

Date: 31/01/2024

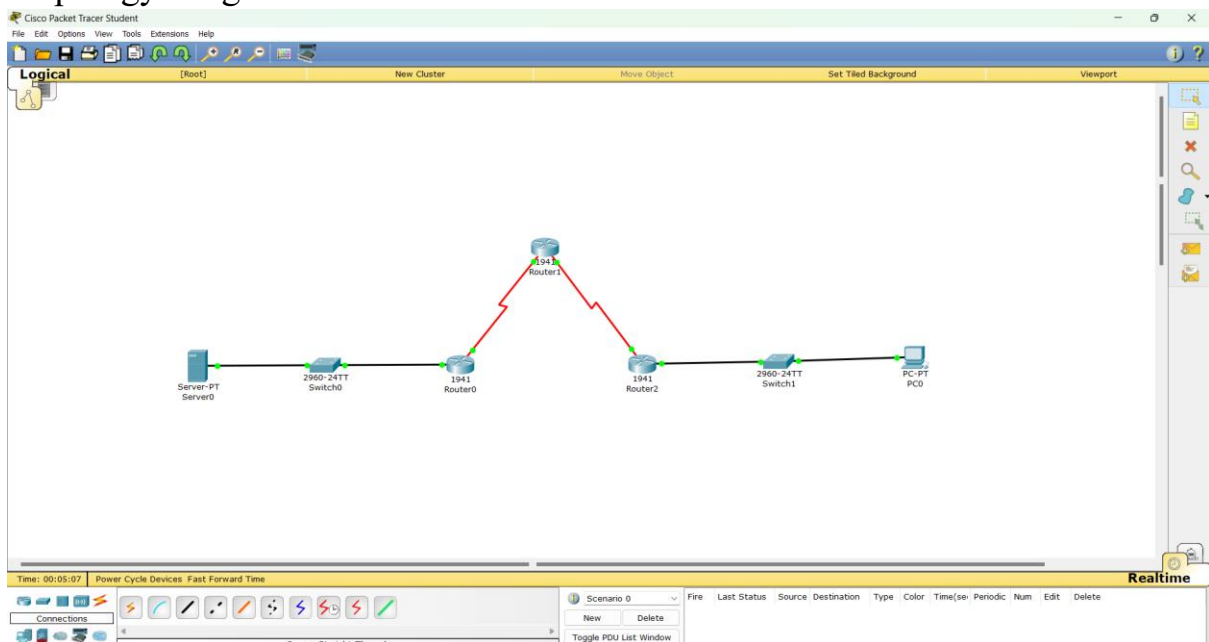
Security in Computing

### Practical 4:

Aim: Configure IP ACLs to Mitigate Attacks

- a. Verify connectivity among devices before firewall configuration.
- b. Use ACLs to ensure remote access to the routers is available only from management station PC-c.
- C Configure ACLs on to mitigate attacks.

### Topology Diagram



### Assign IP Addresses

The screenshot shows the 'IP Configuration' window for a device named 'Server'. The window has tabs for 'Physical', 'Config', 'Services', 'Desktop', and 'Custom Interface'. The 'Config' tab is selected. The 'Interface' dropdown is set to 'FastEthernet0'. The 'IP Configuration' section has two radio buttons: 'DHCP' and 'Static'. The 'Static' radio button is selected. The fields are filled with the following values:

Field	Value
IP Address	192.168.1.3
Subnet Mask	255.255.255.0
Default Gateway	192.168.1.1
DNS Server	

PC

Physical Config Desktop Custom Interface

## IP Configuration

IP Configuration

☐ DHCP ☒ Static

IP Address

Subnet Mask

Default Gateway


DNS Server

R1

Physical Config CLI

## IOS Command Line Interface

```
Router>en
Router#config t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#host R1
R1(config)#interface Serial0/0/0
R1(config-if)#ip address 10.1.1.1 255.255.255.252
R1(config-if)#no shut
R1(config)#interface GigabitEthernet0/1
R1(config-if)#ip address 192.168.1.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#^Z
R1#
%SYS-5-CONFIG_I: Configured from console by console
R1#exit
```

 R2


PhysicalConfigCLI

IOS Command Line Interface

```
Router>en
Router#config t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#host R2
R2(config)#interface Serial0/0/0
R2(config-if)#ip address 10.1.1.2 255.255.255.252
R2(config-if)#no shut
R2(config-if)#interface Serial0/0/1
R2(config-if)#ip address 10.2.2.2 255.255.255.252
R2(config-if)#no shut
R2(config-if)#int loopback1

R2(config-if)#
%LINK-5-CHANGED: Interface Loopback1, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed state to up
ip address 192.168.2.1 255.255.255.0
R2(config-if)#no shut
R2(config-if)#^Z
R2#
%SYS-5-CONFIG_I: Configured from console by console
exit
```

 R3

PhysicalConfigCLI

IOS Command Line Interface

```
Router>en
Router#config t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#host R3
R3(config)#interface Serial0/0/0
R3(config-if)#interface Serial0/0/1
R3(config-if)#ip address 10.2.2.1 255.255.255.252
R3(config-if)#no shut
R3(config-if)#interface GigabitEthernet0/1
R3(config-if)#ip address 192.168.3.1 255.255.255.0
R3(config-if)#no shut
R3(config-if)#^Z
R3#
%SYS-5-CONFIG_I: Configured from console by console
exit
```

## Displaying IP Address Details of Routers

R1

Physical Config CLI

IOS Command Line Interface

```
R1>show ip interface brief
```

Interface	IP-Address	OK?	Method	Status	Protocol
GigabitEthernet0/0	unassigned	YES	manual	administratively down	down
GigabitEthernet0/1	192.168.1.1	YES	manual	up	up
Serial10/0/0	10.1.1.1	YES	manual	up	up
Serial10/0/1	unassigned	YES	unset	administratively down	down
Vlan1	unassigned	YES	unset	administratively down	down

R2

Physical Config CLI

IOS Command Line Interface

```
R2>show ip interface brief
```

Interface	IP-Address	OK?	Method	Status	Protocol
GigabitEthernet0/0	unassigned	YES	unset	administratively down	down
GigabitEthernet0/1	unassigned	YES	unset	administratively down	down
Serial10/0/0	10.1.1.2	YES	manual	up	up
Serial10/0/1	10.2.2.2	YES	manual	up	up
Loopback1	192.168.2.1	YES	manual	up	up
Vlan1	unassigned	YES	unset	administratively down	down

R3

Physical Config CLI

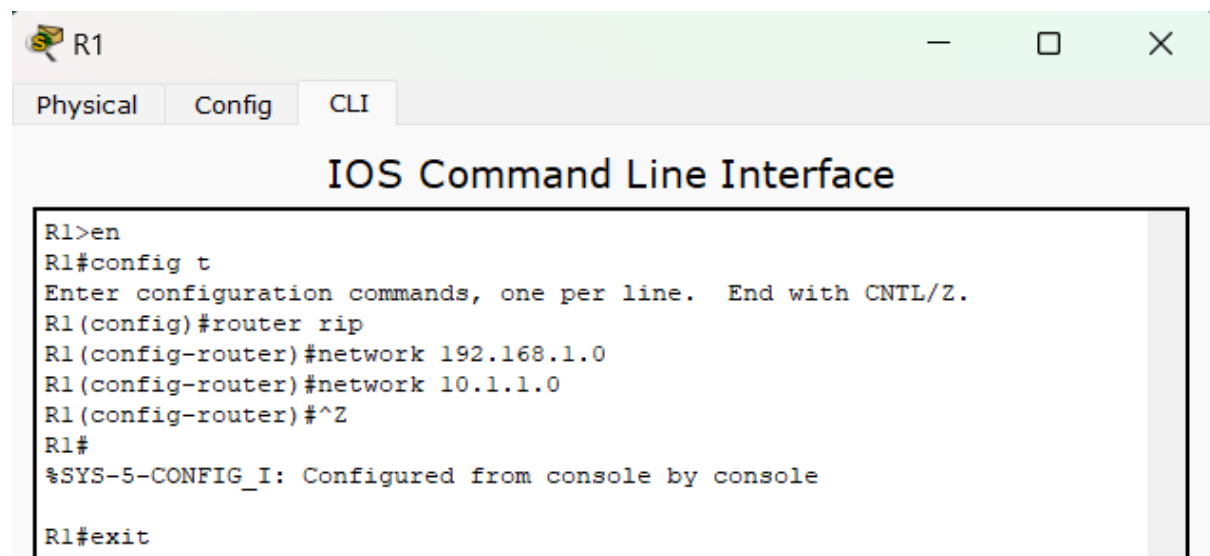
IOS Command Line Interface

```
R3>show ip interface brief
```

Interface	IP-Address	OK?	Method	Status	Protocol
GigabitEthernet0/0	unassigned	YES	unset	administratively down	down
GigabitEthernet0/1	192.168.3.1	YES	manual	up	up
Serial10/0/0	unassigned	YES	unset	administratively down	down
Serial10/0/1	10.2.2.1	YES	manual	up	up
Vlan1	unassigned	YES	unset	administratively down	down

