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VIKAS COLLEGE OF ARTS, SCIENCE & COMMERCE

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Vikas High School Marg, Kannamwar Nagar No 2, Vikhroli (E), Mumbai – 400083

Dr. R. K. Patra
Principal

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Chairman. V. V. Edu. Society

This is to certify that _____,

a student of T.Y.B.Sc. (Information Technology) (Semester VI) with college-enrolled Roll No.
_____/ University Seat No. _____,

has satisfactorily completed the practical work for the subject Information Security Practical in the Information Technology program from the University of Mumbai for the academic year 2024-2025.

Guided By
Prof. Abhishek

College Seal

Head Of Department
DR. Seema Rahul

External Examiner

Practical no	Title	Date	Sign
1	Configure Cisco Routers for Syslog, NTP, and SSH Operations		
2	Configuring Extended ACLs		
3	Configure AAA Authentication		
4	Configure IP ACLs to Mitigate Attacks		
5	Configuring IPv6 ACLs		
6	Configuring a Zone-Based Policy Firewall (ZPF)		
7	Configure IOS Intrusion Prevention System (IPS) Using the CLI		

PRACTICAL NO 1:

Configure Cisco Routers for Syslog, NTP, and SSH Operations

OSPF, MD5 Authentication

- OSPF is a routing protocol. Two routers speaking OSPF to each other exchange information about the routes they know about and the cost for them to get there.
- When many OSPF routers are part of the same network, information about all of the routes in a network are learned by all of the OSPF routers within that network—technically called an **area**. (We'll talk more about area as we go on).
- Each OSPF router passes along information about the routes and costs they've heard about to all of their adjacent OSPF routers, called **neighbors**.
- OSPF routers rely on **cost** to compute the shortest path through the network between themselves and a remote router or network destination.
- The shortest path computation is done using Djikstra's algorithm. This algorithm isn't unique to OSPF. Rather, it's a mathematical algorithm that happens to have an obvious application to networking.

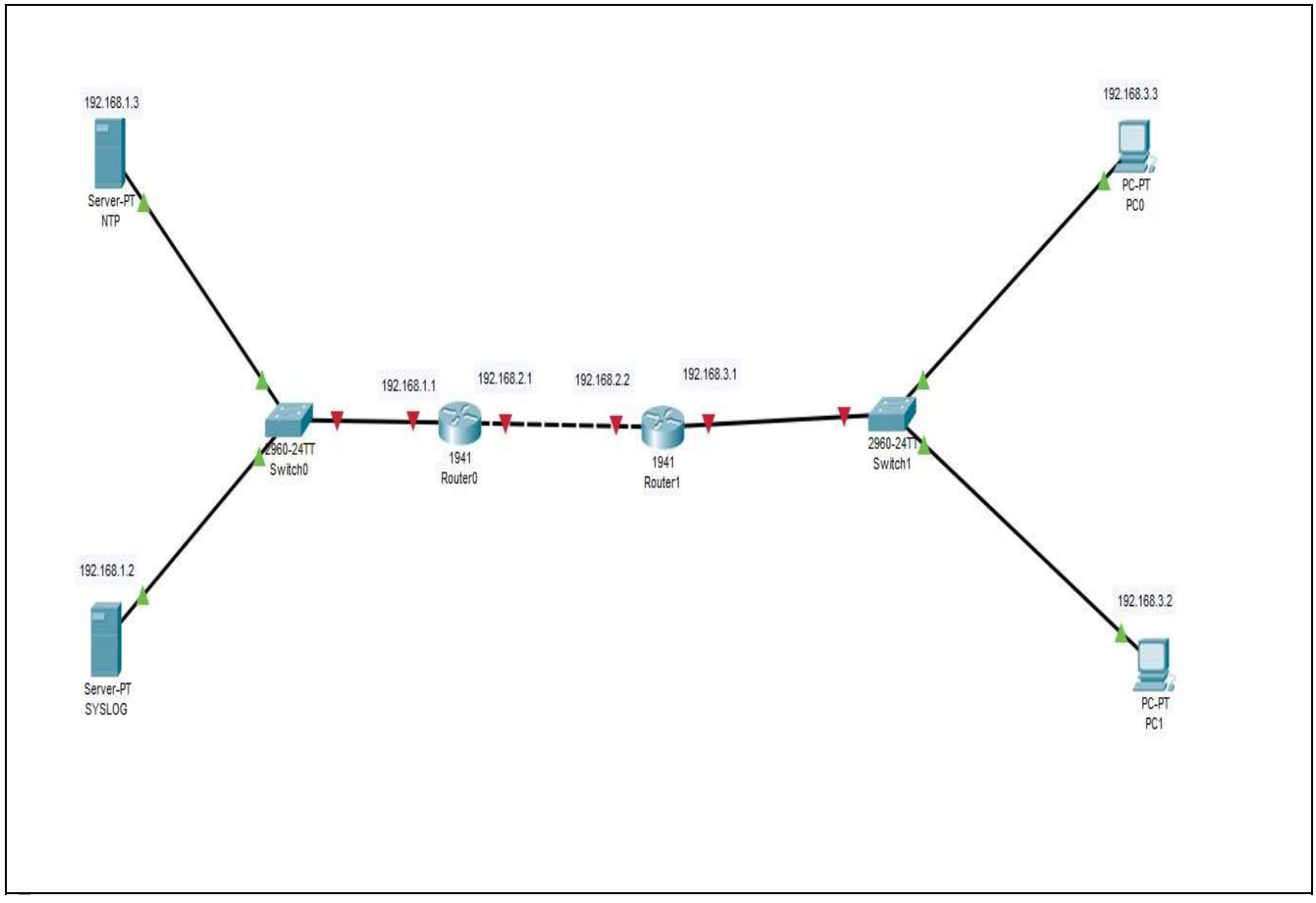
MD5 Authentication

- MD5 authentication provides higher security than plain text authentication.
- This method uses the MD5 algorithm to compute a hash value from the contents of the OSPF packet and a password (or key).
- This hash value is transmitted in the packet, along with a key ID and a non-decreasing sequence number.
- The receiver, which knows the same password, calculates its own hash value.
- If nothing in the message changes, the hash value of the receiver should match the hash value of the sender which is transmitted with the message.
- The key ID allows the routers to reference multiple passwords.
- This makes password migration easier and more secure.

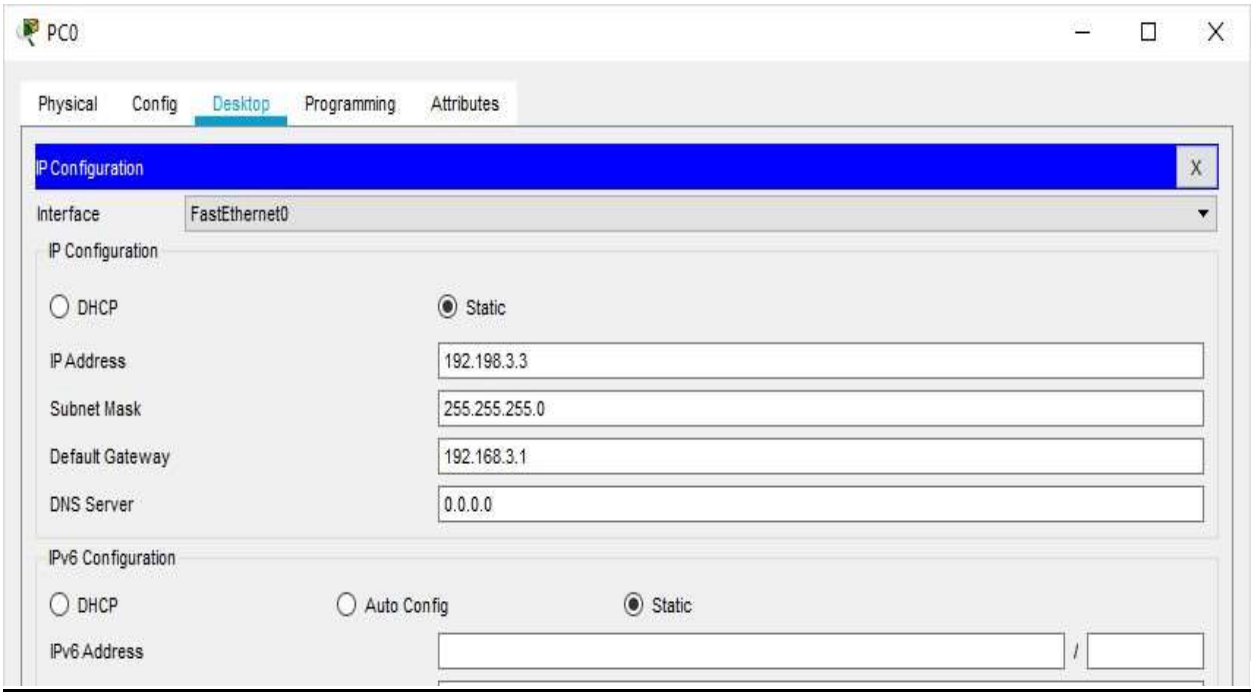
- For example, to migrate from one password to another, configure a password under a different key ID and remove the first key.
- The sequence number prevents replay attacks, in which OSPF packets are captured, modified, and retransmitted to a router.
- As with plain text authentication, MD5 authentication passwords do not have to be the same throughout an area. However, they do need to be the same between neighbors.

