, the name of the server PC is “server”. The server_ip_address is the **IP address** of the server PC. In our case, this was found out to be **192.168.0.120** in the previous step. From the **client PC,** the following command needs to be executed to connect to the server that has been set up:

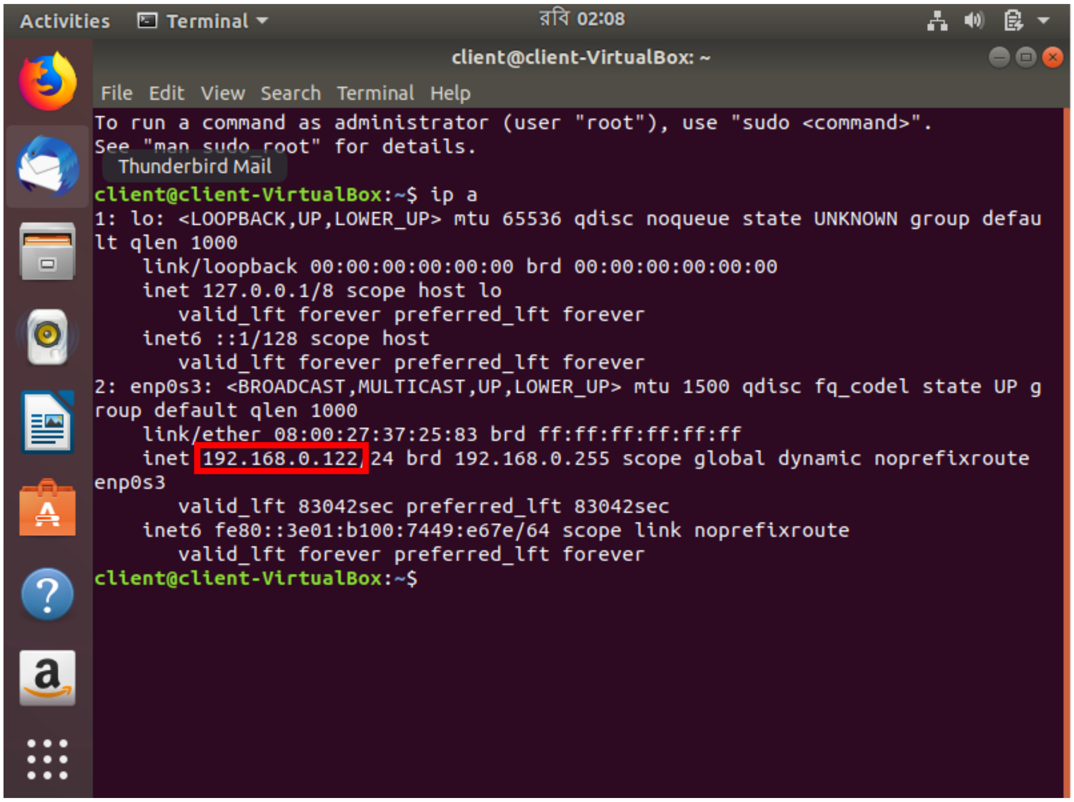
```
ssh server@192.168.0.120
```

The screenshot below shows the result of running this command from the **client PC:**



The command will prompt the user to enter the **server PC's** password. Upon entering the correct password, a remote connection will be set from the **client PC** to the **server PC.** This can be observed by the fact that the directory in the **client's** terminal actually points to the **server's** home directory, as shown in the red frame. This shows that an **SSH connection has been successfully established.**

d. For further demonstration, the **client's IP address** is also noted.