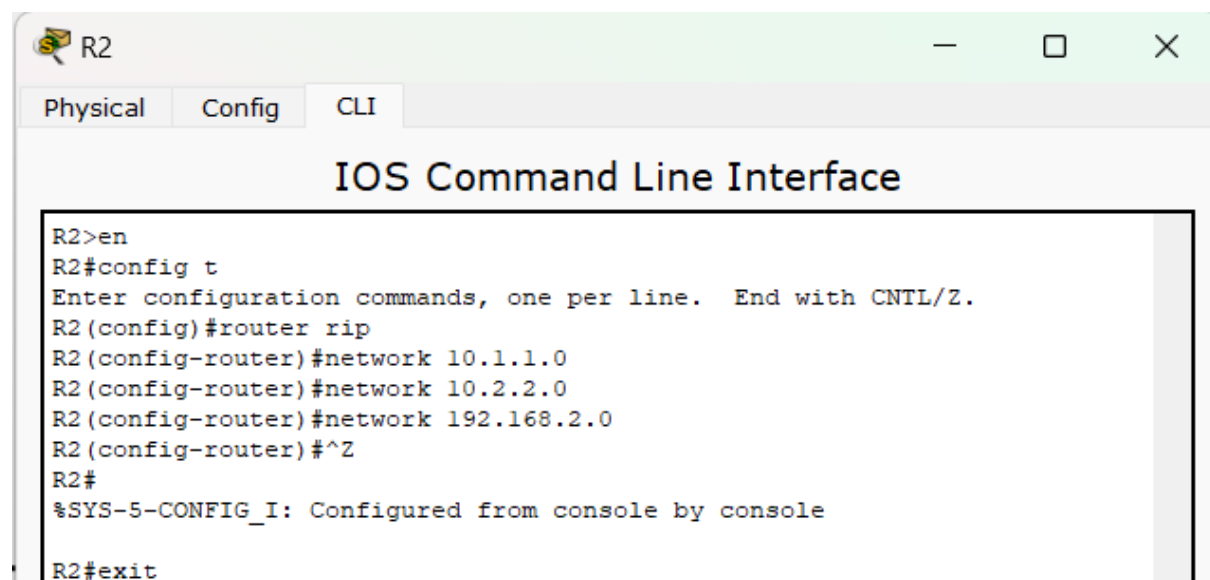
```
R3>
```

## Configure RIP on routers



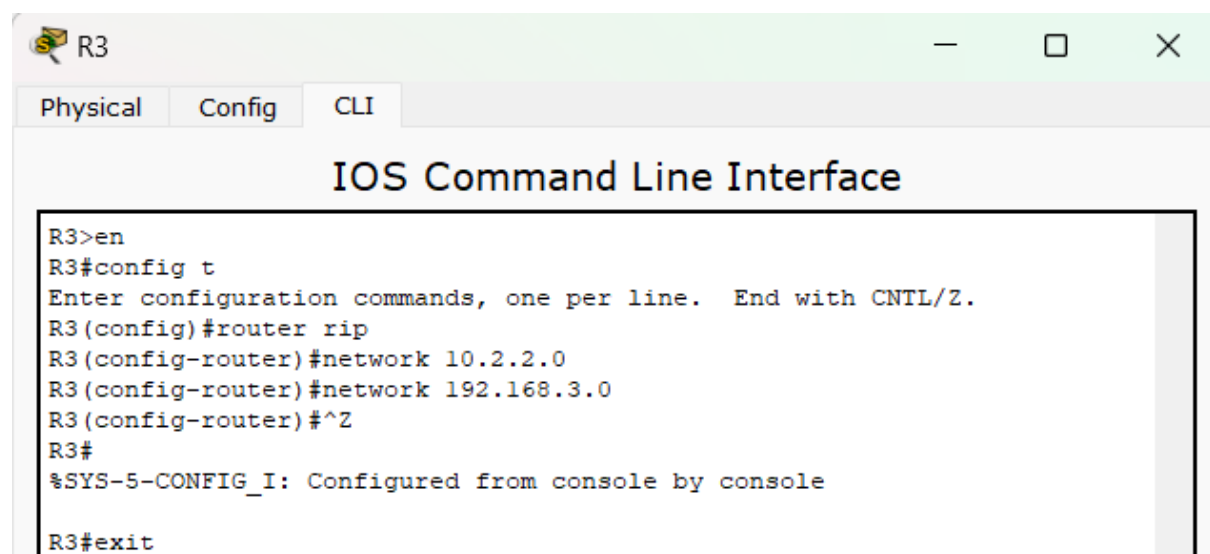
A screenshot of a network simulator window titled 'R1'. It has three tabs: 'Physical', 'Config', and 'CLI', with 'CLI' selected. The window displays the 'IOS Command Line Interface'. The command history shows the following sequence: 'R1>en', 'R1#config t', a prompt 'Enter configuration commands, one per line. End with CNTL/Z.', 'R1(config)#router rip', 'R1(config-router)#network 192.168.1.0', 'R1(config-router)#network 10.1.1.0', 'R1(config-router)#^Z', 'R1#', a system message '%SYS-5-CONFIG\_I: Configured from console by console', and finally 'R1#exit'.

```
R1>en
R1#config t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#router rip
R1(config-router)#network 192.168.1.0
R1(config-router)#network 10.1.1.0
R1(config-router)#^Z
R1#
%SYS-5-CONFIG_I: Configured from console by console
R1#exit
```



A screenshot of a network simulator window titled 'R2'. It has three tabs: 'Physical', 'Config', and 'CLI', with 'CLI' selected. The window displays the 'IOS Command Line Interface'. The command history shows the following sequence: 'R2>en', 'R2#config t', a prompt 'Enter configuration commands, one per line. End with CNTL/Z.', 'R2(config)#router rip', 'R2(config-router)#network 10.1.1.0', 'R2(config-router)#network 10.2.2.0', 'R2(config-router)#network 192.168.2.0', 'R2(config-router)#^Z', 'R2#', a system message '%SYS-5-CONFIG\_I: Configured from console by console', and finally 'R2#exit'.

```
R2>en
R2#config t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#router rip
R2(config-router)#network 10.1.1.0
R2(config-router)#network 10.2.2.0
R2(config-router)#network 192.168.2.0
R2(config-router)#^Z
R2#
%SYS-5-CONFIG_I: Configured from console by console
R2#exit
```



A screenshot of a network simulator window titled 'R3'. It has three tabs: 'Physical', 'Config', and 'CLI', with 'CLI' selected. The window displays the 'IOS Command Line Interface'. The command history shows the following sequence: 'R3>en', 'R3#config t', a prompt 'Enter configuration commands, one per line. End with CNTL/Z.', 'R3(config)#router rip', 'R3(config-router)#network 10.2.2.0', 'R3(config-router)#network 192.168.3.0', 'R3(config-router)#^Z', 'R3#', a system message '%SYS-5-CONFIG\_I: Configured from console by console', and finally 'R3#exit'.

```
R3>en
R3#config t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#router rip
R3(config-router)#network 10.2.2.0
R3(config-router)#network 192.168.3.0
R3(config-router)#^Z
R3#
%SYS-5-CONFIG_I: Configured from console by console
R3#exit
```

## ➤ Displaying routing table of routers

```
R1
Physical Config CLI
IOS Command Line Interface

R1>show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

    10.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
C       10.1.1.0/30 is directly connected, Serial0/0/0
L       10.1.1.1/32 is directly connected, Serial0/0/0
R       10.2.2.0/30 [120/1] via 10.1.1.2, 00:00:05, Serial0/0/0
       192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.1.0/24 is directly connected, GigabitEthernet0/1
L       192.168.1.1/32 is directly connected, GigabitEthernet0/1
R       192.168.2.0/24 [120/1] via 10.1.1.2, 00:00:05, Serial0/0/0
R       192.168.3.0/24 [120/2] via 10.1.1.2, 00:00:05, Serial0/0/0
R1>
```

```
R2
Physical Config CLI
IOS Command Line Interface

R2>show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS
inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

    10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
C       10.1.1.0/30 is directly connected, Serial0/0/0
L       10.1.1.2/32 is directly connected, Serial0/0/0
C       10.2.2.0/30 is directly connected, Serial0/0/1
L       10.2.2.2/32 is directly connected, Serial0/0/1
R       192.168.1.0/24 [120/1] via 10.1.1.1, 00:00:17, Serial0/0/0
       192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.2.0/24 is directly connected, Loopback1
L       192.168.2.1/32 is directly connected, Loopback1
R       192.168.3.0/24 [120/1] via 10.2.2.1, 00:00:19, Serial0/0/1
R2>
```