Example

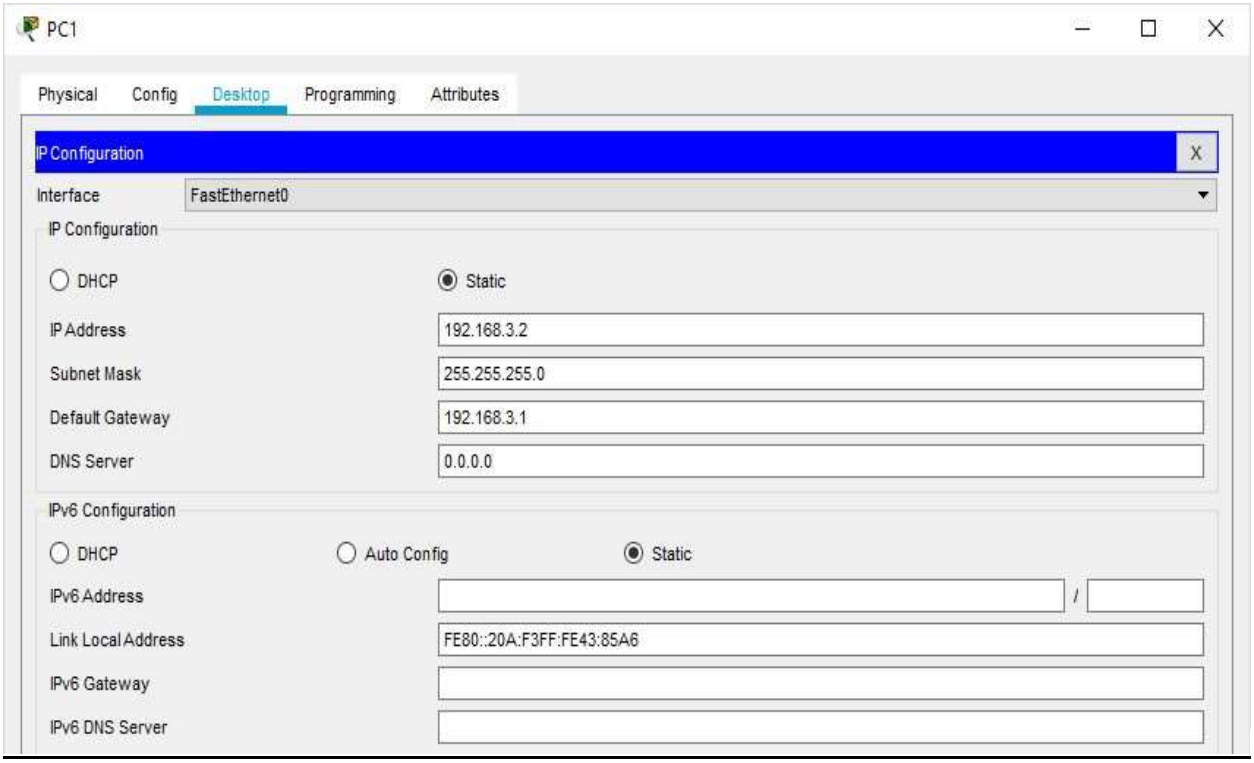
Consider the following topology



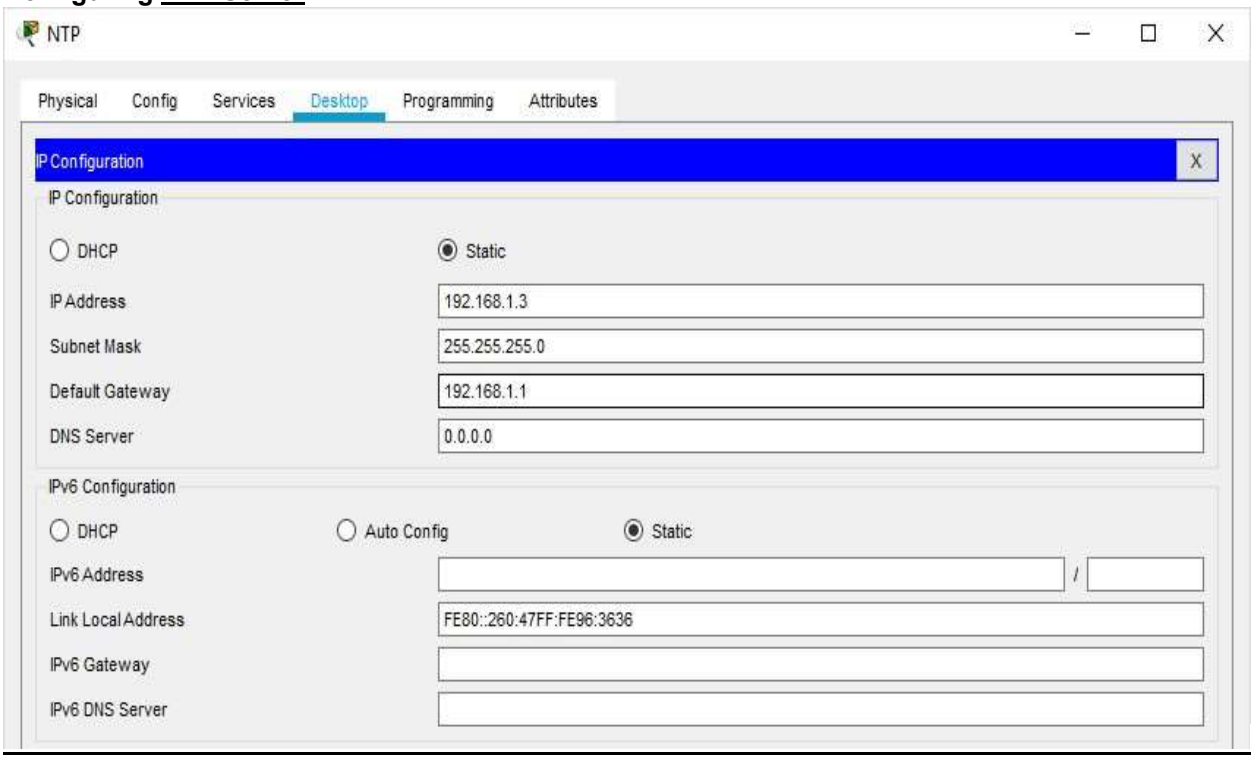
Configuring PC0



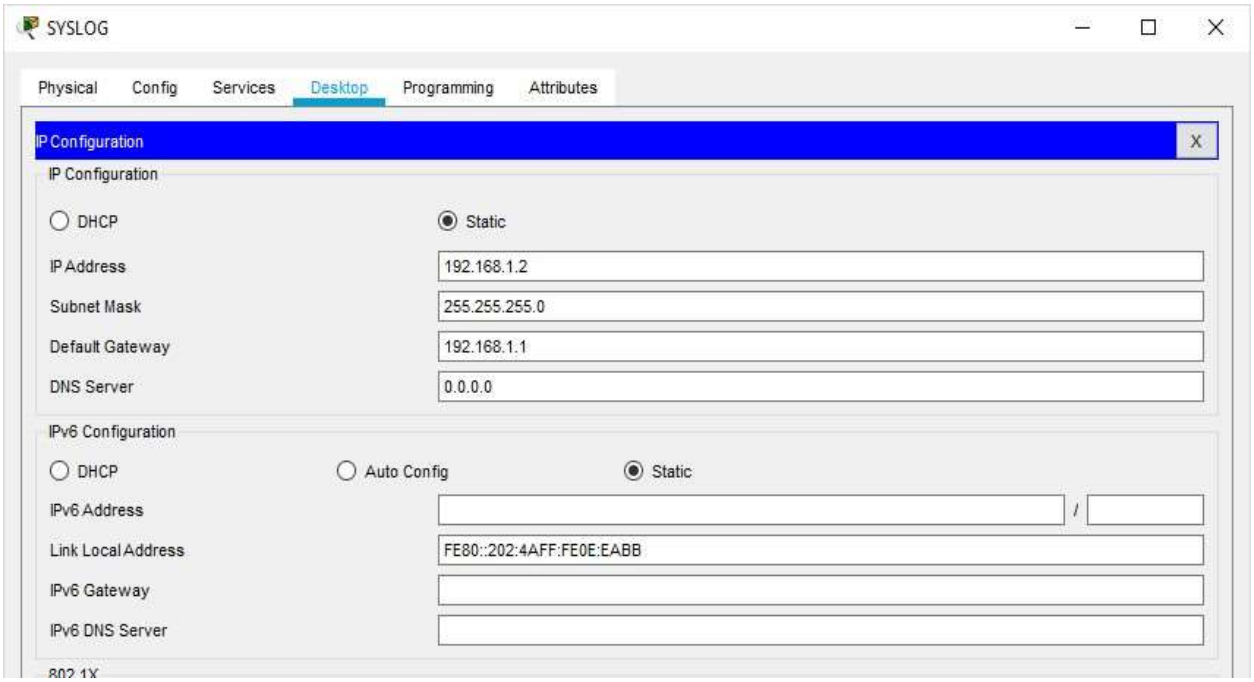
Configuring PC1



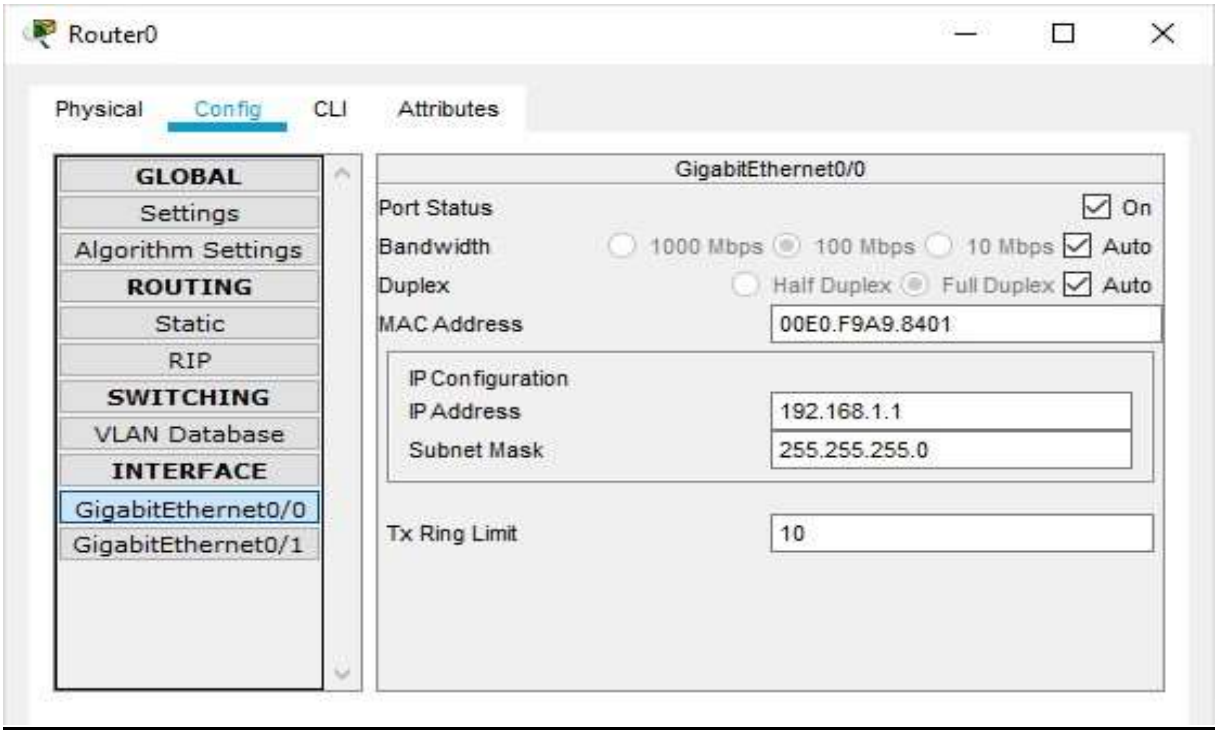
Configuring NTP Server

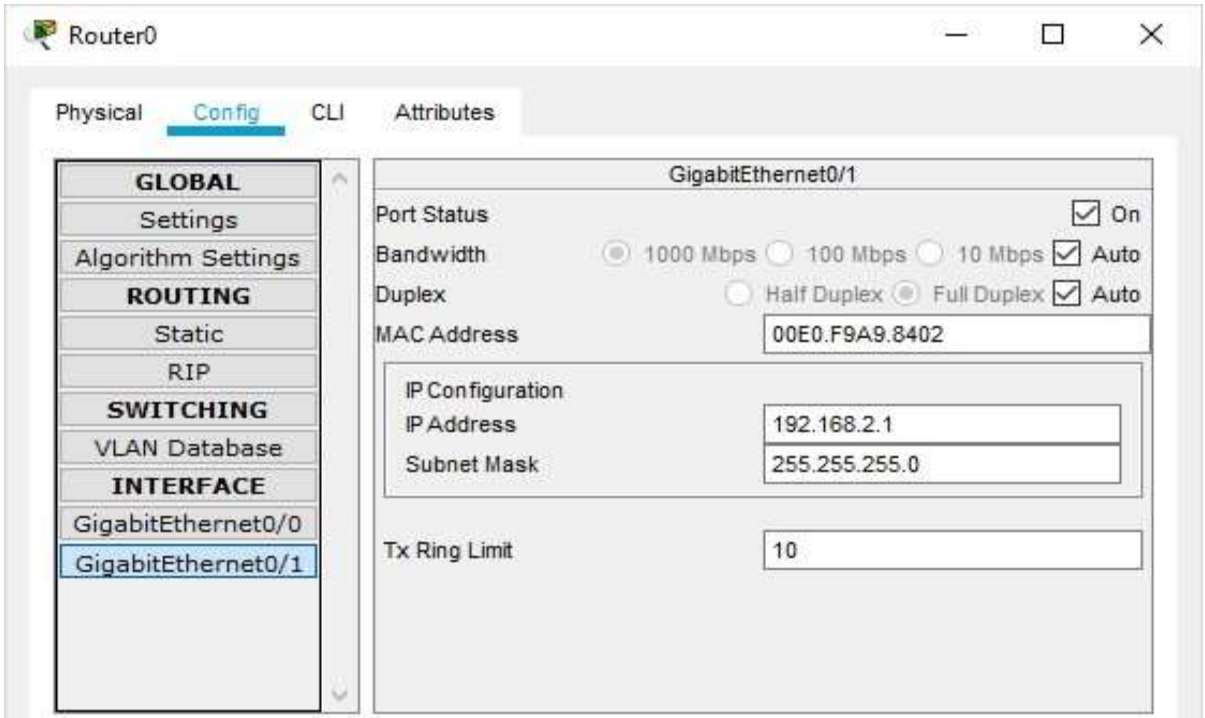


Configuring SYSLOG Server



Router0


Router0
Physical
Config
CLI
Attributes
GLOBAL
Settings
Algorithm Settings
ROUTING
Static
RIP
SWITCHING
VLAN Database
INTERFACE
GigabitEthernet0/0
GigabitEthernet0/1
GigabitEthernet0/0
Port Status
On
Bandwidth
1000 Mbps
100 Mbps
10 Mbps
Auto
Duplex
Half Duplex
Full Duplex
Auto
MAC Address
00E0.F9A9.8401
IP Configuration
IP Address
192.168.1.1
Subnet Mask
255.255.255.0
Tx Ring Limit
10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Half Duplex
Full Duplex
Auto
MAC Address
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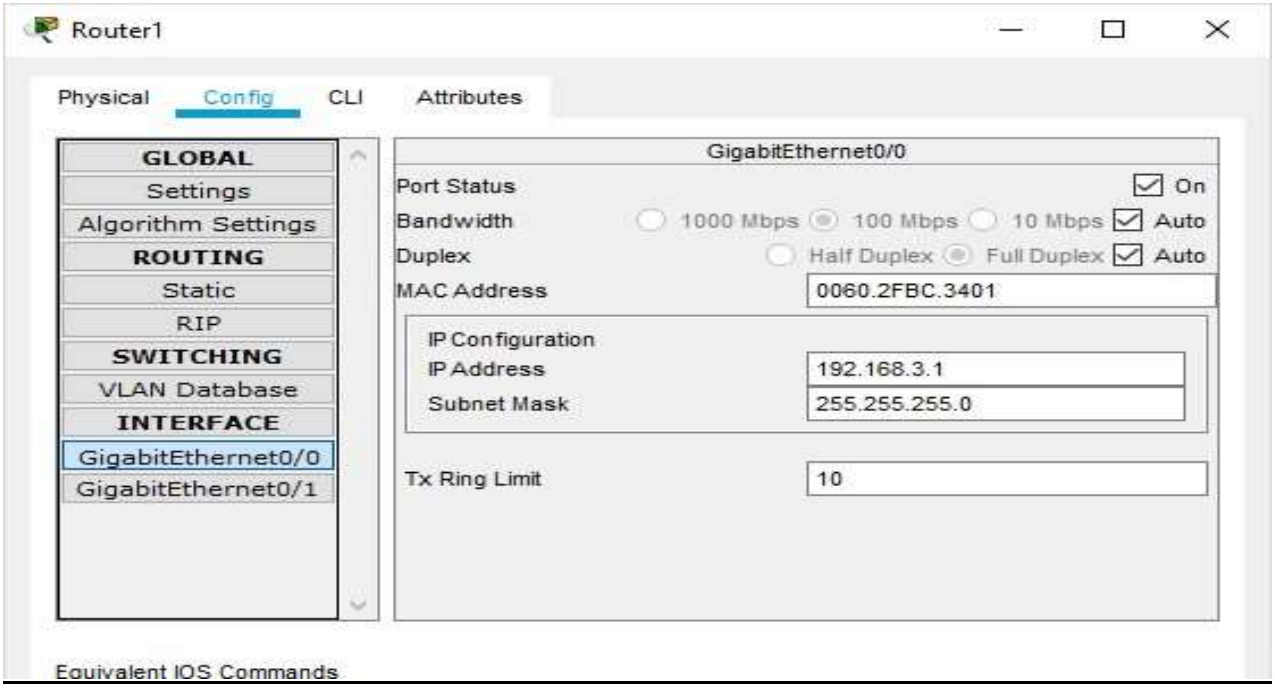
IP Configuration
IP Address
192.168.2.1
Subnet Mask
255.255.255.0
Tx Ring Limit
10

Router1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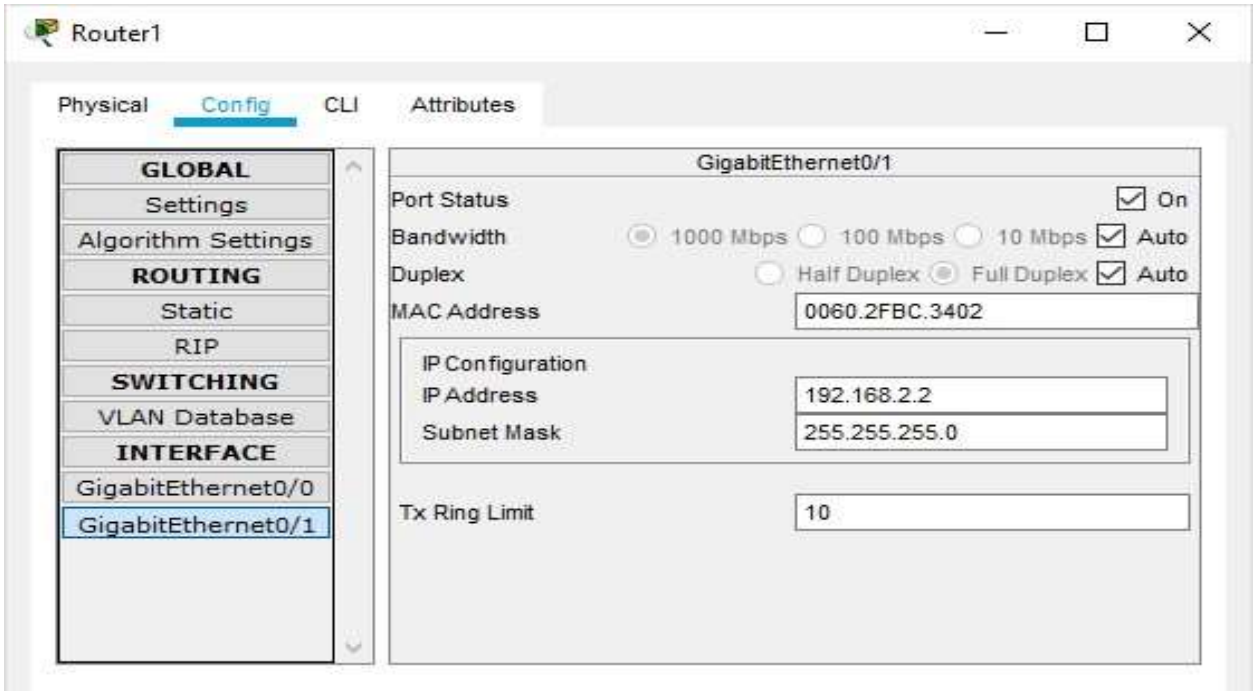
Auto
MAC Address
0060.2FBC.3401
IP Configuration
IP Address
192.168.3.1
Subnet Mask
255.255.255.0
Tx Ring Limit
10
Equivalent IOS Commands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GigabitEthernet0/0
GigabitEthernet0/1
GigabitEthernet0/1
Port Status
On
Bandwidth
1000 Mbps
100 Mbps
10 Mbps
Auto
Duplex
Half Duplex
Full Duplex
Auto
MAC Address
0060.2FBC.3402
IP Configuration
IP Address
192.168.2.2
Subnet Mask
255.255.255.0
Tx Ring Limit
10