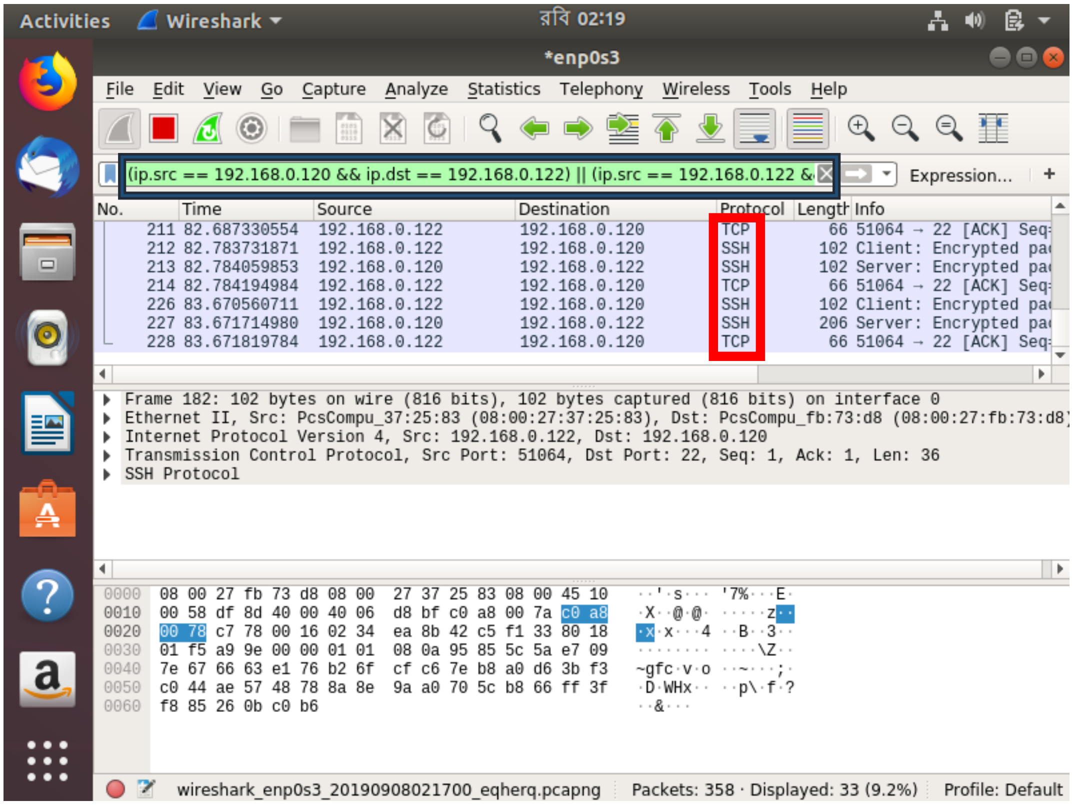


As seen from the screenshot above, the **client's IP address** is found to be **192.168.0.122.**

3. From the **attacker** PC, the following have been done:

   a. **scapy** and **Wireshark** have been installed, as prerequisites of demonstrating the attack.

   b. To demonstrate that the **attacker** is capable of capturing packets from the **client** to the **server,** and vice versa, Wireshark is opened from the **attacker PC**, and a filter is applied to show all captured traffic between the **server** and the **client.** This is shown in the screenshot below:



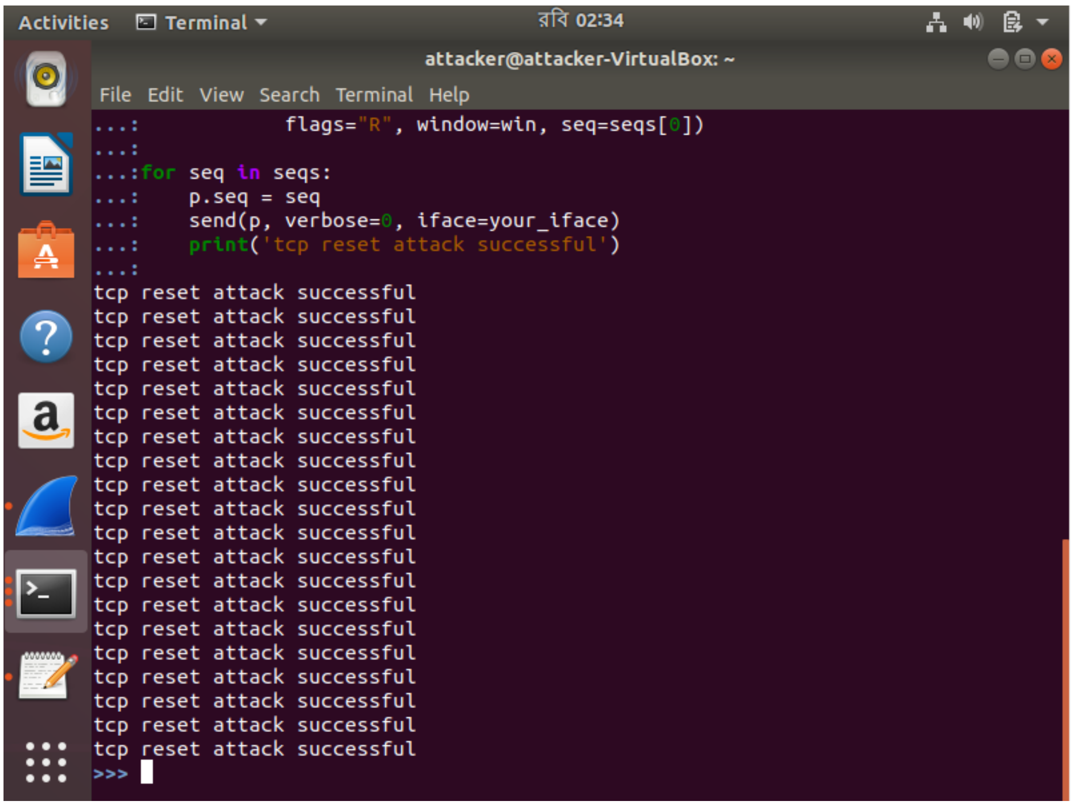
The blue frame in the screenshot above shows the filter that has been applied to view packets between the **server** and **client** only. The red frame shows that the **server** and the **client** are communicating via the **TCP** and **SSH** protocols. This proves that a successful **SSH connection** exists between them. This capturing was done from the **attacker PC**, proving that the **attacker** has the ability of capturing, and hence, sniffing packets from between the **server** and the **client.**

4. The code for the attack has been written in python, using scapy. The code sniffs in a packet between the SSH server and the SSH client. This will be possible as long as the **attacker**, the **client** and the **server** are connected to the same network. A **range of sequence numbers** is then set, starting from the **ack** of the sniffed packet to a predefined maximum value. A **forged packet** is then constructed. The **source IP address**, **destination IP address, source port number** and **destination port number** of this forged packet are set to be those of the sniffed packet. The **Reset Bit** of the forged packet is set. A loop then sends a series of packets to the victim's machine, with the sequence number of every

packet being set consecutively to a number taken from the range of sequence numbers mentioned earlier.