R3

PhysicalConfigCLI

IOS Command Line Interface

```
R3>show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B -
BGP
        D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
        N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
        E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
        i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS
inter area
        * - candidate default, U - per-user static route, o - ODR
        P - periodic downloaded static route

Gateway of last resort is not set

    10.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
R       10.1.1.0/30 [120/1] via 10.2.2.2, 00:00:18, Serial0/0/1
C       10.2.2.0/30 is directly connected, Serial0/0/1
L       10.2.2.1/32 is directly connected, Serial0/0/1
R      192.168.1.0/24 [120/2] via 10.2.2.2, 00:00:18, Serial0/0/1
R      192.168.2.0/24 [120/1] via 10.2.2.2, 00:00:18, Serial0/0/1
        192.168.3.0/24 is variably subnetted, 2 subnets, 2 masks
C      192.168.3.0/24 is directly connected, GigabitEthernet0/1
L      192.168.3.1/32 is directly connected, GigabitEthernet0/1
R3>
```

➤ **Configure SSH on R2**

R2

PhysicalConfigCLI

IOS Command Line Interface

```
R2>en
R2#config t
Enter configuration commands, one per line.  End with CNTL/Z.
R2(config)#ip domain-name securityincomputing.com
R2(config)#username admin secret pwd
R2(config)#line vty 0 4
R2(config-line)#login local
R2(config-line)#transport input ssh
R2(config-line)#crypto key zeroize rsa
% No Signature RSA Keys found in configuration.

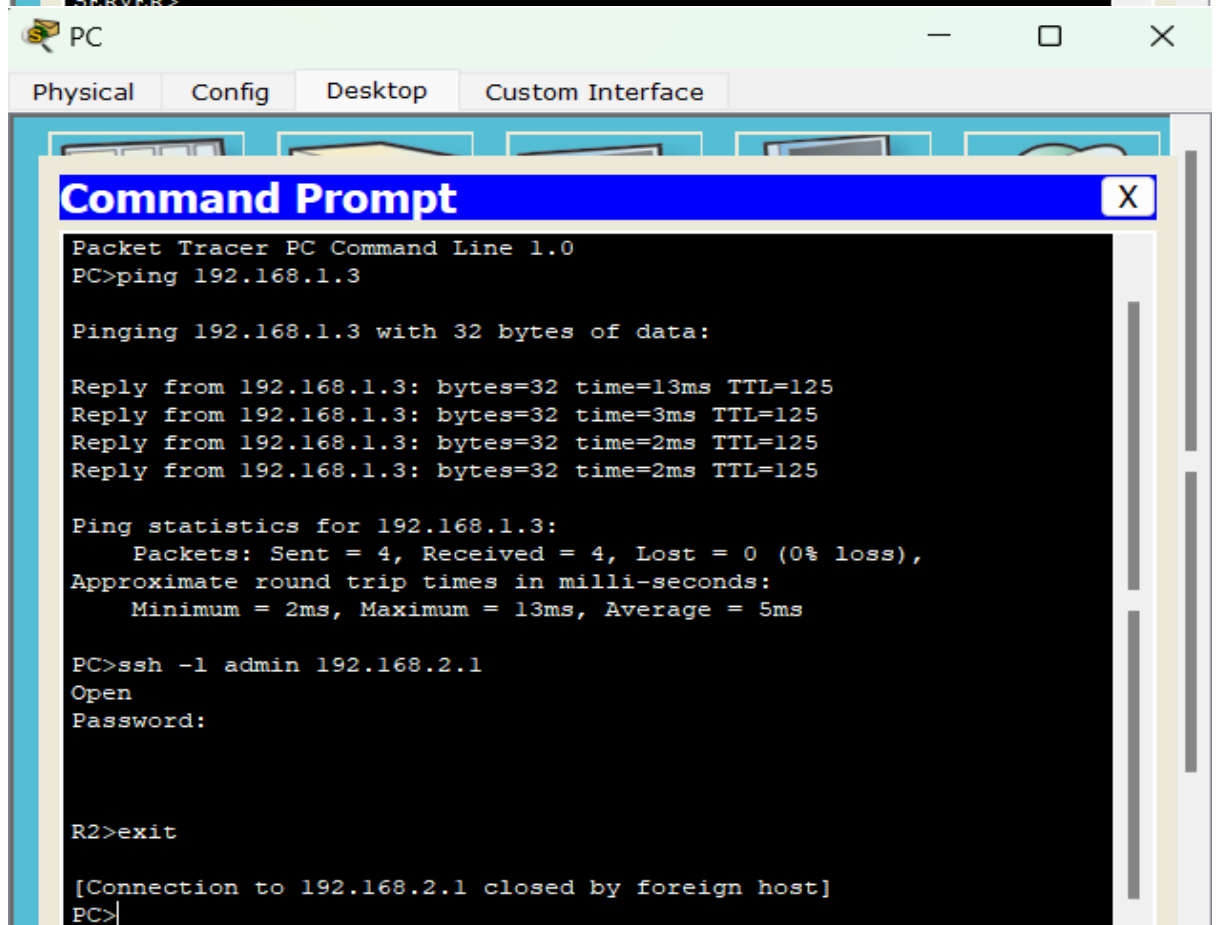
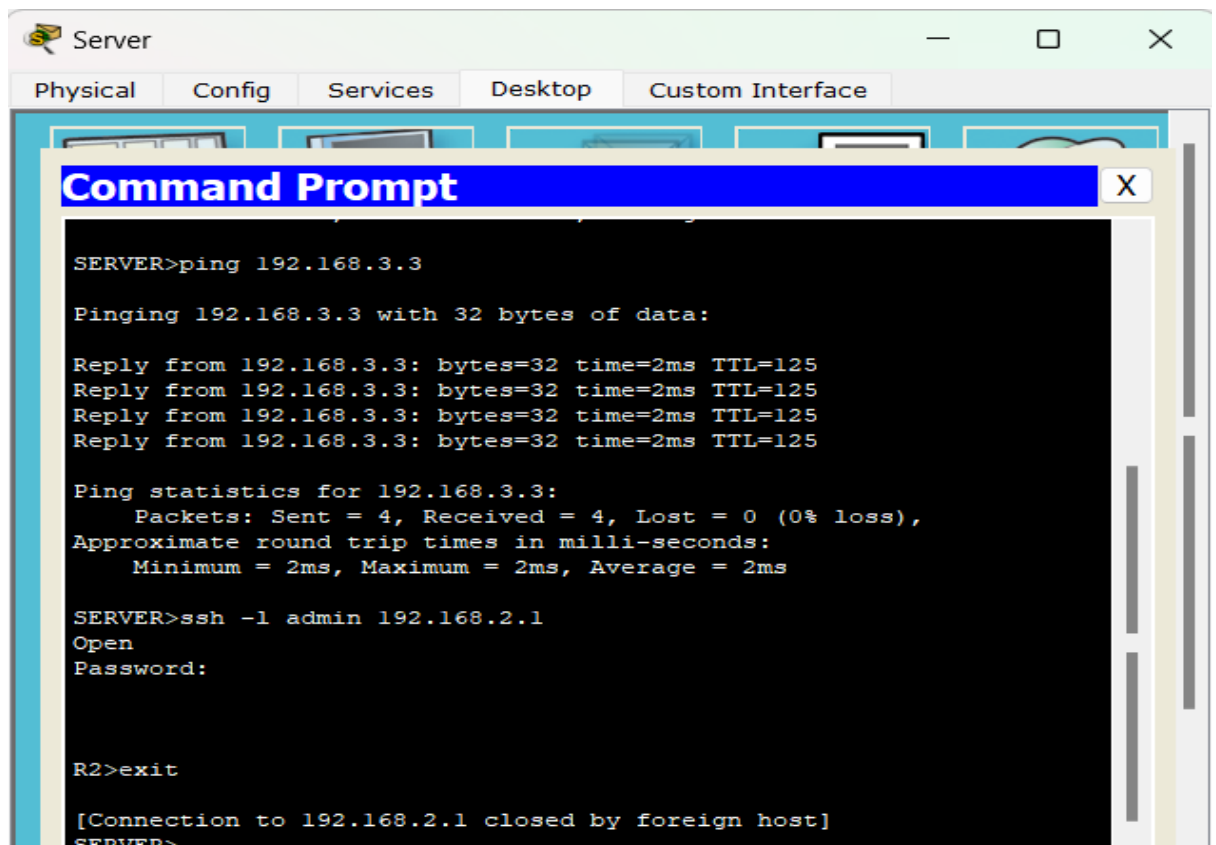
R2(config)#crypto key generate rsa
The name for the keys will be: R2.securityincomputing.com
Choose the size of the key modulus in the range of 360 to 2048 for your
  General Purpose Keys. Choosing a key modulus greater than 512 may take
  a few minutes.
How many bits in the modulus [512]: 1024
% Generating 1024 bit RSA keys, keys will be non-exportable...[OK]

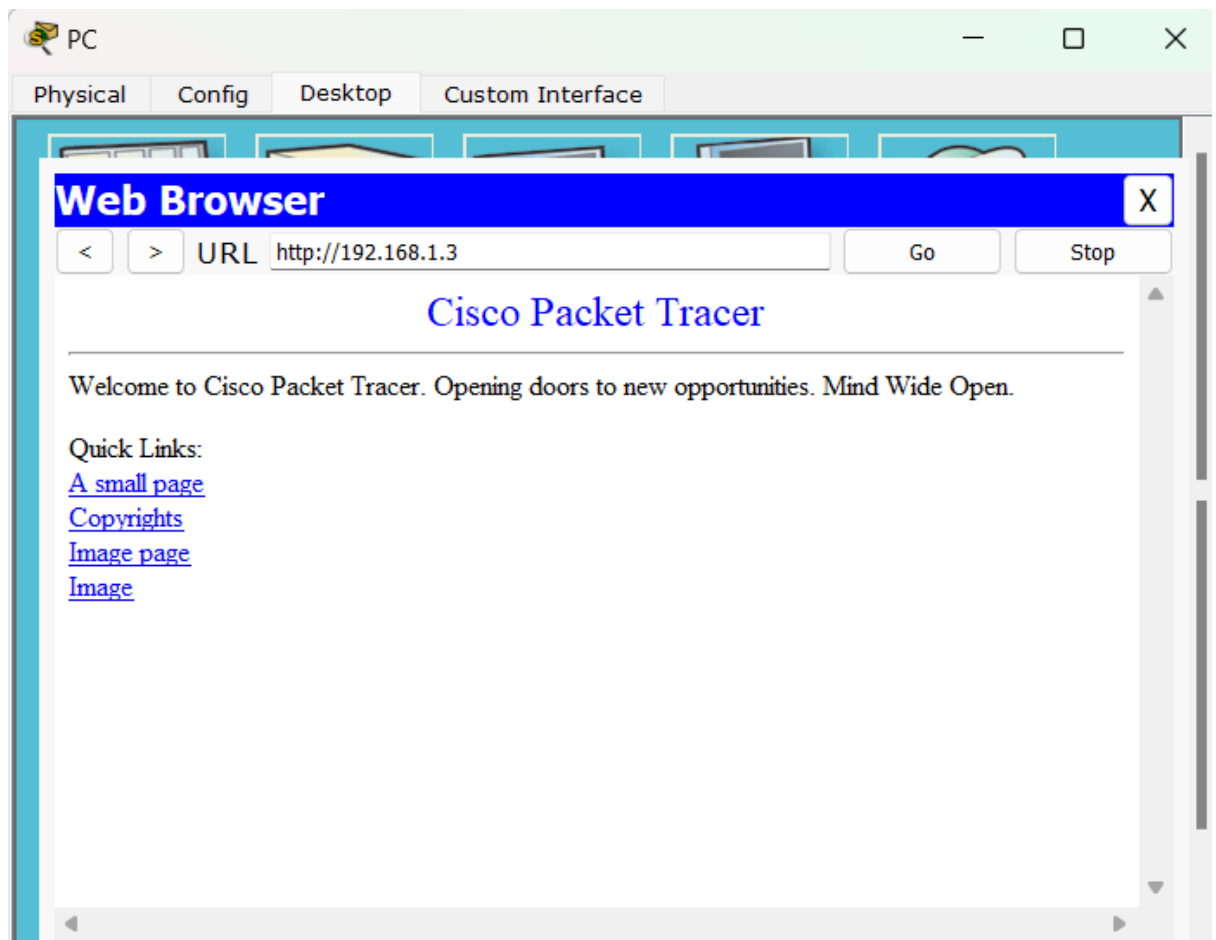
R2(config)#ip ssh time-out 90
*Mar 1 0:37:42.439:  %SSH-5-ENABLED: SSH 2 has been enabled
R2(config)#ip ssh authentication-retries 2
R2(config)#ip ssh version 2
R2(config)#^Z
R2#
%SYS-5-CONFIG_I: Configured from console by console

R2#exit
```