Part 1: Configure OSPF MD5 Authentication

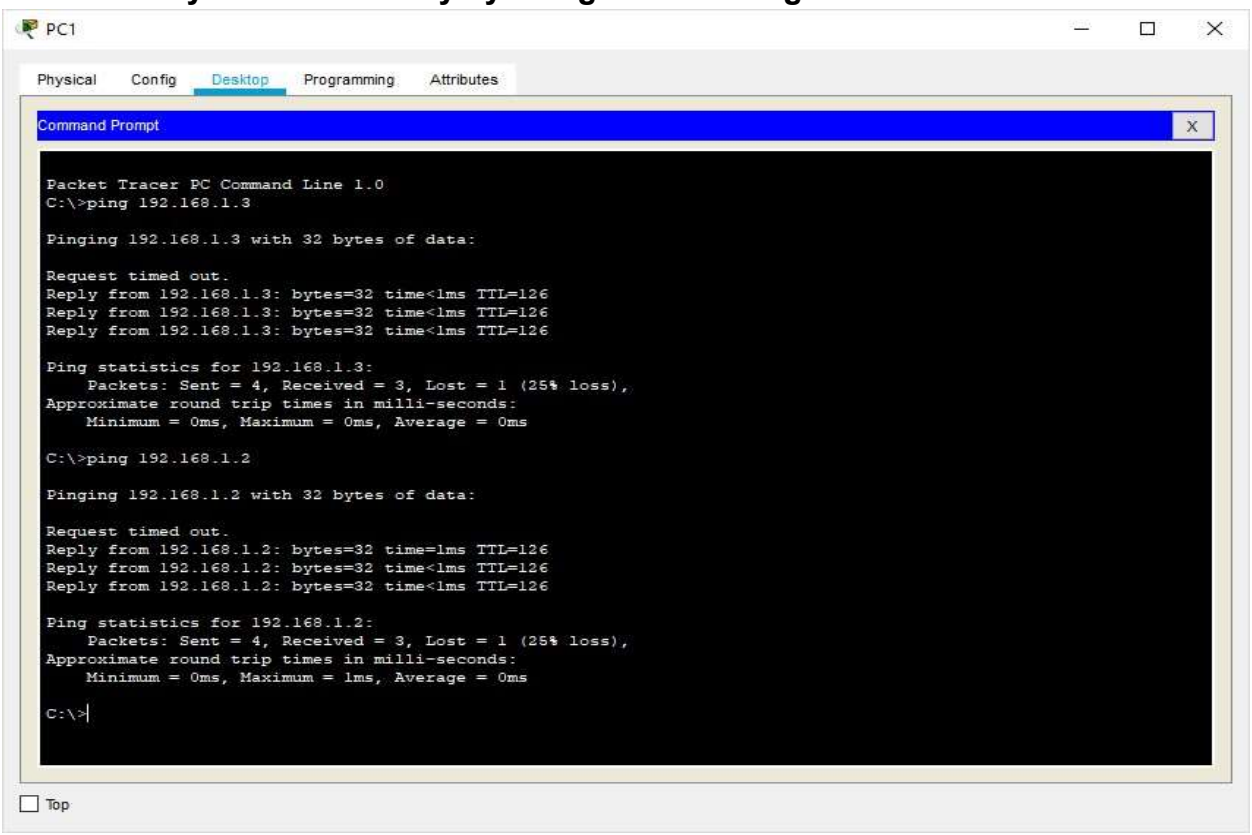
ROUTER 0: Type the following command in the CLI mode

```
Router>enable
Router#configure terminal
Router(config)#router ospf 1
Router(config-router)#network 192.168.1.0 0.255.255.255 area 1
Router(config-router)#network 192.168.2.0 0.255.255.255 area 1
Router(config-router)#exit
Router(config)#exit
Router#
```

ROUTER 1: Type the following command in the CLI mode

```
Router>enable
Router#configure terminal
Router(config)#router ospf 1
Router(config-router)#network 192.168.3.0 0.255.255.255 area 1
Router(config-router)#network 192.168.2.0 0.255.255.255 area 1
Router(config-router)#exit
Router(config)#exit
Router#
```

Now we verify the connectivity by using the following



Hence OSPF has been verified

MD5 Authentication

ROUTER 0: Type the following command in the CLI mode

Router>enable
Router#
Router#configure terminal
Router(config)#interface GigabitEthernet0/1
Router(config-if)#ip ospf authentication message-digest
Router(config-if)#ip ospf message-digest-key 1 md5 smile
Router(config-if)#exit
Router(config)#exit

ROUTER 1: Type the following command in the CLI mode

```
Router>enable
Router#
Router#configure terminal
Router(config)#interface GigabitEthernet0/1
Router(config-if)#ip ospf authentication message-digest
Router(config-if)#ip ospf message-digest-key 1 md5 smile
Router(config-if)#exit
Router(config)#exit
```

Verify the MD5 Authentication using the following command in the CLI mode of Router0

Router#show ip ospf interface gigabitEthernet 0/1

We get the following output:

```
GigabitEthernet0/1 is up, line protocol is up
Internet address is 192.168.2.1/24, Area 1
Process ID 1, Router ID 192.168.2.1, Network Type BROADCAST, Cost: 1
Transmit Delay is 1 sec, State BDR, Priority 1
Designated Router (ID) 192.168.3.1, Interface address 192.168.2.2
Backup Designated Router (ID) 192.168.2.1, Interface address 192.168.2.1
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
Hello due in 00:00:06
Index 2/2, flood queue length 0
Next 0x0(0)/0x0(0)
Last flood scan length is 1, maximum is 1
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 1, Adjacent neighbor count is 1
Adjacent with neighbor 192.168.3.1 (Designated Router)
Suppress hello for 0 neighbor(s)
```

Message digest authentication enabled

```
Youngest key id is 1
```

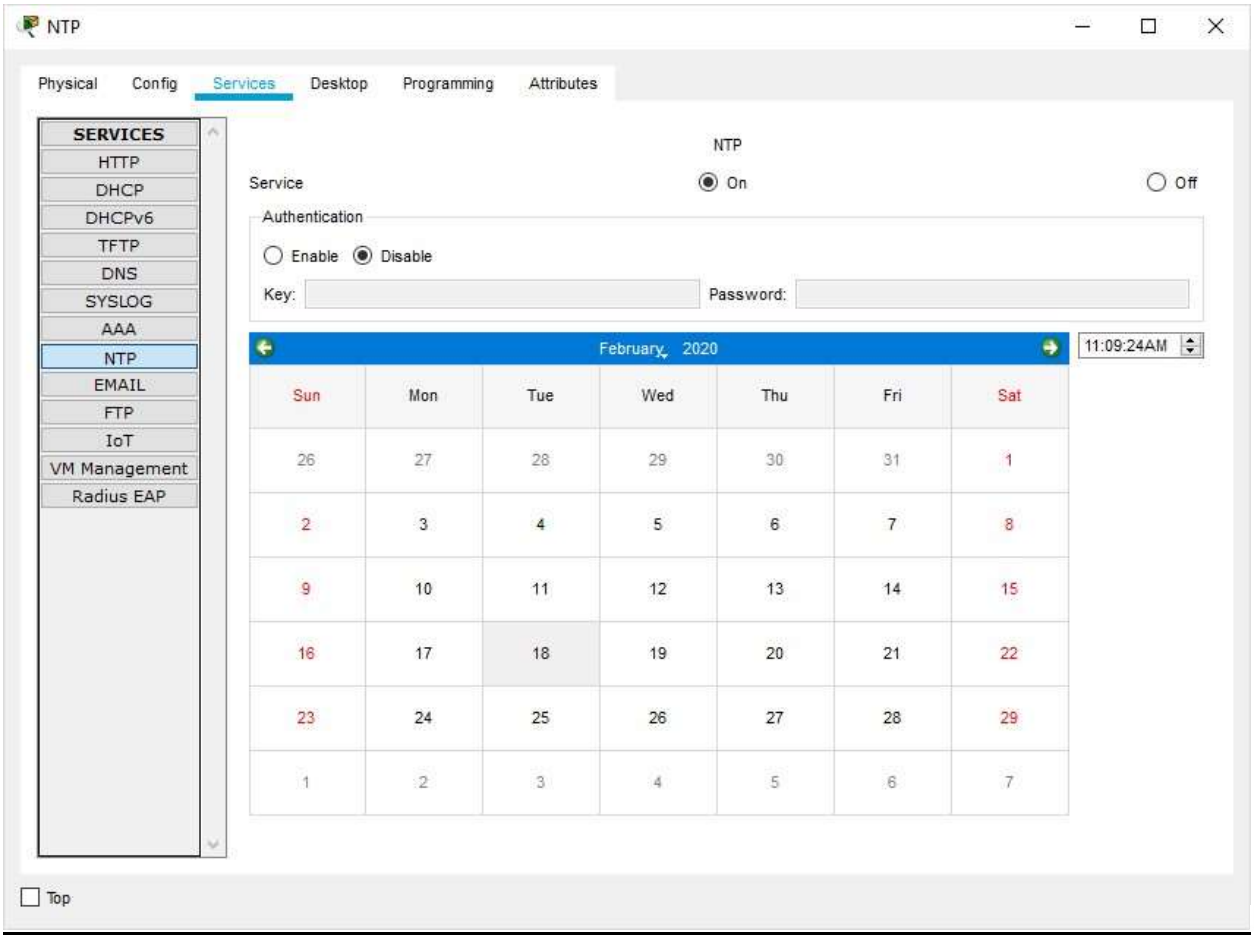
MD5 Authentication has been verified

b) NTP

- Network Time Protocol (NTP) is a TCP/IP protocol used to synchronize computer clocks across data networks.
- NTP was developed in the 1980s by D.L. Mills at the University of Delaware to achieve highly accurate time synchronization and to sustain the effects of variable latency over packet-switched data networks through a jitter buffer.

We use the same topology to study the given protocol

Configure NTP Server and enable the NTP service



We must disable the NTP service on other servers else output won't be obtained

Now Go to CLI Mode of Router4 and type the following commands on both the Routers

```
Router#config
Router#configure t
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#ntp server 192.168.1.3
Router(config)#ntp up
Router(config)#ntp update-calendar
Router(config)#exit
Router#
```

To verify the Output we use the following command

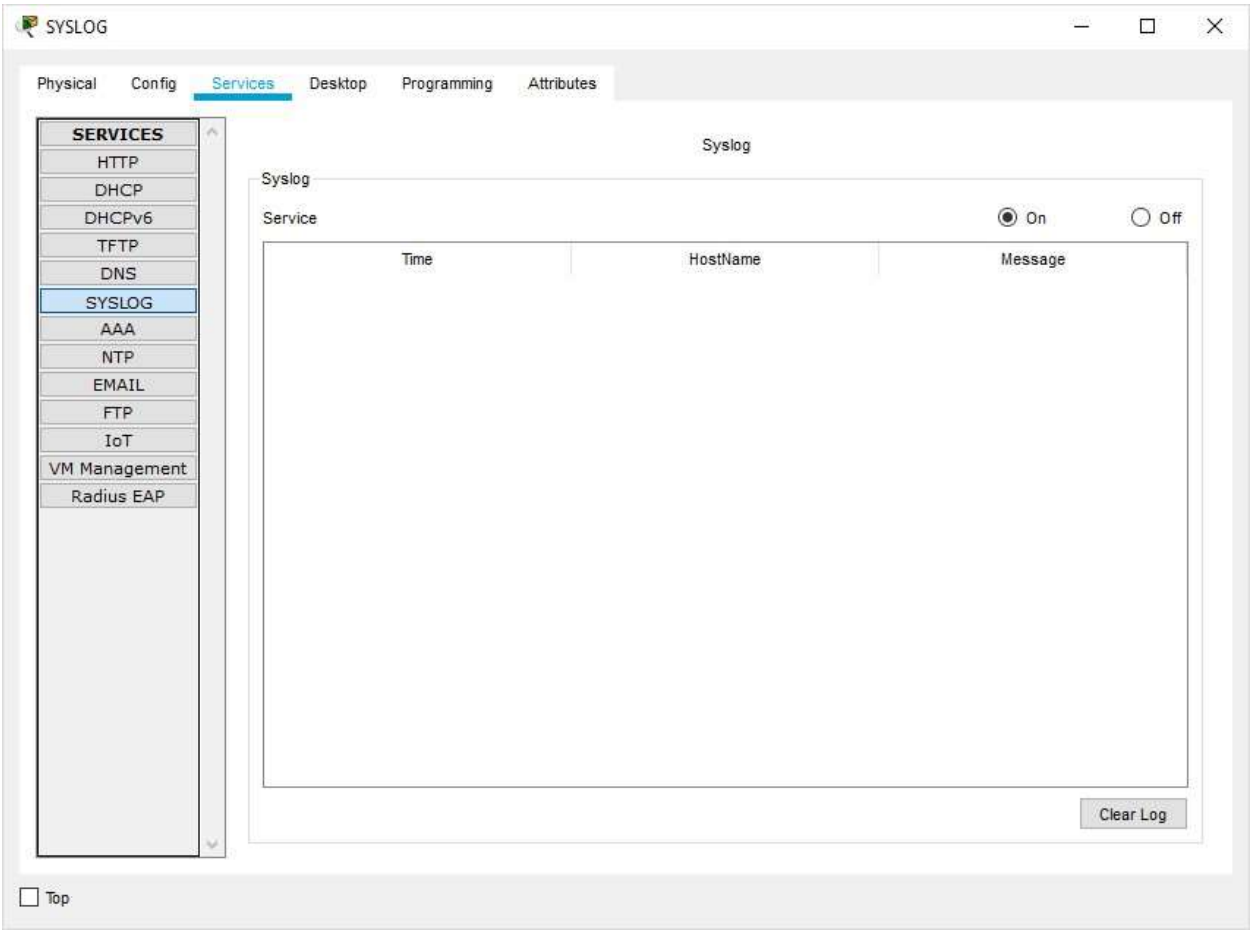
```
Router#show clock
11:14:58.985 UTC Tue Feb 18 2020
Router#
```

c) SYSLOG server

Configure SYSLOG Server and enable the service

- Syslog is a way for network devices to send event messages to a logging server – usually known as a Syslog server.
- The Syslog **protocol** is supported by a wide range of devices and can be used to log different types of events.
- For example, a router might send messages about users logging on to console sessions, while a web-server might log access-denied events.