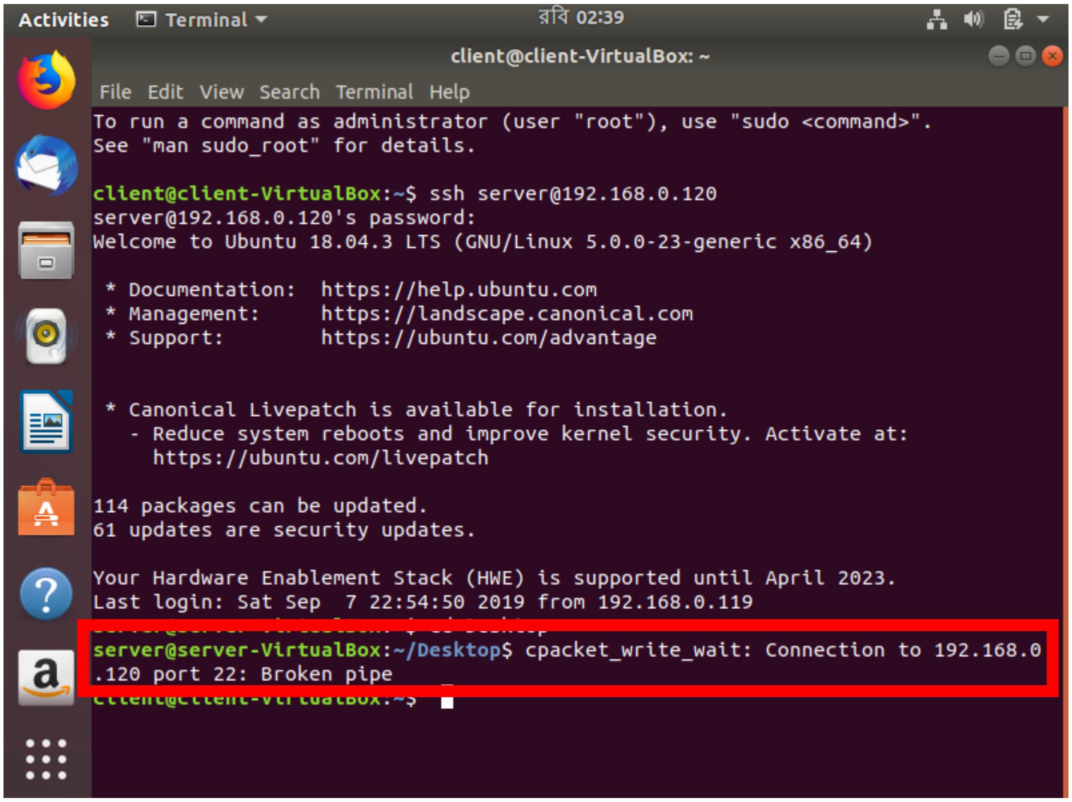
The code will take in the IP address of either the SSH server or the SSH client as its input. These have already been found out in previous steps.

The following screenshot shows the result of running the code from the **attacker PC,** with the **server**'s IP address given as input into the code**:**



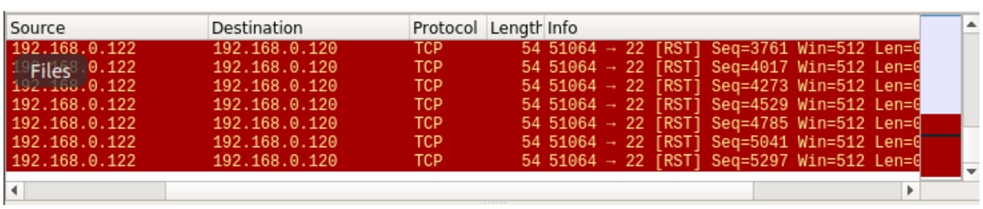
The code prints “tcp reset successful” every time it sends a forged packet with a different sequence number to the server.

A successful attack will **break the SSH connection** between the **server** and the **client.** This can be observed from the **client** with a notification that reads “Broken pipe”. This is shown in the screenshot below:



As shown in the red frame of the screenshot above, the connection to the **server(192.168.0.120, port 22)** has been broken. **Port 22** is the port over which **TCP connection** for **SSH** is normally established.

The success of the attack can be further assessed by observing the traffic between the **server** and the **client**, from the **attacker,** by using **Wireshark.**



The screenshot above has been taken from Wireshark running in the **attacker PC.** It clearly shows that **TCP RST packets** have been received from the client to the server. This can be seen by the **[RST]** bits under the “info” section of the screenshot.

Therefore, the **TCP RST attack has been successful.**

Possible Countermeasures against TCP RESET attacks

- Choosing sequence numbers (seq's) and acknowledgement numbers (ack's) "randomly" will help to prevent TCP Reset attacks. The attack depends largely on the attacker's ability to "guess" the ack of recent packets between the connections they are trying to break. Assignment of seq's and ack's in a way that is only known to the source and the receiver, but appears random to the attacker, will help prevent TCP Reset attack.

- TCP pacing is a technique where the TCP packet sources can space the data packets to be sent away from each other, so that it is possible to mitigate the burst packet transmissions. TCP Reset attack will lead to denial of service attacks, leading to congestions and eventual packet losses. By preventing burst transmissions, the durations of congestions and dropping of packets by the receiver will be reduced.