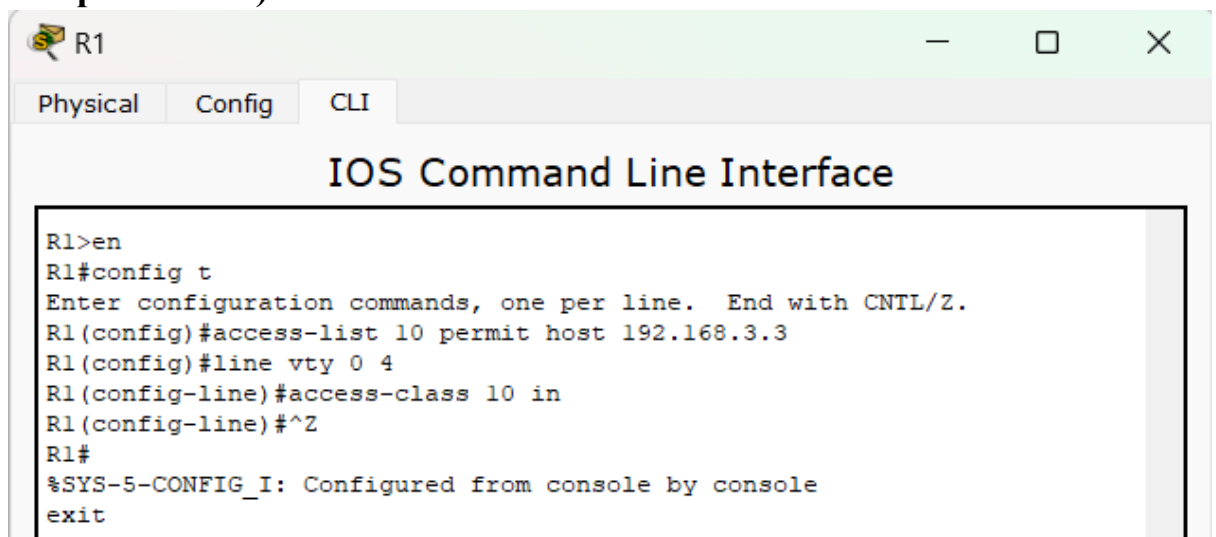
- **Verify Basic Network Connectivity before ACL Configuration**

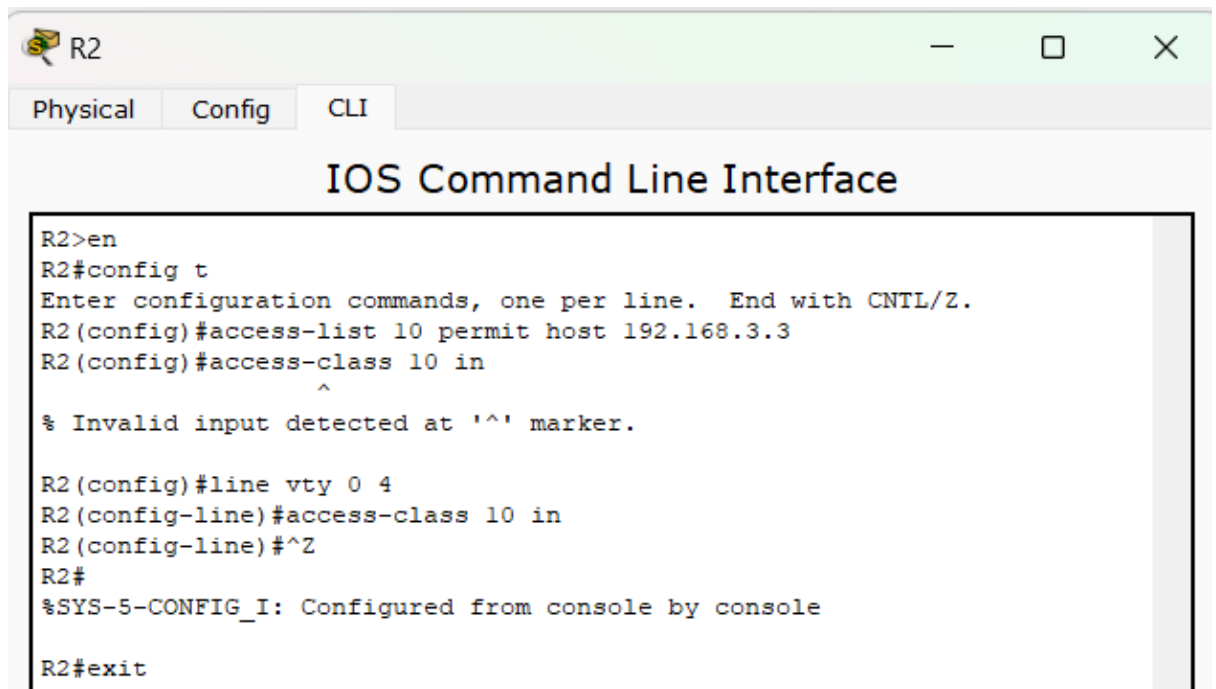






- **Configure ACL on routers (block all remote access to the routers except from PC)**