Turn ON the SYSLOG service on the server

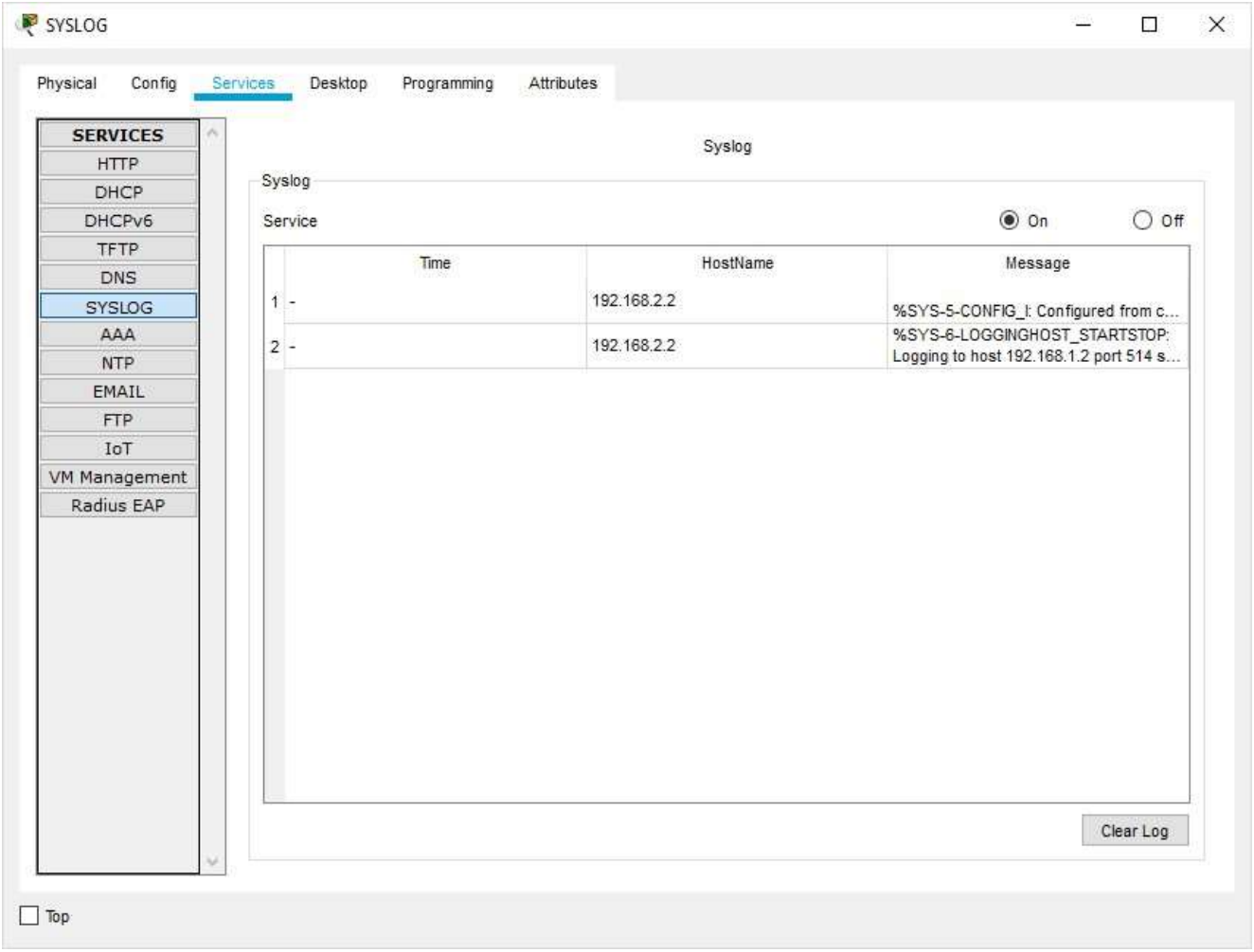


And Turn OFF on all other Servers

<u>Now Go to CLI Mode of any Router and type the following commands in all the Routers.</u>

```
Router#
Router#configure terminal
Router(config)#logging 192.168.1.2
Router(config)#exit
Router#
```

Output:



d) SSH

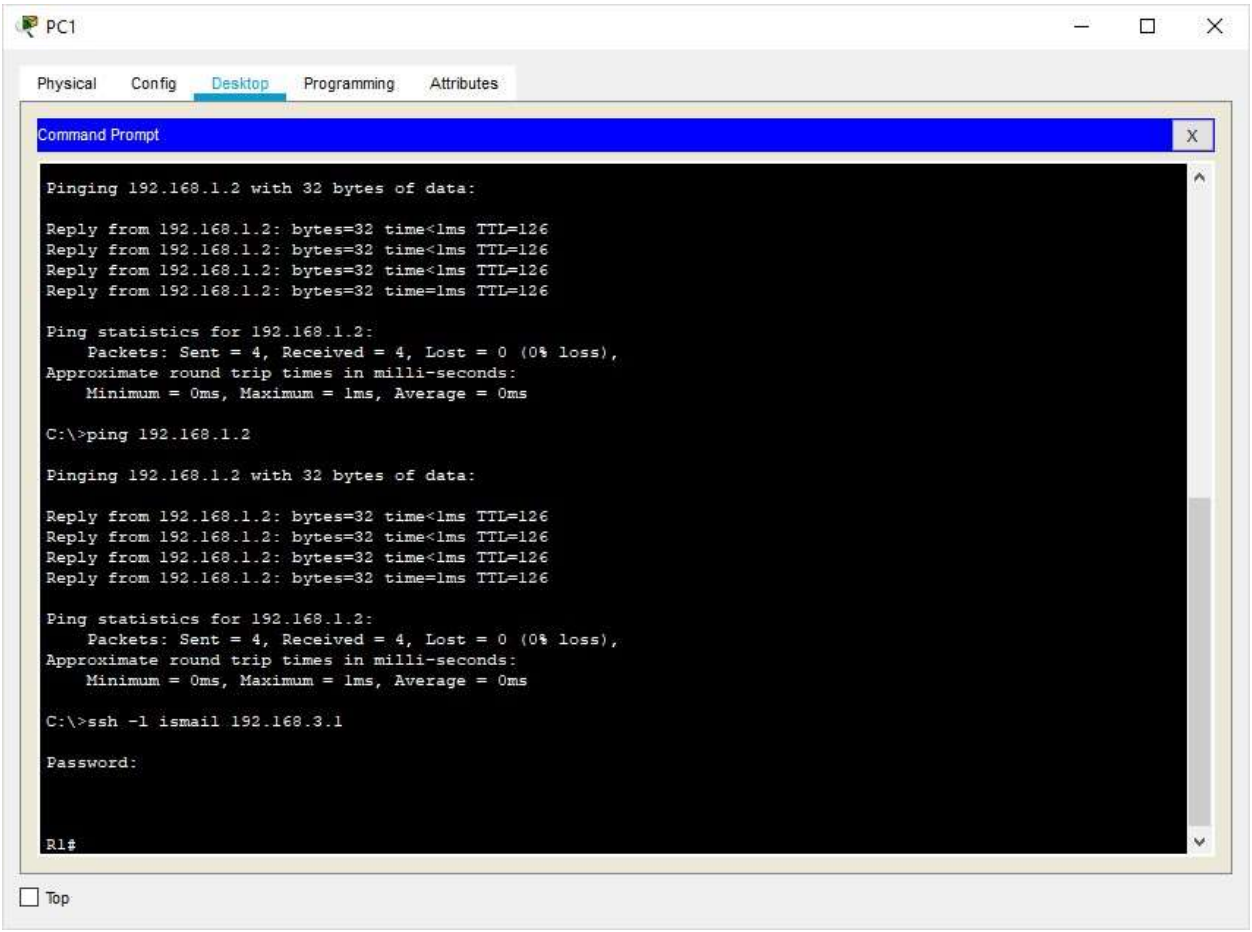
- An **SSH server** is a software program which uses the secure shell protocol to accept connections from remote computers.
- The way **SSH works** is by making use of a client-server model to allow for authentication of two remote systems and encryption of the data that passes between them.
- It organizes the secure connection by authenticating the client and opening the correct shell environment if the verification is successful.

Now Go to CLI Mode of Router0 and type the following commands.

```
Router#configure terminal
Router(config)#ip domain-name ismail.com
Router(config)#hostname R1
R1(config)#
R1(config)#crypto key generate rsa


The name for the keys will be: R1.ismail.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.


R1(config)#line vty 0 4
R1(config-line)#transport input ssh
R1(config-line)#login local
R1(config-line)#exit
R1(config)#username ismail privilege 15 password cisco R1(config)#
```

Output: Go to cmd of PC1 and type the command ssh

–l ismail 192.168.3.1 and type the password cisco



Hence SSH is also verified

PRACTICAL NO 2: Configure ACLs

The Cisco Access Control List (ACL) are used for filtering traffic based on a given filtering criteria on a router or switch interface. Based on the conditions supplied by the ACL, a packet is allowed or blocked from further movement.

Cisco ACLs are available for several types of routed protocols including IP, IPX, AppleTalk, XNS, DECnet, and others. However, we will be discussing ACLs pertaining to TCP/IP protocol only.

ACLs for TCP/IP traffic filtering are primarily divided into two types:

- Standard Access Lists, and
- Extended Access Lists

Standard Access Control Lists:

Standard IP ACLs range from 1 to 99. A Standard Access List allows you to permit or deny traffic FROM specific IP addresses. The destination of the packet and the ports involved can be anything.

This is the command syntax format of a standard ACL.

access-list *access-list-number* {permit|deny}

{host|source source-wildcard|any} Standard

ACL example:

access-list 10 permit 192.168.2.0 0.0.0.255

This list allows traffic from all addresses in the range 192.168.2.0 to 192.168.2.255

Note that when configuring access lists on a router, you must identify each access list uniquely by assigning either a name or a number to the protocol's access list.

There is an implicit deny added to every access list. If you entered the command:

show access-list 10 The

output looks like:

access-list 10 permit 192.168.2.0 0.0.0.255 access-list 10 deny any

Extended Access Control Lists:

Extended IP ACLs allow you to permit or deny traffic from specific IP addresses to a specific destination IP address and port. It also allows you to have granular control by specifying controls for different types of protocols such as ICMP, TCP, UDP, etc within the ACL statements. Extended IP ACLs range from 100 to 199. In Cisco IOS Software Release 12.0.1, extended ACLs began to use additional numbers (2000 to 2699).

The syntax for IP Extended ACL is given below:

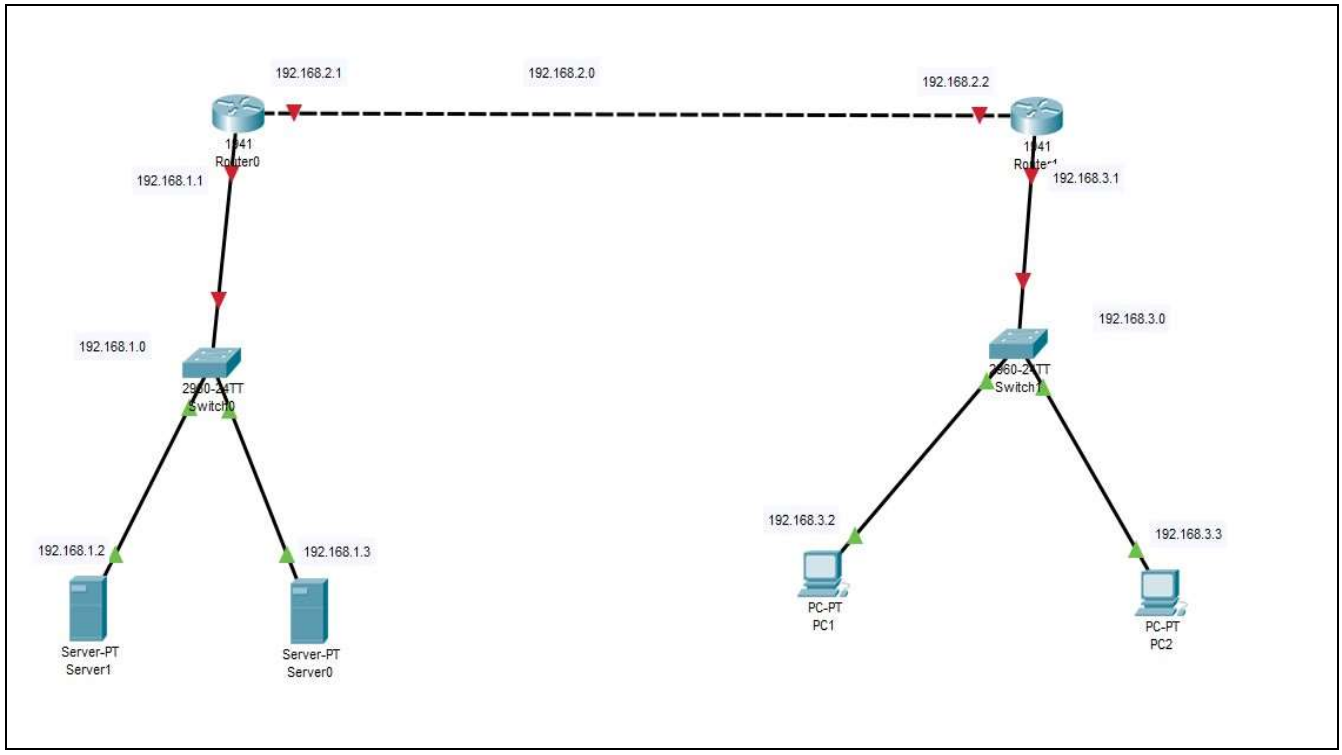
access-list access-list-number {deny | permit} protocol source source-wildcard *destination* destination-wildcard [precedence precedence]

Note that the above syntax is simplified, and given for general understanding only.
Extended ACL example:
access-list 110 - Applied to traffic leaving the office (outgoing) access-list
110 permit tcp 92.128.2.0 0.0.0.255 any eq 80
ACL 110 permits traffic originating from any address on the 92.128.2.0 network. The 'any' statement means that the traffic is allowed to have any destination address with the limitation of going to port 80. The value of 0.0.0.0/255.255.255.255 can be specified as 'any'.