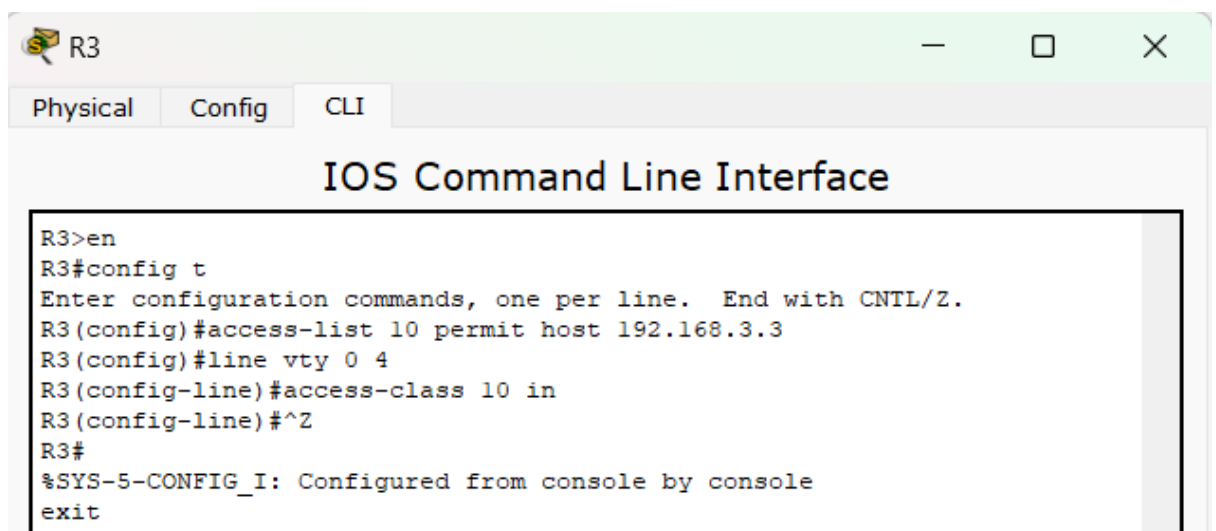




The screenshot shows the CLI window for router R2. The title bar says 'R2'. There are three tabs: 'Physical', 'Config', and 'CLI', with 'CLI' being the active tab. The main area is titled 'IOS Command Line Interface'. The command history shows the following sequence: 'R2>en' to enter enable mode, 'R2#config t' to enter configuration mode, 'R2(config)#access-list 10 permit host 192.168.3.3' to create an ACL, 'R2(config)#access-class 10 in' to apply it to the console line, an '^' character indicating an invalid input, a message '% Invalid input detected at '^' marker.', 'R2(config)#line vty 0 4' to enter line configuration, 'R2(config-line)#access-class 10 in' to apply the ACL, 'R2(config-line)#^Z' to exit line configuration, 'R2#' to return to configuration mode, a message '%SYS-5-CONFIG\_I: Configured from console by console', and finally 'R2#exit' to return to user EXEC mode.

```
R2>en
R2#config t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#access-list 10 permit host 192.168.3.3
R2(config)#access-class 10 in
^
% Invalid input detected at '^' marker.

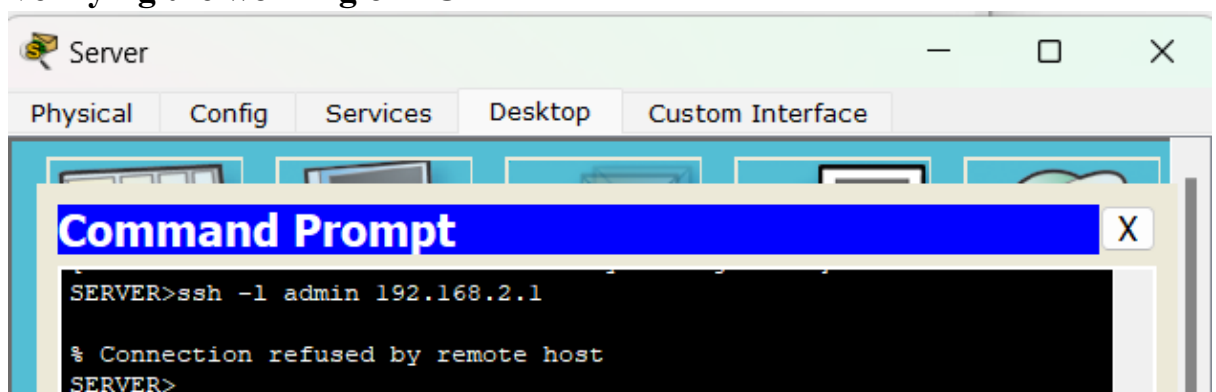
R2(config)#line vty 0 4
R2(config-line)#access-class 10 in
R2(config-line)#^Z
R2#
%SYS-5-CONFIG_I: Configured from console by console
R2#exit
```



The screenshot shows the CLI window for router R3. The title bar says 'R3'. There are three tabs: 'Physical', 'Config', and 'CLI', with 'CLI' being the active tab. The main area is titled 'IOS Command Line Interface'. The command history shows the following sequence: 'R3>en' to enter enable mode, 'R3#config t' to enter configuration mode, 'R3(config)#access-list 10 permit host 192.168.3.3' to create an ACL, 'R3(config)#line vty 0 4' to enter line configuration, 'R3(config-line)#access-class 10 in' to apply it, 'R3(config-line)#^Z' to exit line configuration, 'R3#' to return to configuration mode, a message '%SYS-5-CONFIG\_I: Configured from console by console', and finally 'exit' to return to user EXEC mode.

```
R3>en
R3#config t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#access-list 10 permit host 192.168.3.3
R3(config)#line vty 0 4
R3(config-line)#access-class 10 in
R3(config-line)#^Z
R3#
%SYS-5-CONFIG_I: Configured from console by console
exit
```