Applying an ACL to a router interface:

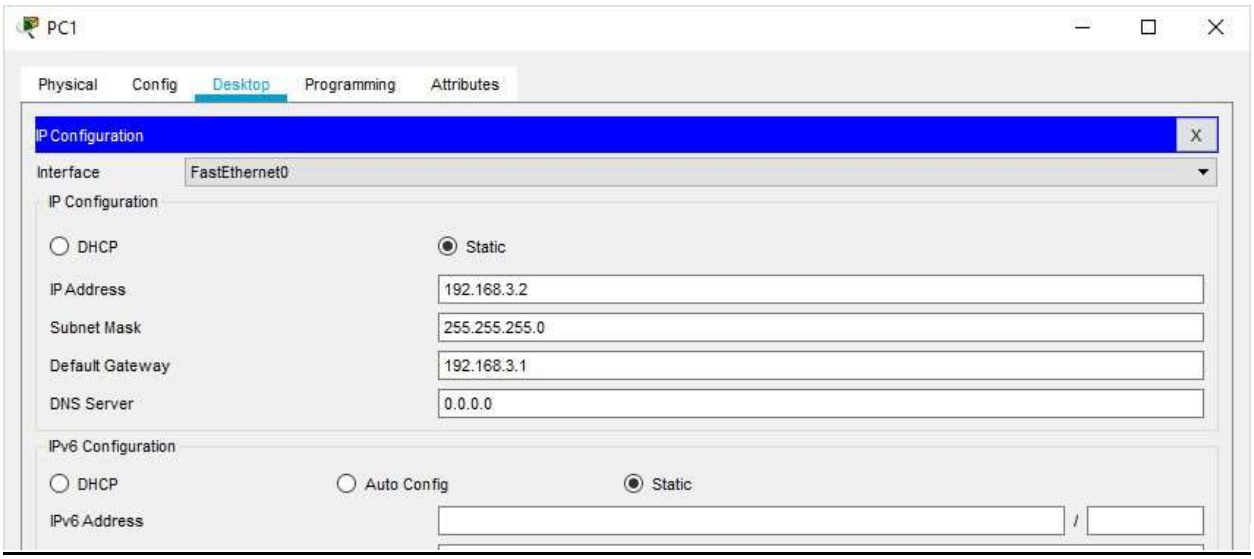
After the ACL is defined, it must be applied to the interface (inbound or outbound). The syntax for applying an ACL to a router interface is given below: interface <interface>
ip access-group {number|name} {in|out}
An Access List may be specified by a name or a number. "in" applies the ACL to the inbound traffic, and "out" applies the ACL on the outbound traffic.
Example: To apply the standard ACL created in the previous example, use the following commands:
Rouer(config)#interface serial0
Rouer(config-if)#ip access-group 10 out

Consider the following topology

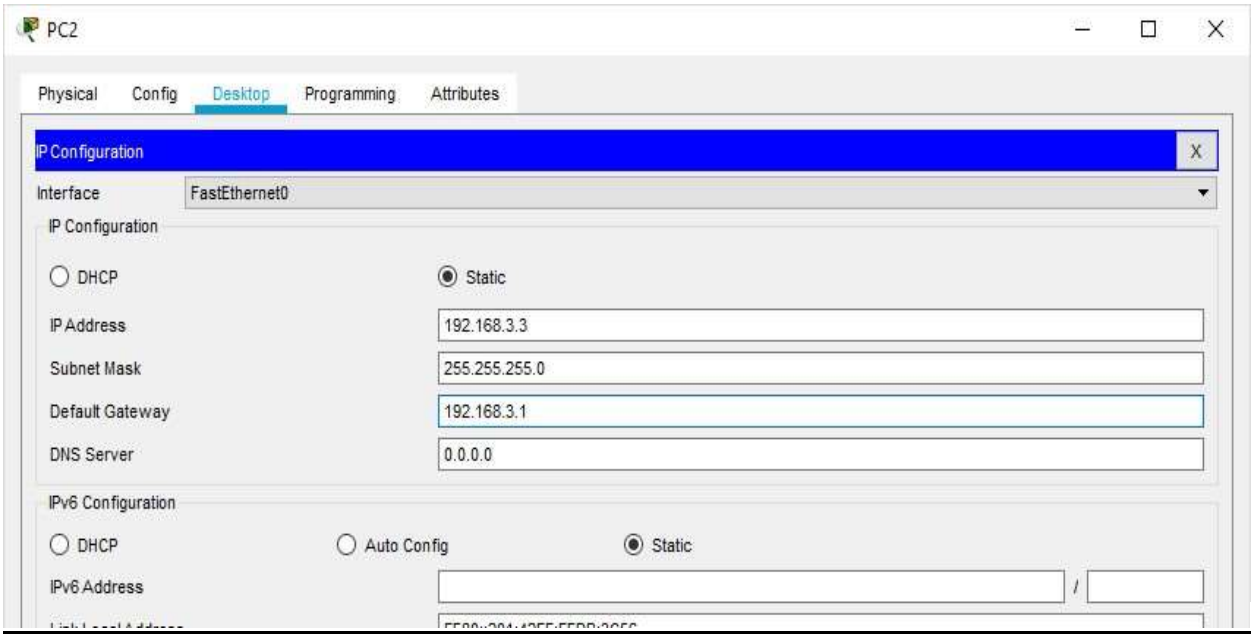


Part 1: Configure, Apply and Verify an Extended Numbered ACL

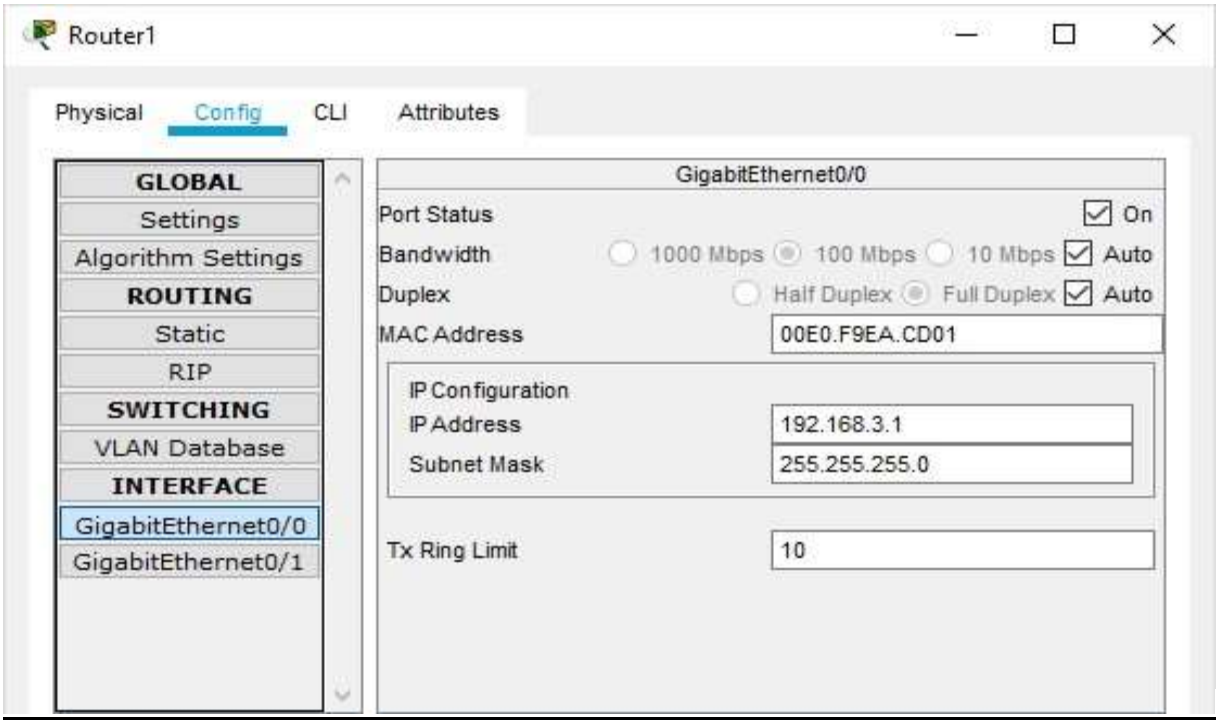
Configuring PC1

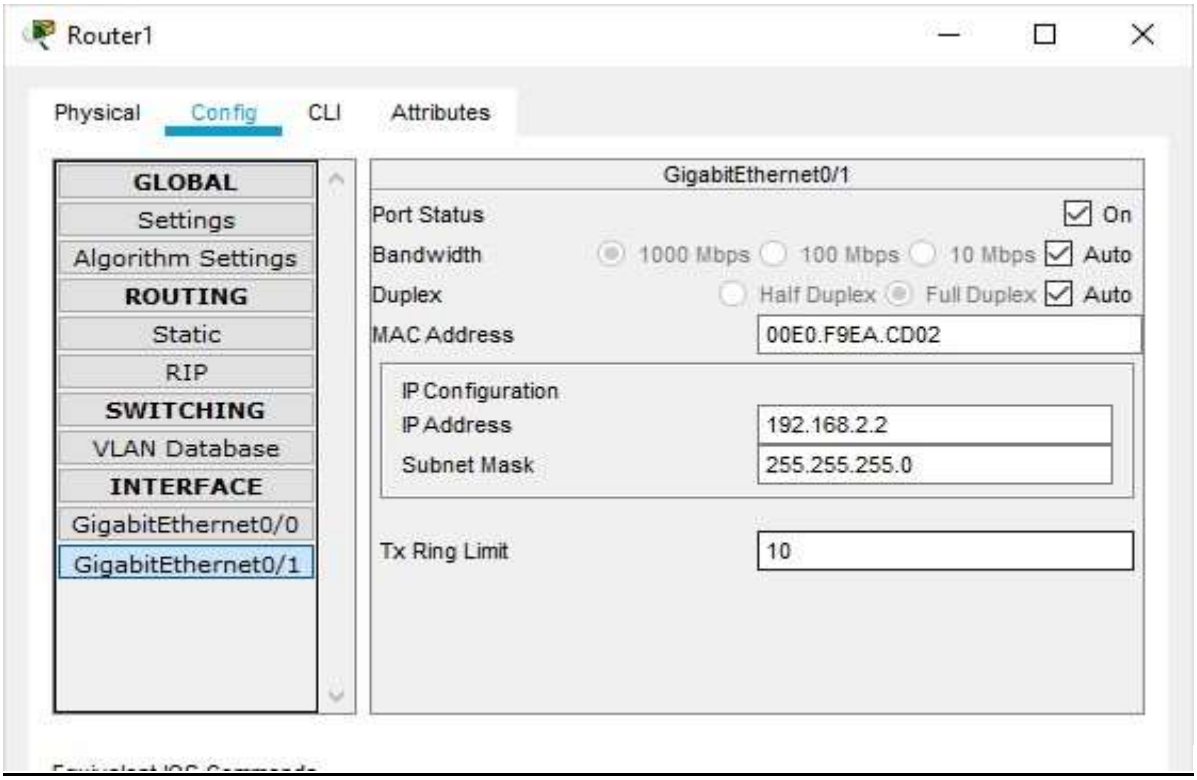


Configuring PC2

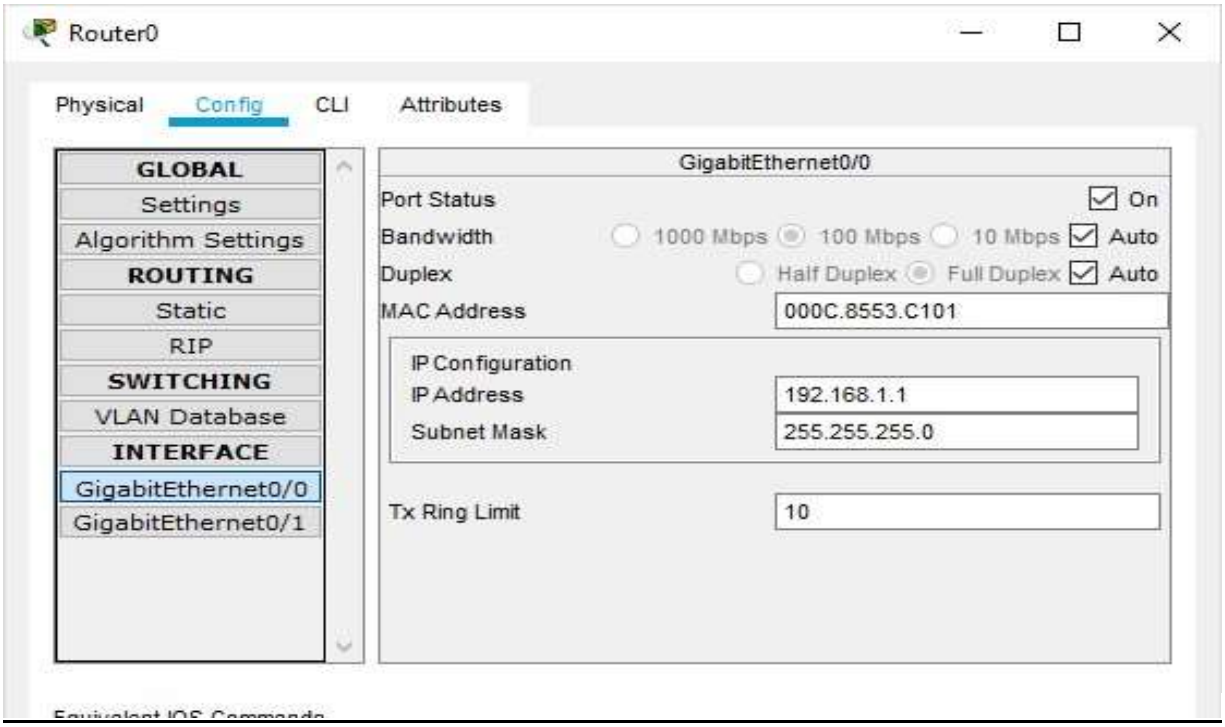


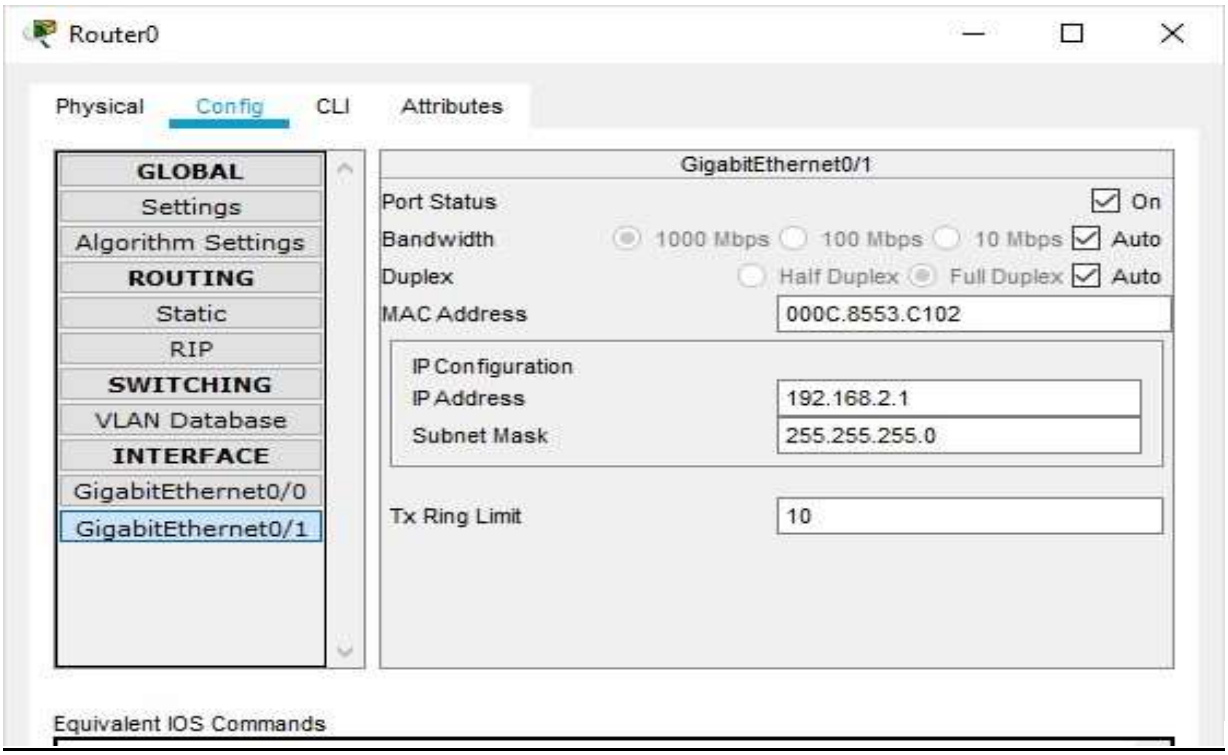
Configuring Router1



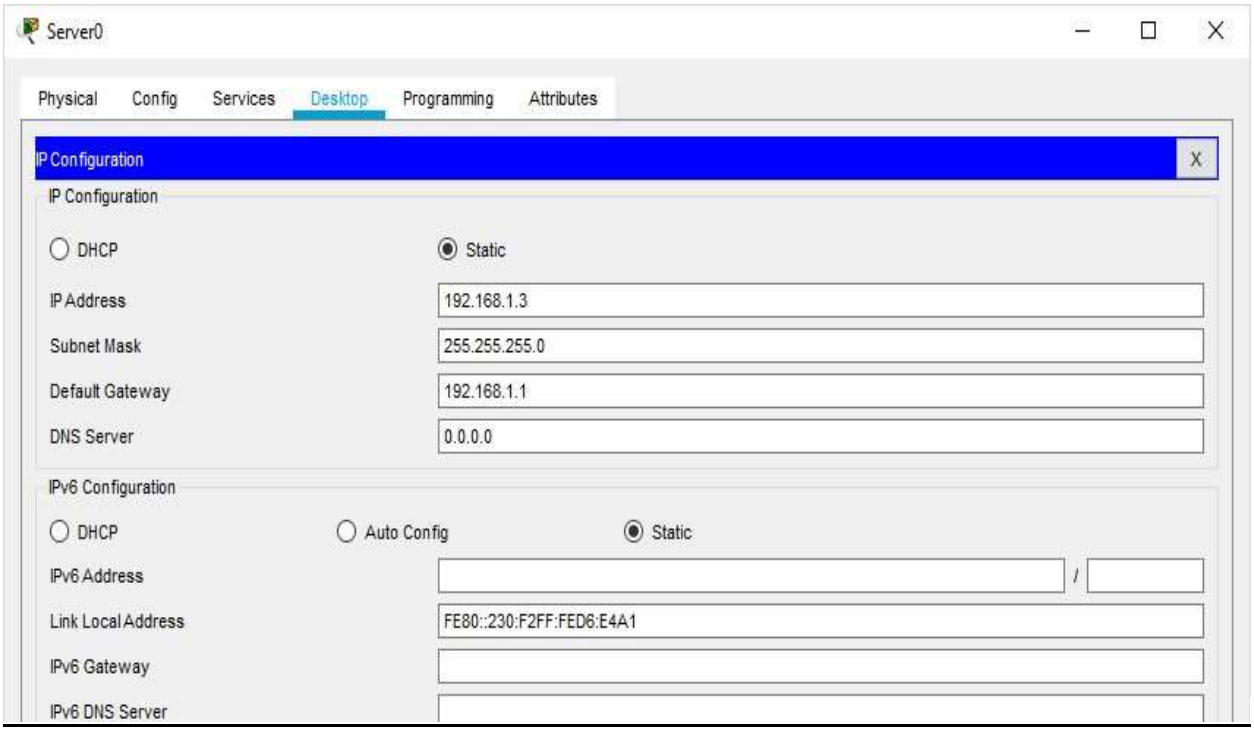


Configuring Router0

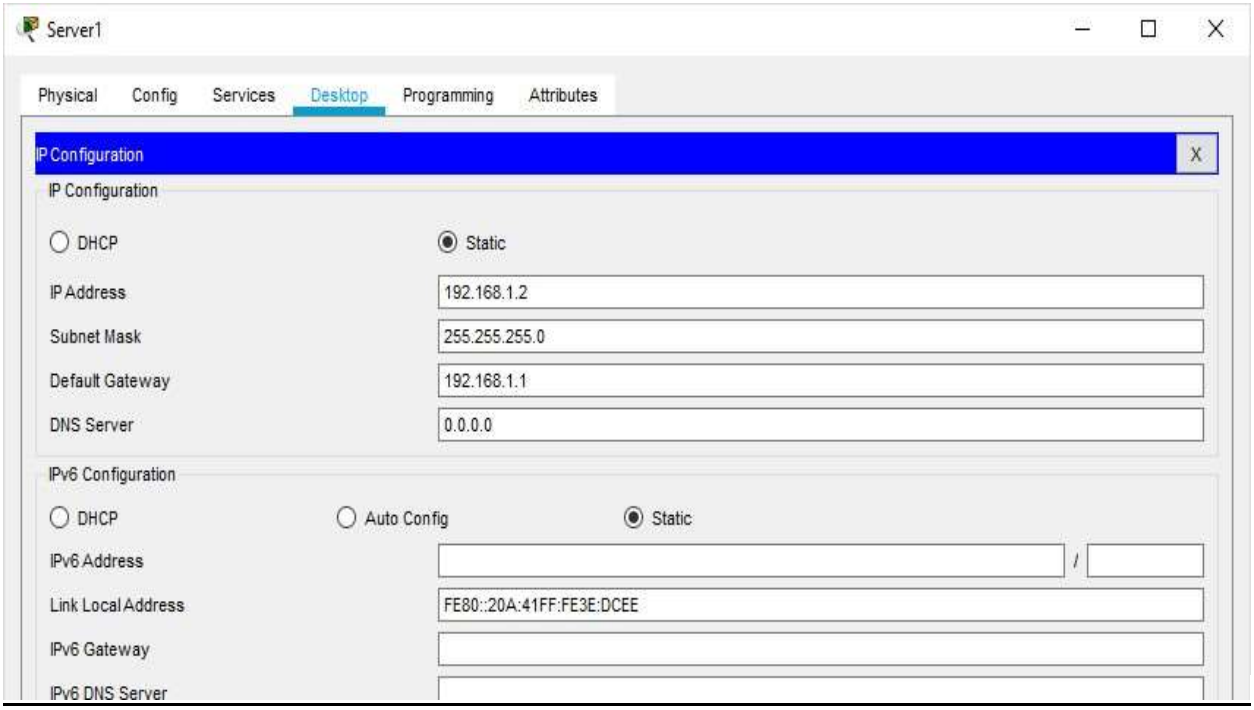




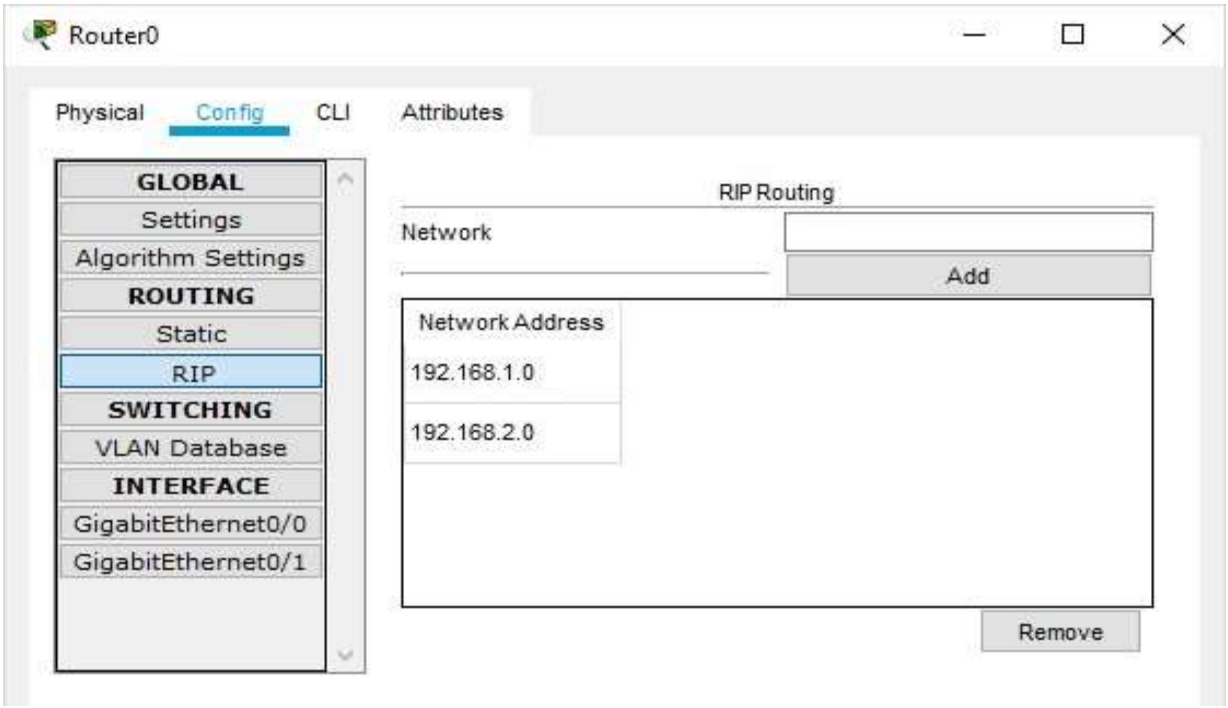
Configuring Server0

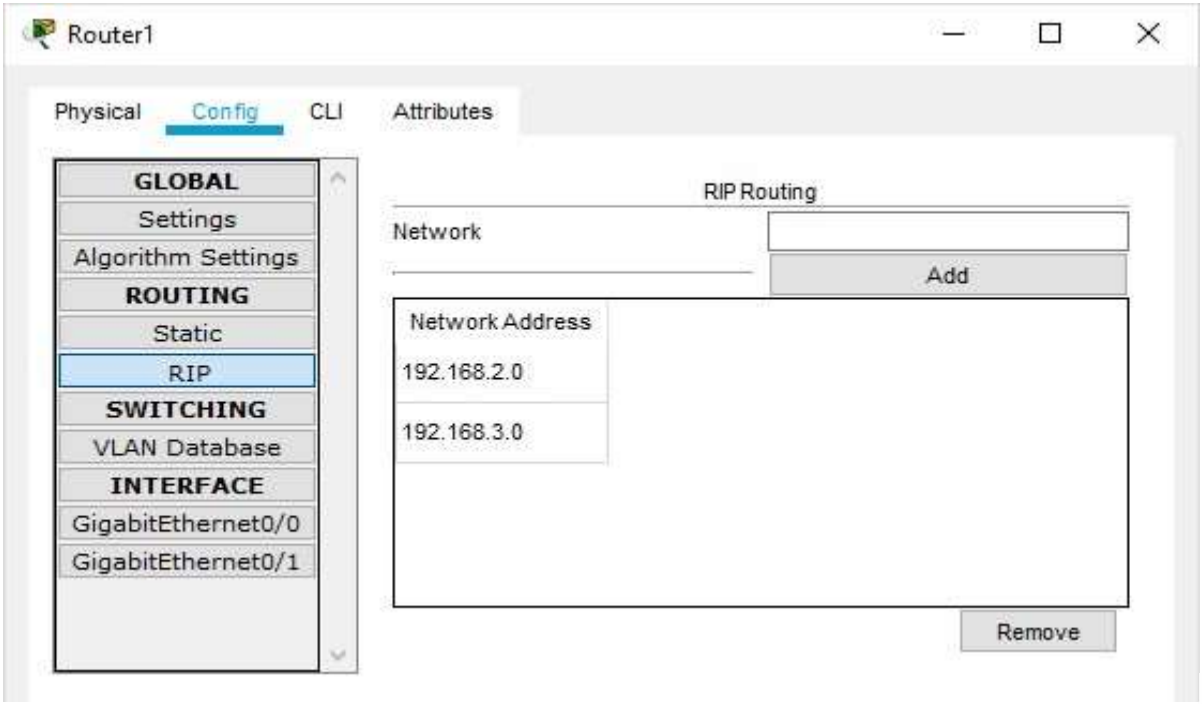


Configuring Server1



Set the RIP protocol on both the Routers as follows





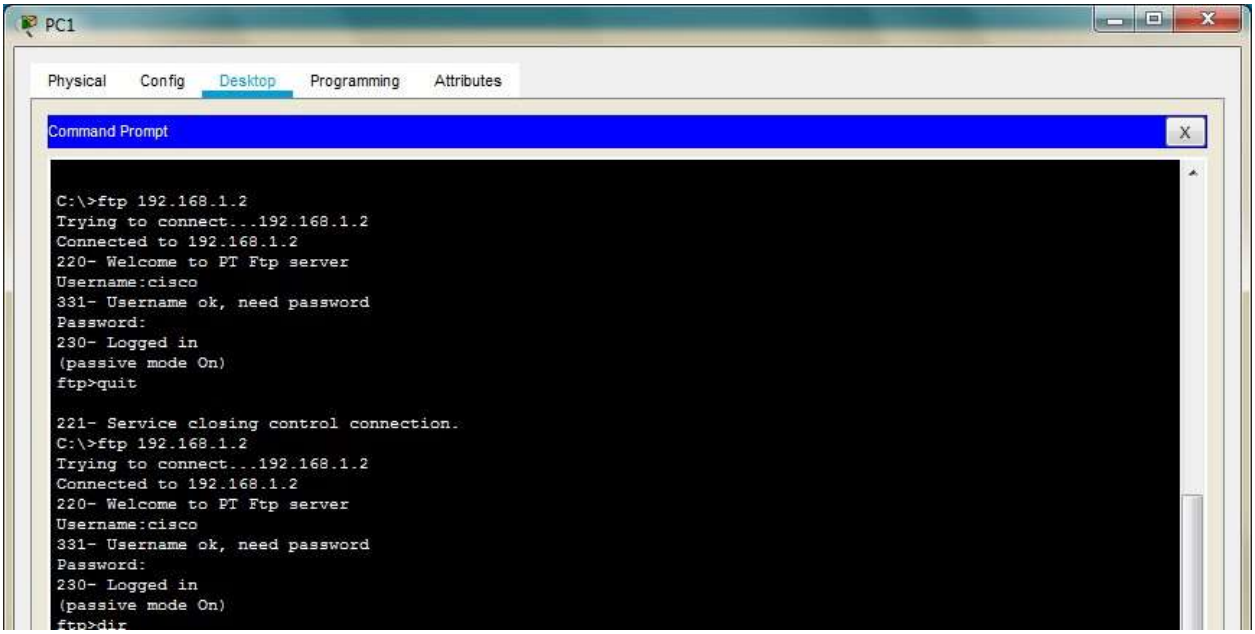
Check the connectivity by using the ping command