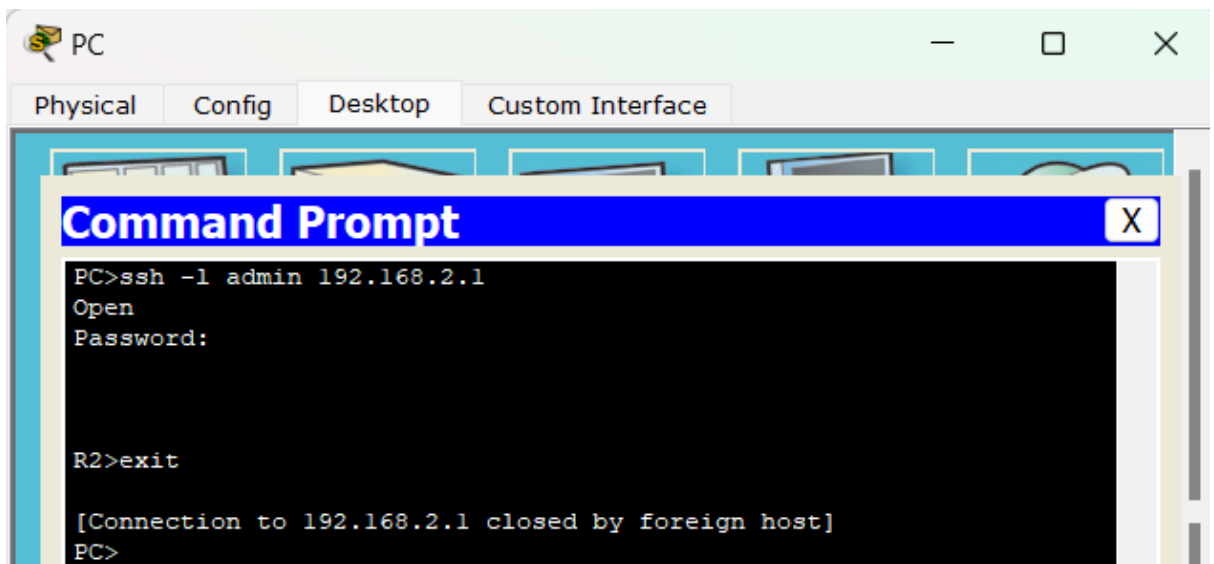
➤ Verifying the working of ACL



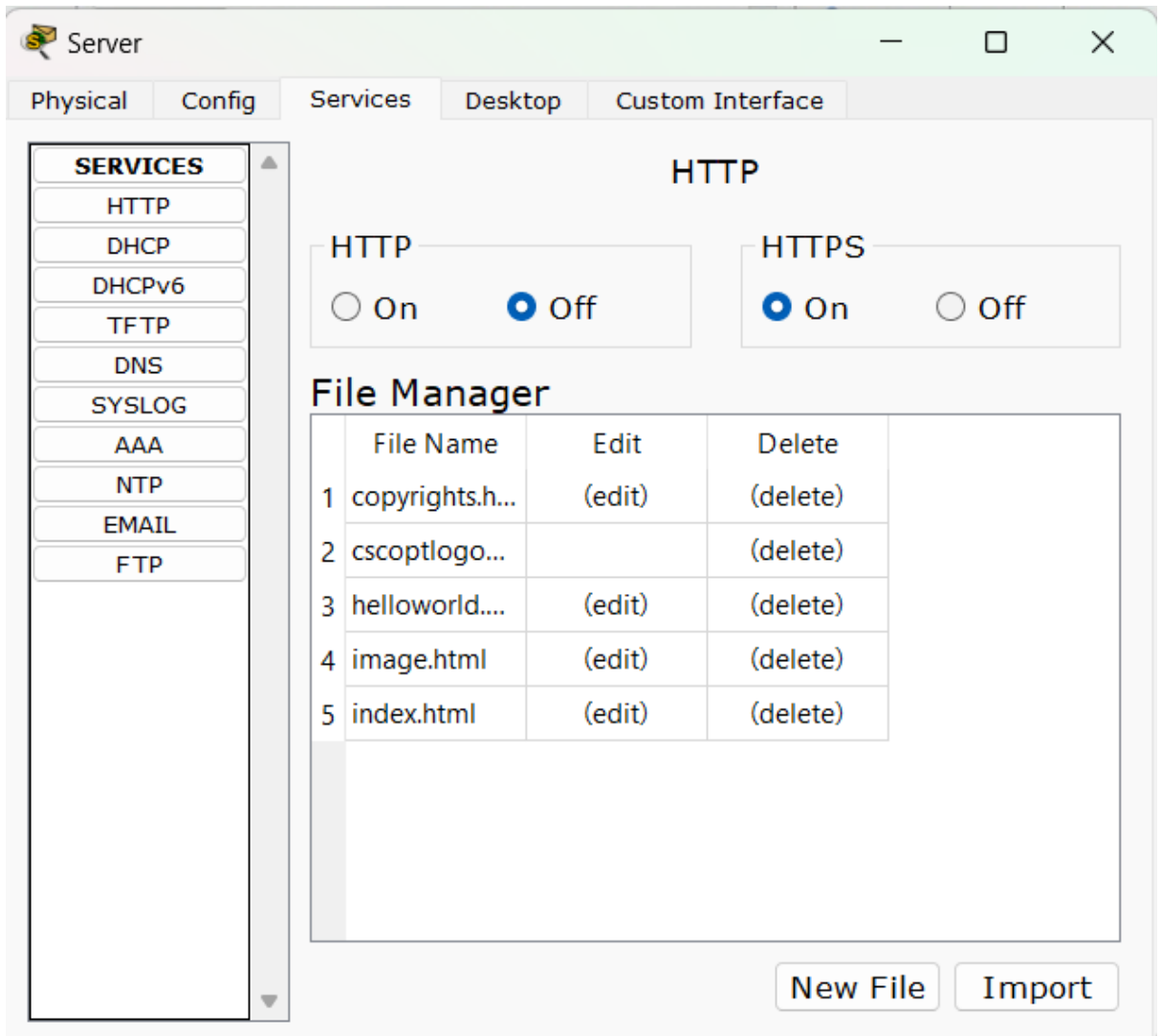
The screenshot shows a 'Server' window with tabs for 'Physical', 'Config', 'Services', 'Desktop', and 'Custom Interface'. A 'Command Prompt' window is open in the foreground. The command history shows the following sequence: 'SERVER>ssh -l admin 192.168.2.1' to attempt an SSH connection, and a message '% Connection refused by remote host' indicating the connection failed.

```
SERVER>ssh -l admin 192.168.2.1

% Connection refused by remote host
SERVER>
```

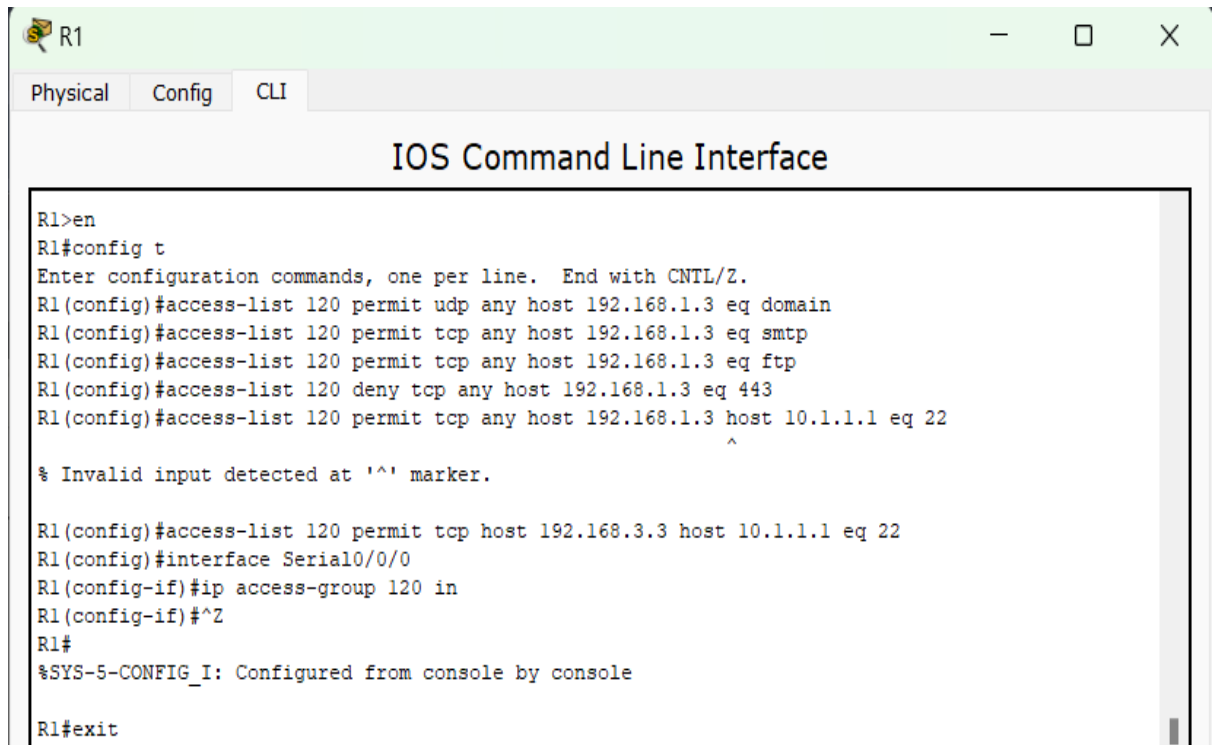


➤ **Disable HTTP and enable HTTPS on server**



➤ **Configure ACL on routers**

- Permit any outside host to access DNS, SMTP, and FTP services on Server
- Deny any outside host access to HTTPS services on Server.
- Permit PC to access RI via SSH.