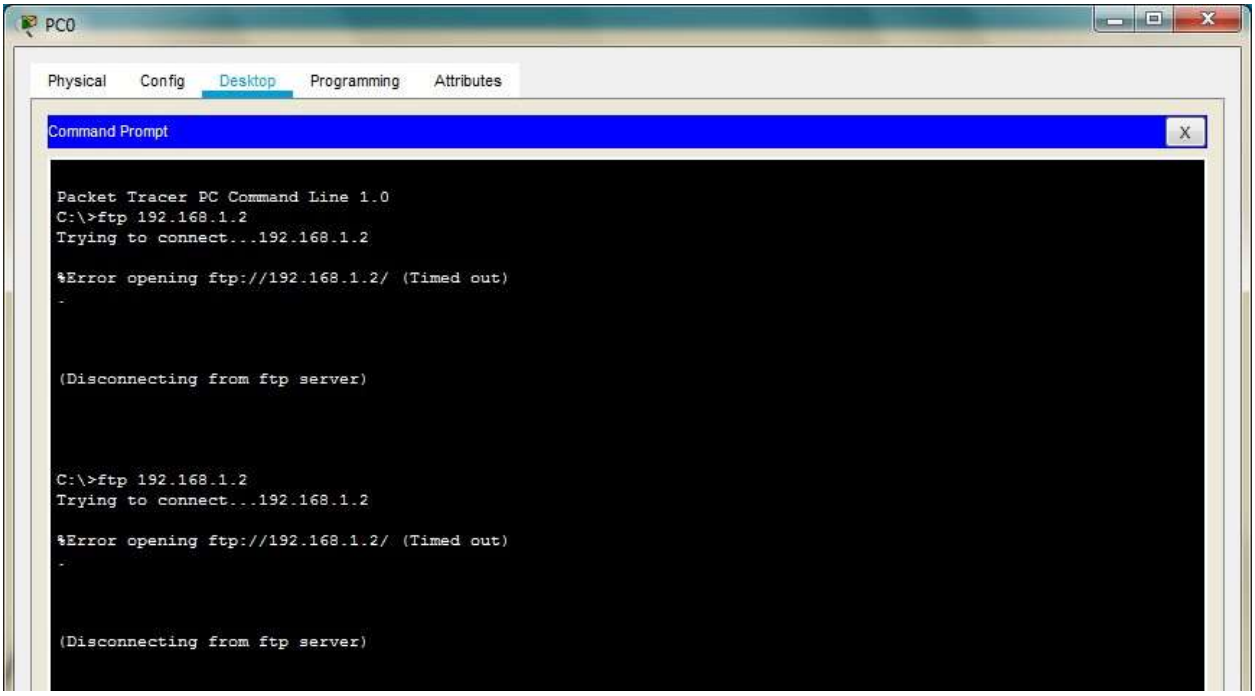
Part 1: Configure, Apply and Verify an Extended Numbered ACL

Type the following commands in Router1

Router#configure terminal
Router(config)#
Router(config)#access-list 100 permit tcp host 192.168.3.2 host 192.168.1.2 eq ftp
Router(config)#interface GigabitEthernet0/1
Router(config-if)#ip access-group 100 out
Router(config-if)#exit Router(config)#

Now verify the ftp (ftp 192.168.1.2) command from both the PCs, one would be successful (PC1) and other (PC0) would fail





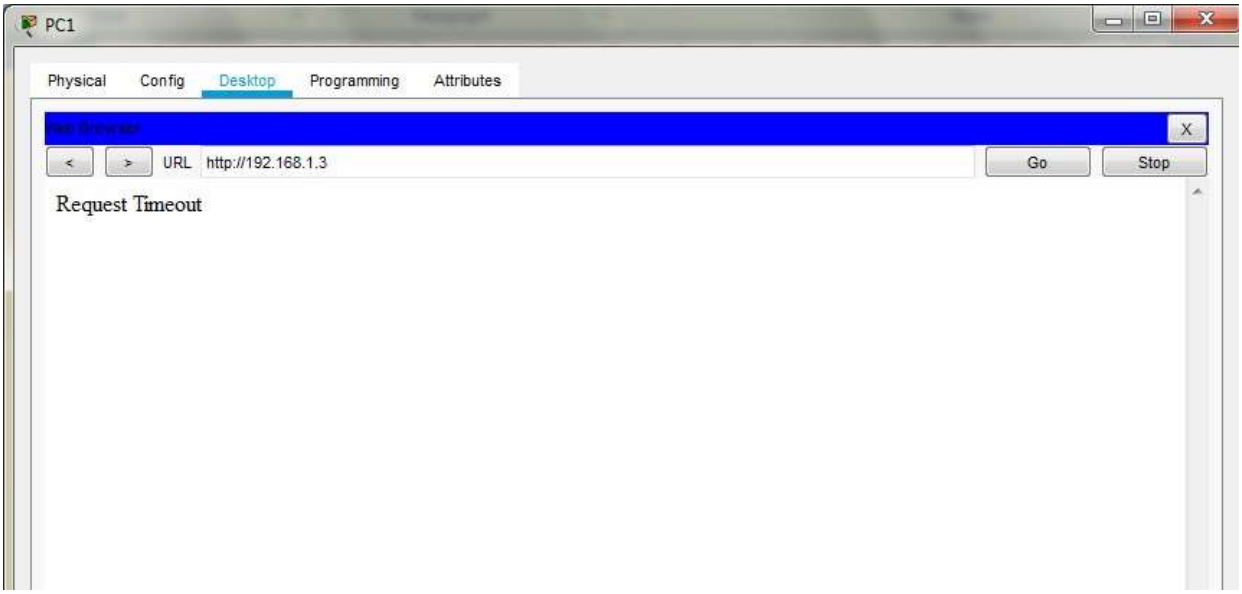
Part 2: Configure, Apply and Verify an Extended Named ACL

We use the same topology for this case

Type the following command in the CLI mode of Router1

Router>
Router>en
Router#configure terminal
Router(config)#ip access-list extended SMILE
Router(config-ext-nacl)#permit tcp host 192.168.3.3 host 192.168.1.3 eq www
Router(config-ext-nacl)#exit
Router(config)#
Router(config)#interface GigabitEthernet0/1
Router(config-if)#ip access-group SMILE out
Router(config-if)#exit
Router(config)#

Now verify the www (192.168.1.3) command from both the PCs browser, one would be successful (PC0) and other (PC1) would fail



Hence Extended Numbered ACLs as well as Extended Named ACLs have been verified

PRACTICAL NO 3: Configure AAA Authentication on Cisco Routers

To provide a centralized management system for the authentication, authorization and accounting (AAA framework), Access Control Server (ACS) is used. For the communication between the client and the ACS server, two protocols are used namely TACACS+ and RADIUS.

TACACS+

Terminal Access Controller Access Control System (TACACS+) is Cisco proprietary protocol which is used for the communication of the Cisco client and Cisco ACS server. It uses TCP port number 49 which makes it reliable.

RADIUS –

Remote Access Dial In User Service (RADIUS) is an open standard protocol used for the communication between any vendor AAA client and ACS server. If one of the client or server is from any other vendor (other than Cisco) then we have to use RADIUS. It uses port number 1812 for authentication and authorization and 1813 for accounting.

TACACS+	RADIUS
Cisco proprietary protocol	open standard protocol
It uses TCP as transmission protocol	It uses UDP as transmission protocol
It uses TCP port number 49.	It uses UDP port number 1812 for authentication and authorization and 1813 for accounting.
Authentication, Authorization and Accounting is separated in TACACS+.	Authentication and Authorization is combined in RADIUS.
All the AAA packets are encrypted.	Only the passwords are encrypted while the other information such as username, accounting information etc are not encrypted.
Preferably used for ACS.	used when ISE is used

It provides more granular control i.e can specify the particular command for authorization.	No external authorization of commands supported.
TACACS+ offers multiprotocol support	No multiprotocol support.
Used for device administration.	used for network access

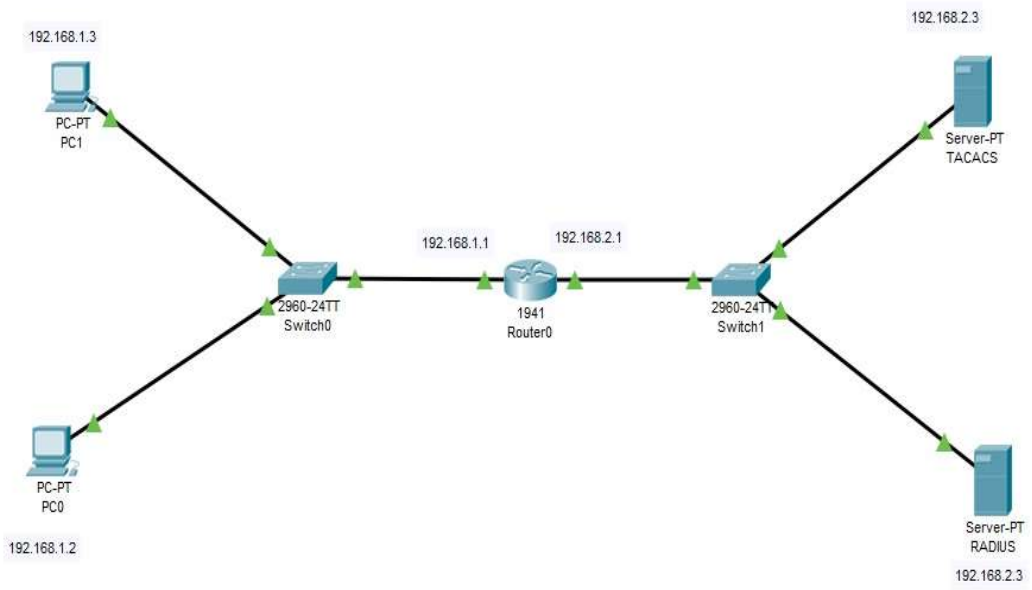
Similarities –
The process is start by Network Access Device (NAD – client of TACACS+ or RADIUS). NAD contact the TACACS+ or RADIUS server and transmit the request for authentication (username and password) to the server. First, NAD obtain username prompt and transmit the username to the server and then again the server is contact by NAD to obtain password prompt and then the password is send to the server. The server replies with access-accept message if the credentials are valid otherwise send an accessreject message to the client. Further authorisation and accounting is different in both protocols as authentication and authorisation is combined in RADIUS

Advantages (TACACS+ over RADIUS) –

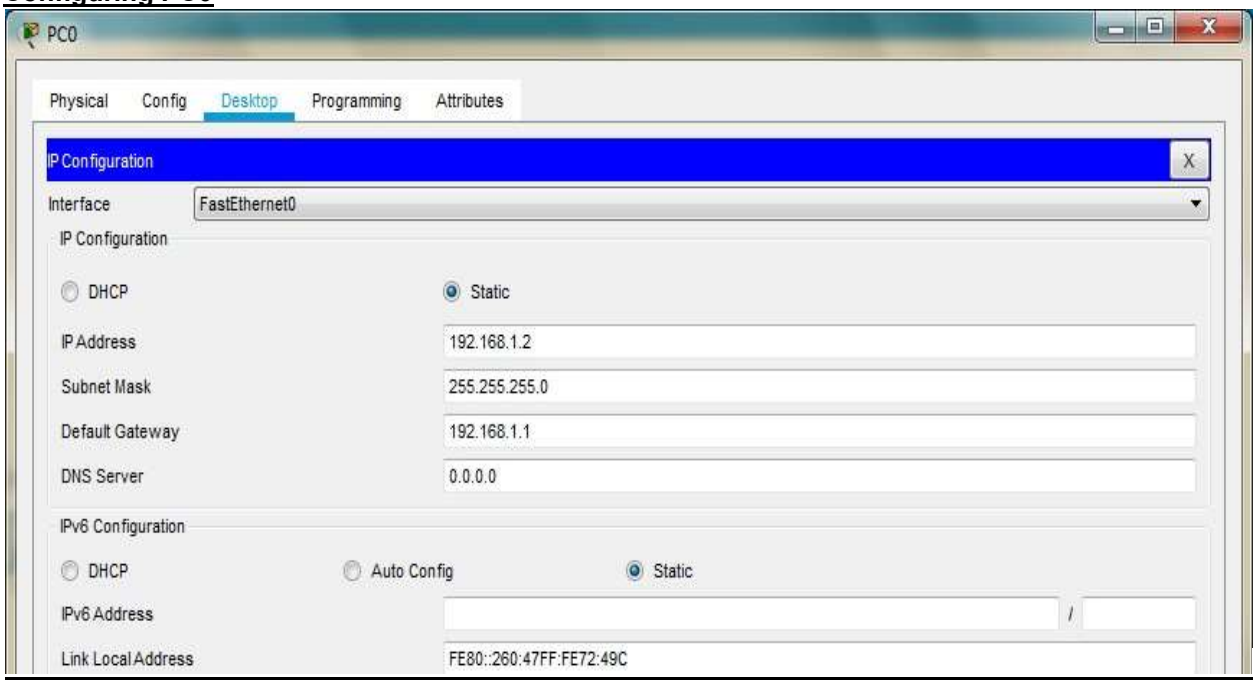
1. As TACACS+ uses TCP therefore more reliable than RADIUS.
2. TACACS+ provides more control over the authorization of commands while in RADIUS, no external authorization of commands is supported.
3. All the AAA packets are encrypted in TACACS+ while only the passwords are encrypted in RADIUS i.e more secure.