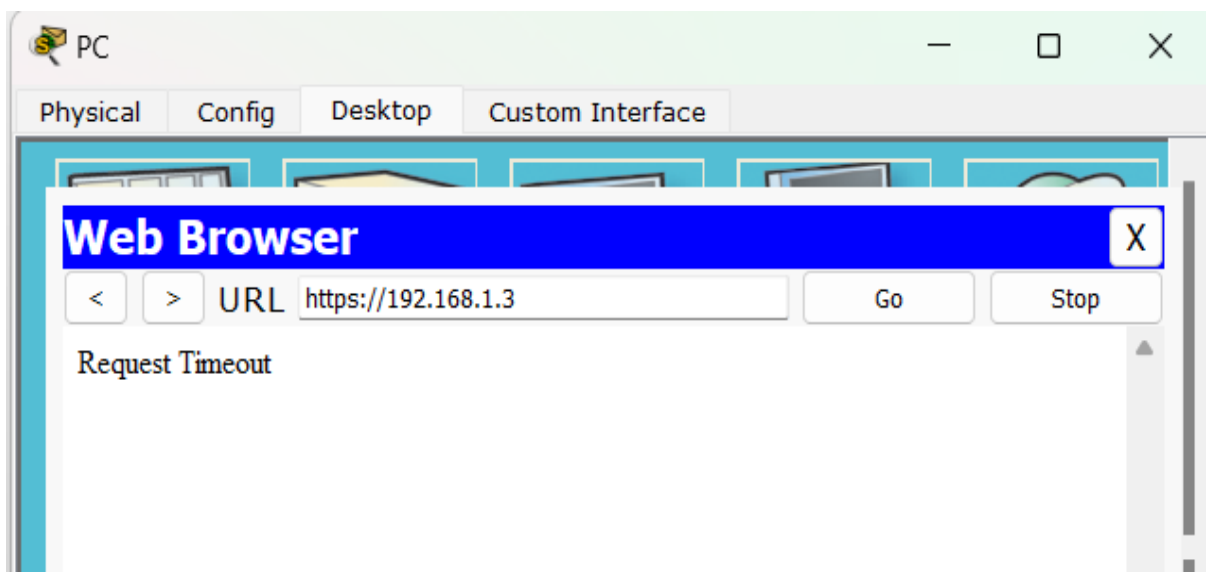


```
R1>en
R1#config t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#access-list 120 permit udp any host 192.168.1.3 eq domain
R1(config)#access-list 120 permit tcp any host 192.168.1.3 eq smtp
R1(config)#access-list 120 permit tcp any host 192.168.1.3 eq ftp
R1(config)#access-list 120 deny tcp any host 192.168.1.3 eq 443
R1(config)#access-list 120 permit tcp any host 192.168.1.3 host 10.1.1.1 eq 22
                                     ^
% Invalid input detected at '^' marker.

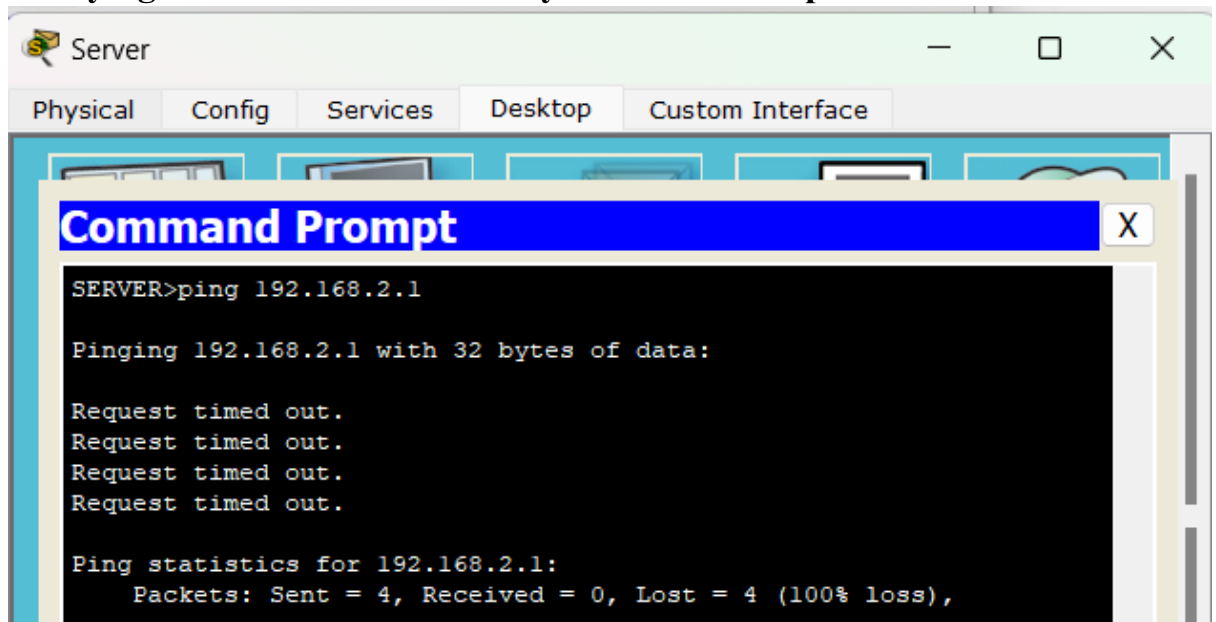
R1(config)#access-list 120 permit tcp host 192.168.3.3 host 10.1.1.1 eq 22
R1(config)#interface Serial0/0/0
R1(config-if)#ip access-group 120 in
R1(config-if)#^Z
R1#
%SYS-5-CONFIG_I: Configured from console by console

R1#exit
```

➤ **Verifying the working of ACL**

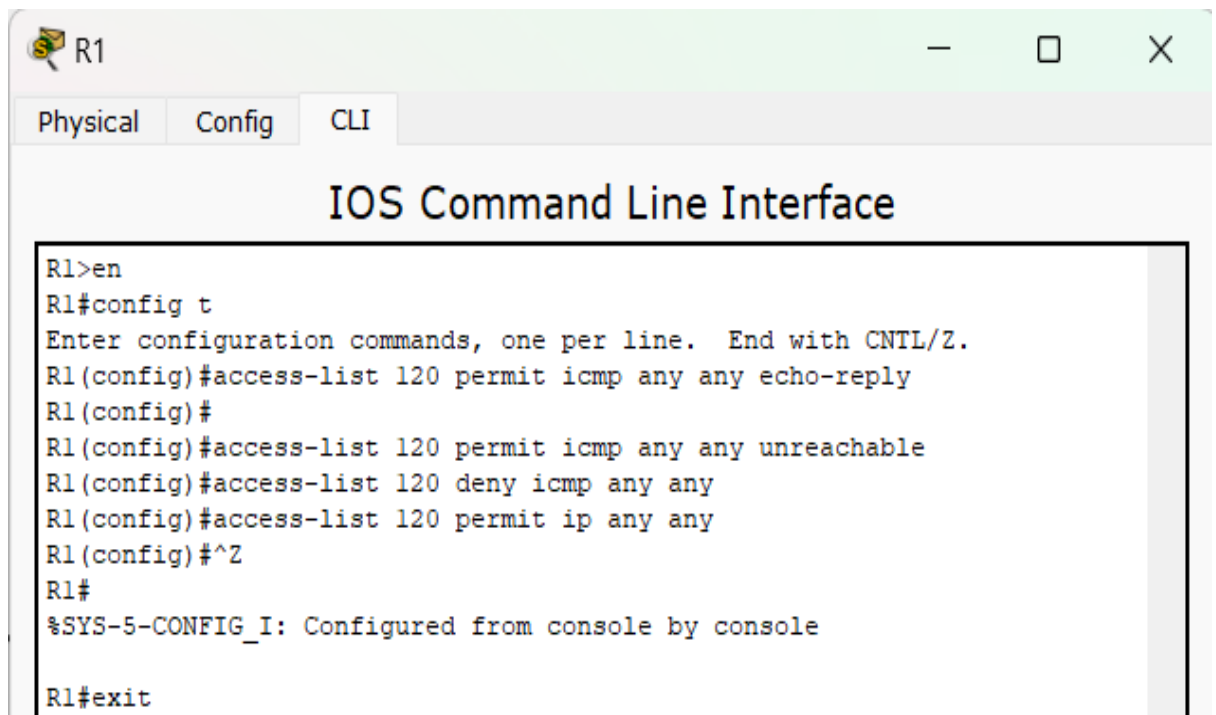


➤ **Verifying the network connectivity before ACL implementation**

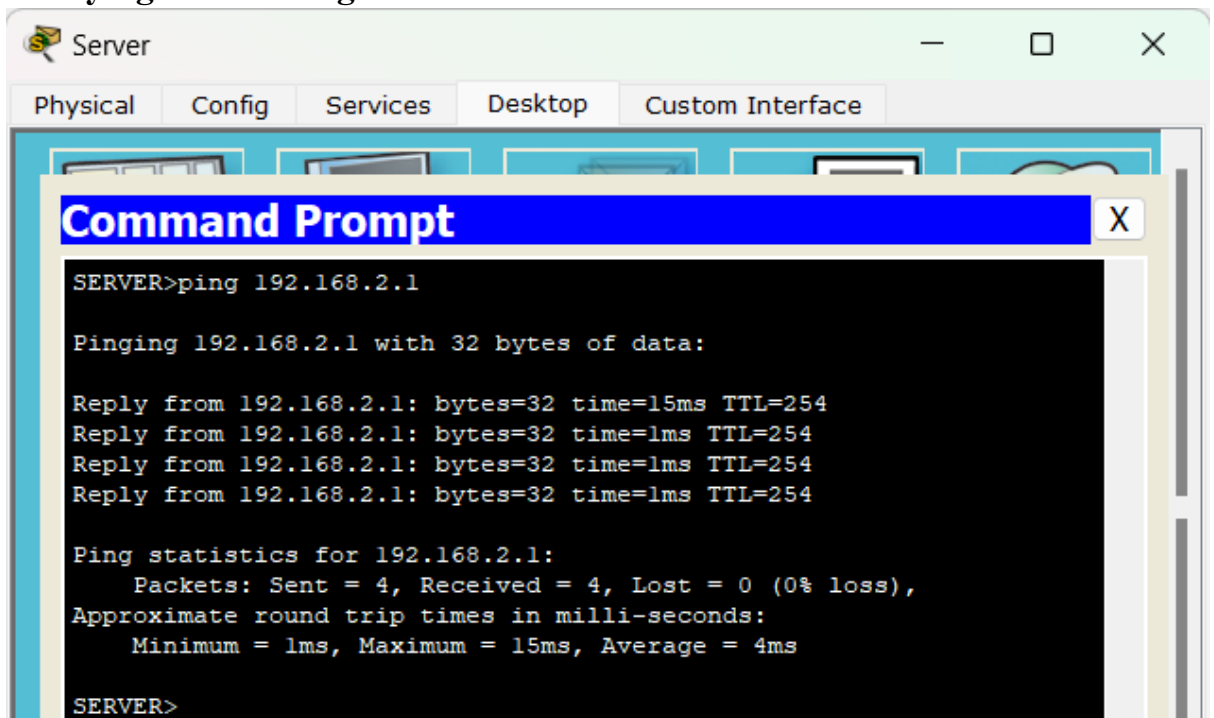


➤ **Modify an Existing ACL on R1**

- (Permit ICMP echo replies and destination unreachable messages from the outside network. Deny all the other incoming ICMP packets.



➤ Verifying the working of ACL



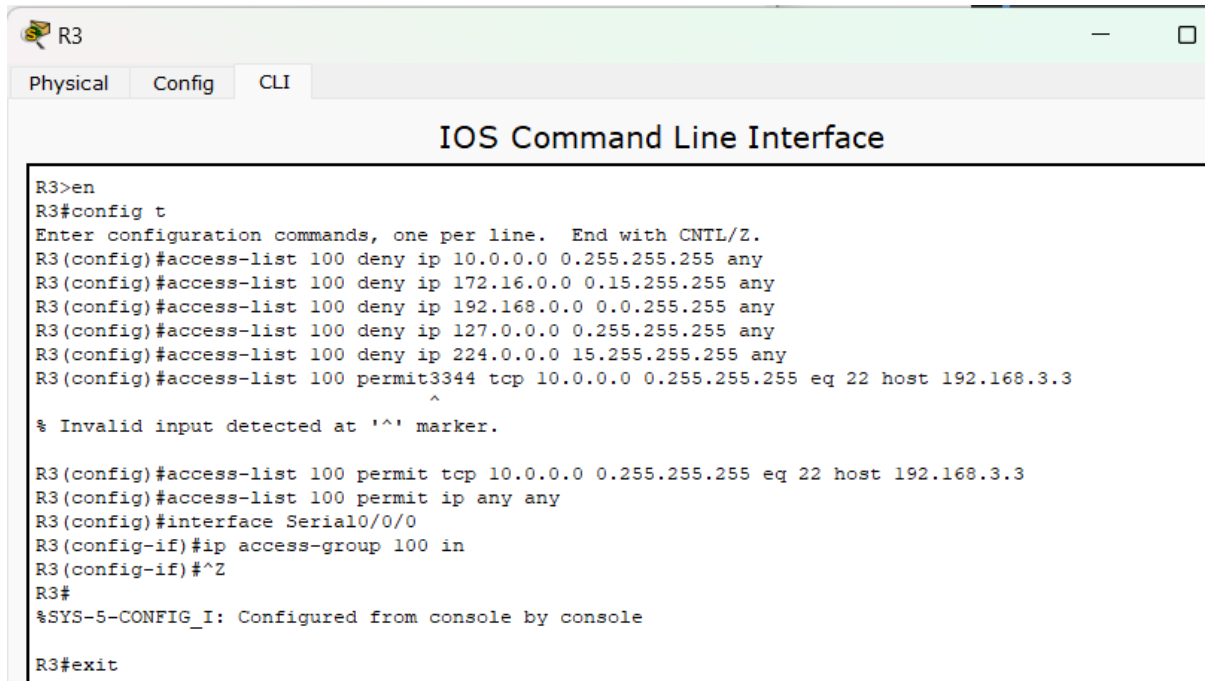
➤ Configure ACL on routers

- (Deny all outbound packets with source address outside the range of internal IP addresses on R3)



## ➤ Configure ACL on routers

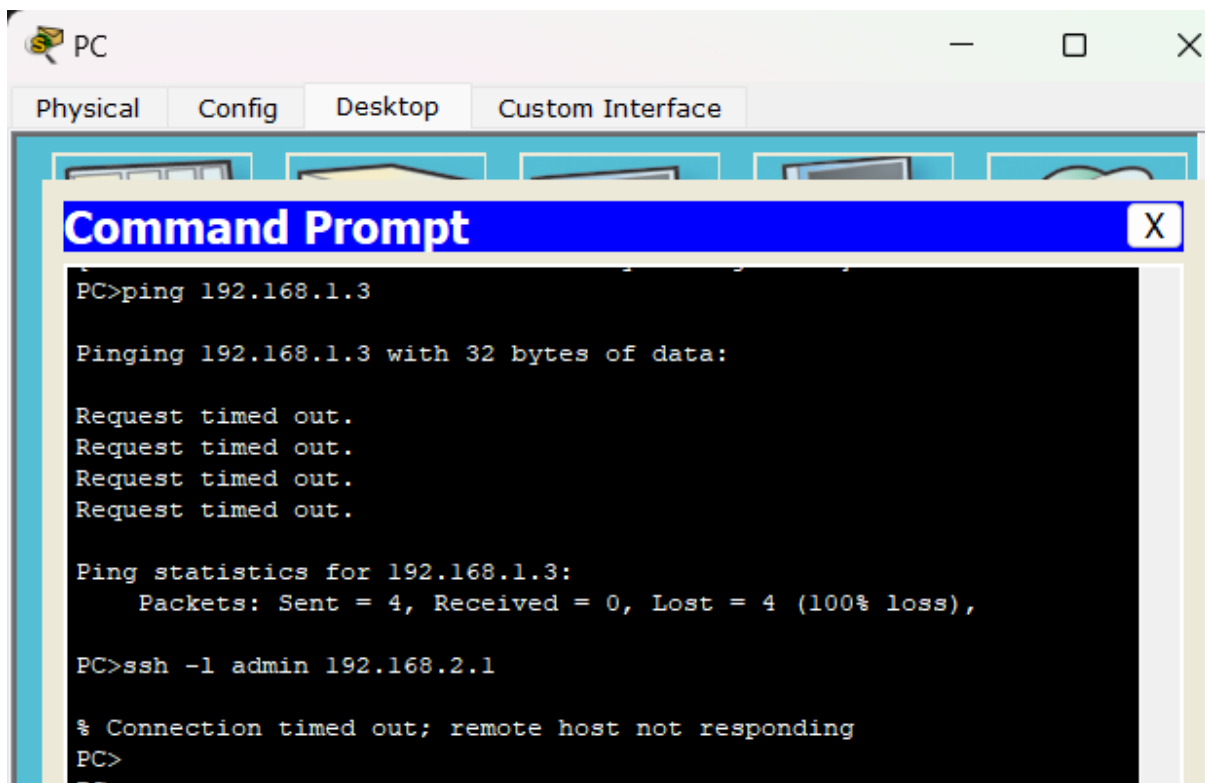
- (On R3, block all packets containing the source IP address from the following pool of addresses: private addresses, 127.0.0.0/8, and any IP multicast address. Permit SSH traffic from the 10.0.0.0/8 network to return to the host PC)



The screenshot shows the R3 router's IOS Command Line Interface. The user has entered the configuration mode and is configuring an access-list 100. The commands entered are: `R3>en`, `R3#config t`, `R3(config)#access-list 100 deny ip 10.0.0.0 0.255.255.255 any`, `R3(config)#access-list 100 deny ip 172.16.0.0 0.15.255.255 any`, `R3(config)#access-list 100 deny ip 192.168.0.0 0.0.255.255 any`, `R3(config)#access-list 100 deny ip 127.0.0.0 0.255.255.255 any`, `R3(config)#access-list 100 deny ip 224.0.0.0 15.255.255.255 any`, and `R3(config)#access-list 100 permit 3344 tcp 10.0.0.0 0.255.255.255 eq 22 host 192.168.3.3`. An error message indicates an invalid input at the '^' marker. The user then corrects the command to `R3(config)#access-list 100 permit tcp 10.0.0.0 0.255.255.255 eq 22 host 192.168.3.3`, followed by `R3(config)#access-list 100 permit ip any any`, `R3(config)#interface Serial0/0/0`, `R3(config-if)#ip access-group 100 in`, `R3(config-if)#^Z`, `R3#`, and `R3#exit`. A system message indicates the configuration was applied from the console.

```
R3>en
R3#config t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#access-list 100 deny ip 10.0.0.0 0.255.255.255 any
R3(config)#access-list 100 deny ip 172.16.0.0 0.15.255.255 any
R3(config)#access-list 100 deny ip 192.168.0.0 0.0.255.255 any
R3(config)#access-list 100 deny ip 127.0.0.0 0.255.255.255 any
R3(config)#access-list 100 deny ip 224.0.0.0 15.255.255.255 any
R3(config)#access-list 100 permit3344 tcp 10.0.0.0 0.255.255.255 eq 22 host 192.168.3.3
      ^
% Invalid input detected at '^' marker.

R3(config)#access-list 100 permit tcp 10.0.0.0 0.255.255.255 eq 22 host 192.168.3.3
R3(config)#access-list 100 permit ip any any
R3(config)#interface Serial0/0/0
R3(config-if)#ip access-group 100 in
R3(config-if)#^Z
R3#
%SYS-5-CONFIG_I: Configured from console by console
R3#exit
```



The screenshot shows a PC's Command Prompt window. The user has entered `PC>ping 192.168.1.3`, which results in four 'Request timed out.' messages. The ping statistics for 192.168.1.3 show 4 packets sent, 0 received, and 100% loss. The user then enters `PC>ssh -l admin 192.168.2.1`, which results in a 'Connection timed out; remote host not responding' message.

```
PC>ping 192.168.1.3

Pinging 192.168.1.3 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 192.168.1.3:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

PC>ssh -l admin 192.168.2.1

% Connection timed out; remote host not responding
PC>
```