Advantage (RADIUS over TACACS+) –

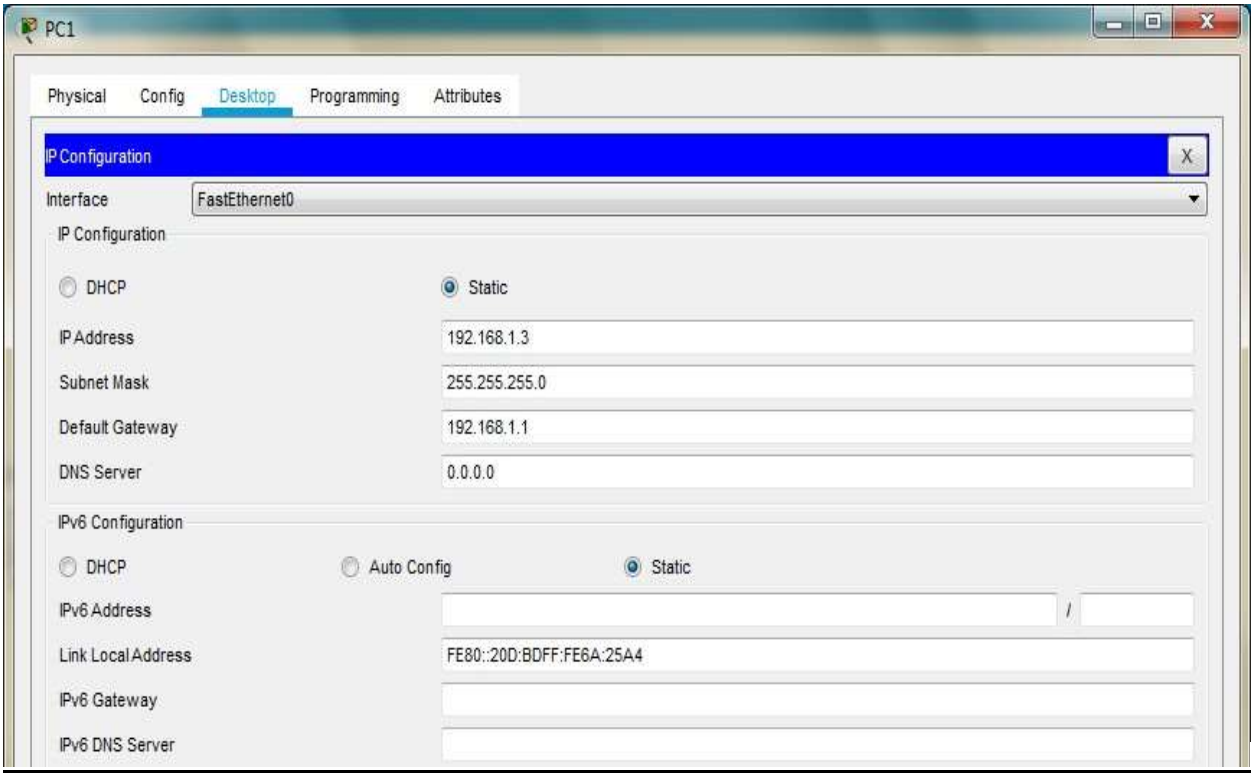
1. As it is open standard therefore RADIUS can be used with other vendors device while because TACACS+ is Cisco proprietary, it can be used with Cisco devices only.
2. It has more extensive accounting support than TACACS+. We use the following Topology for the present case



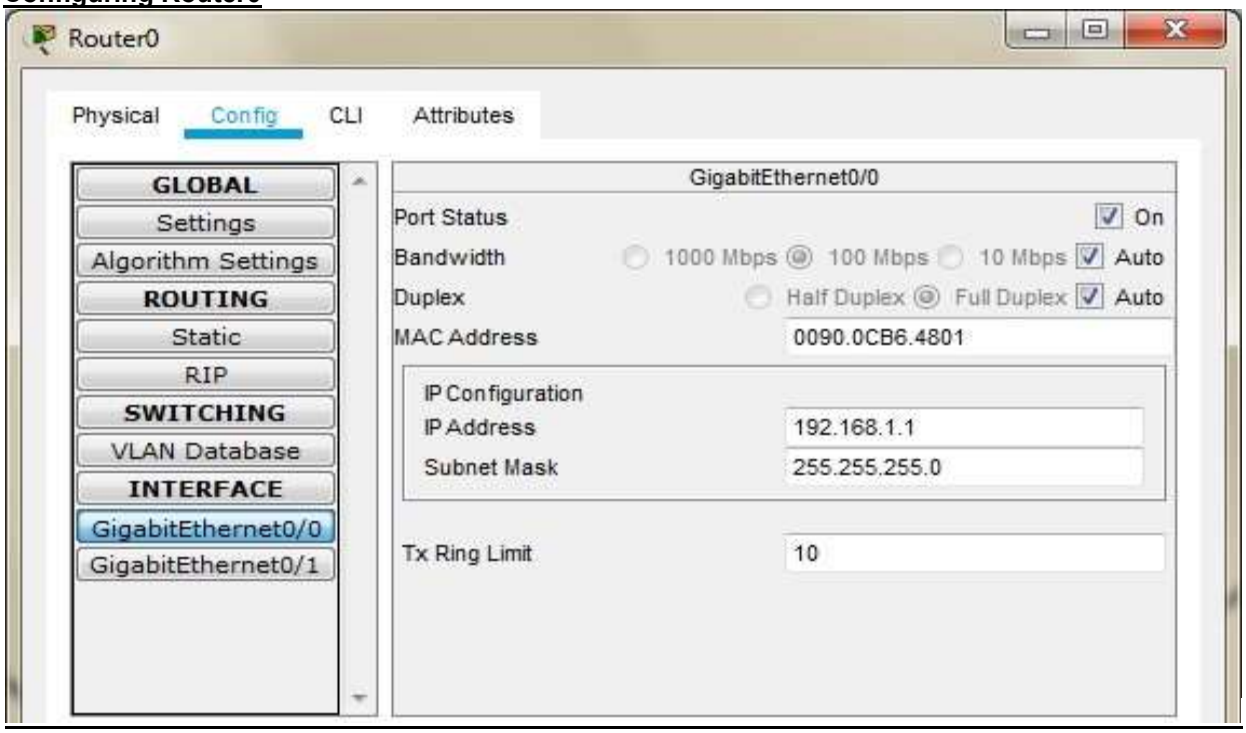
Configuring PC0

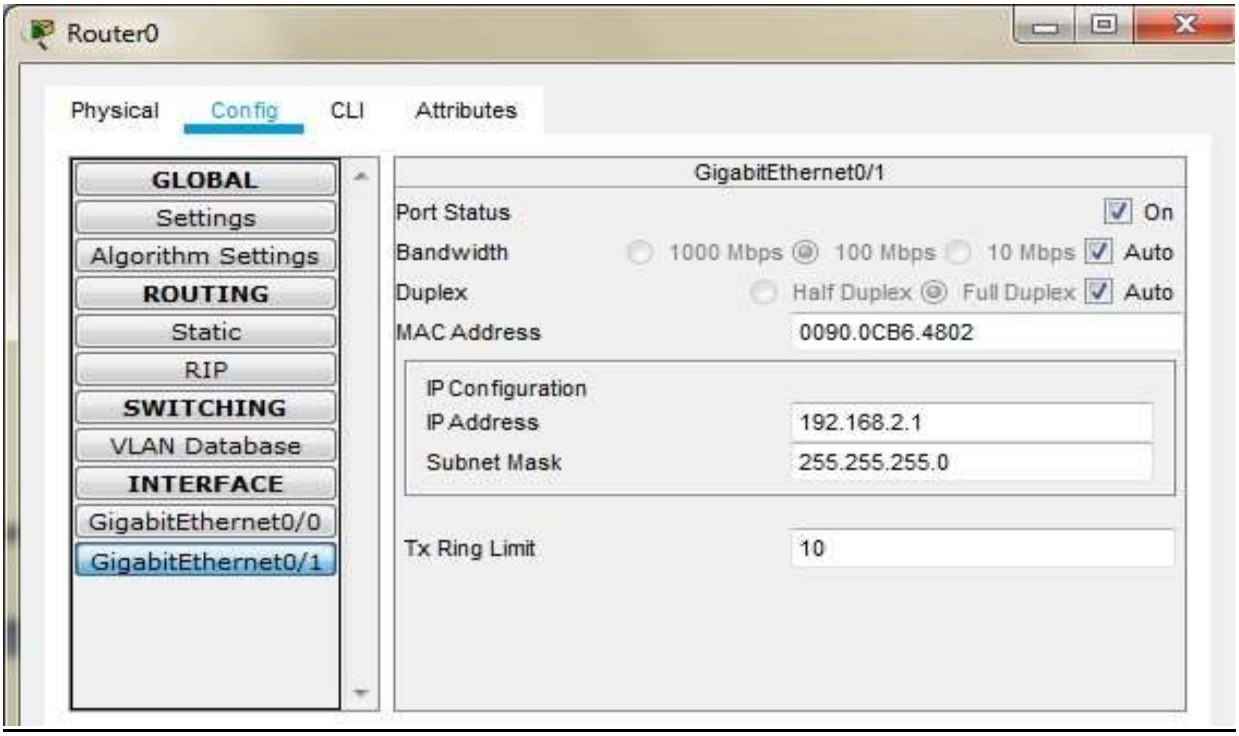


Configuring PC1



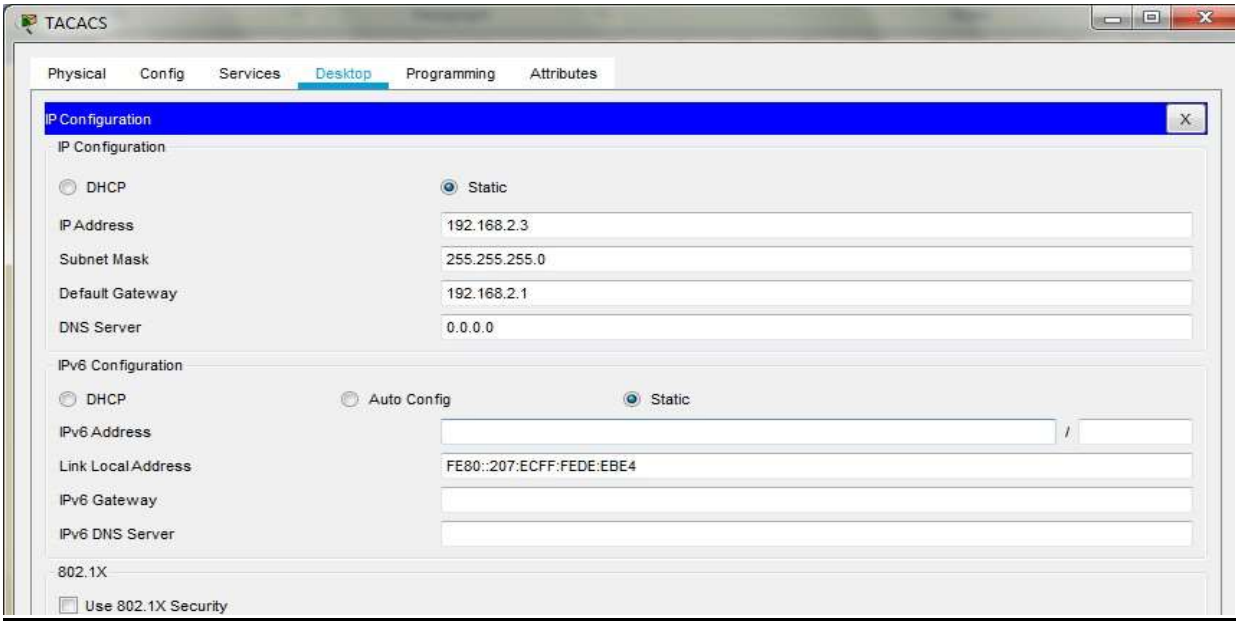
Configuring Router0

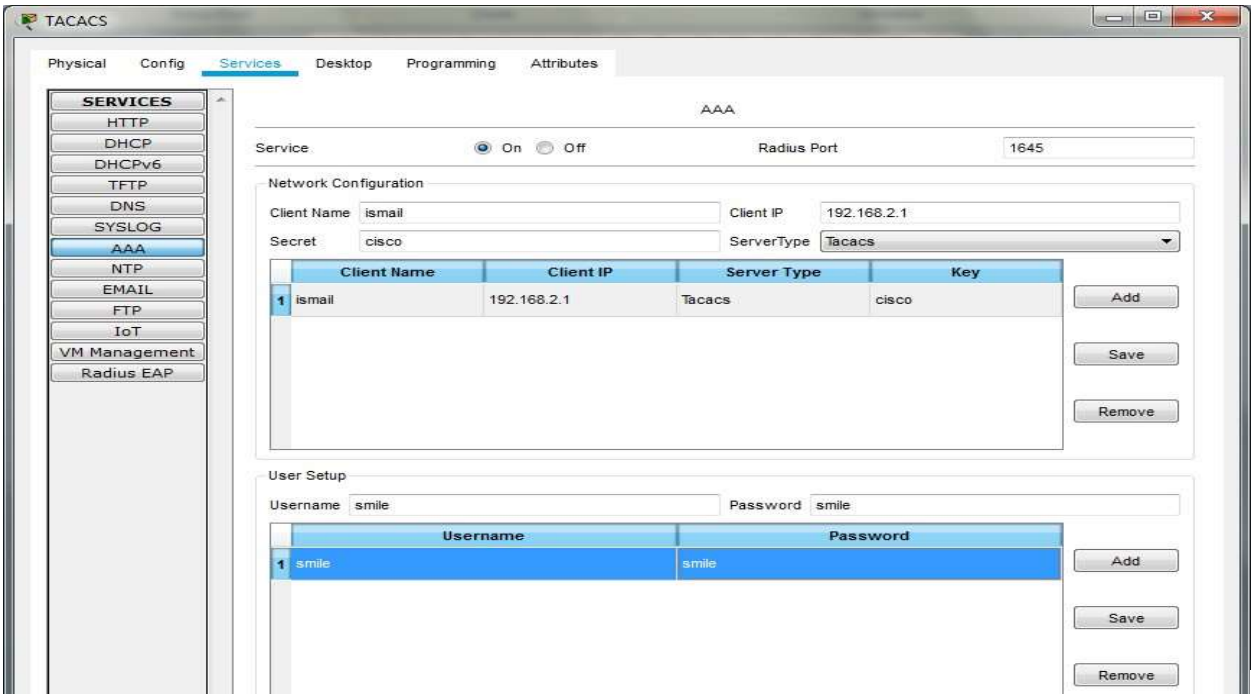




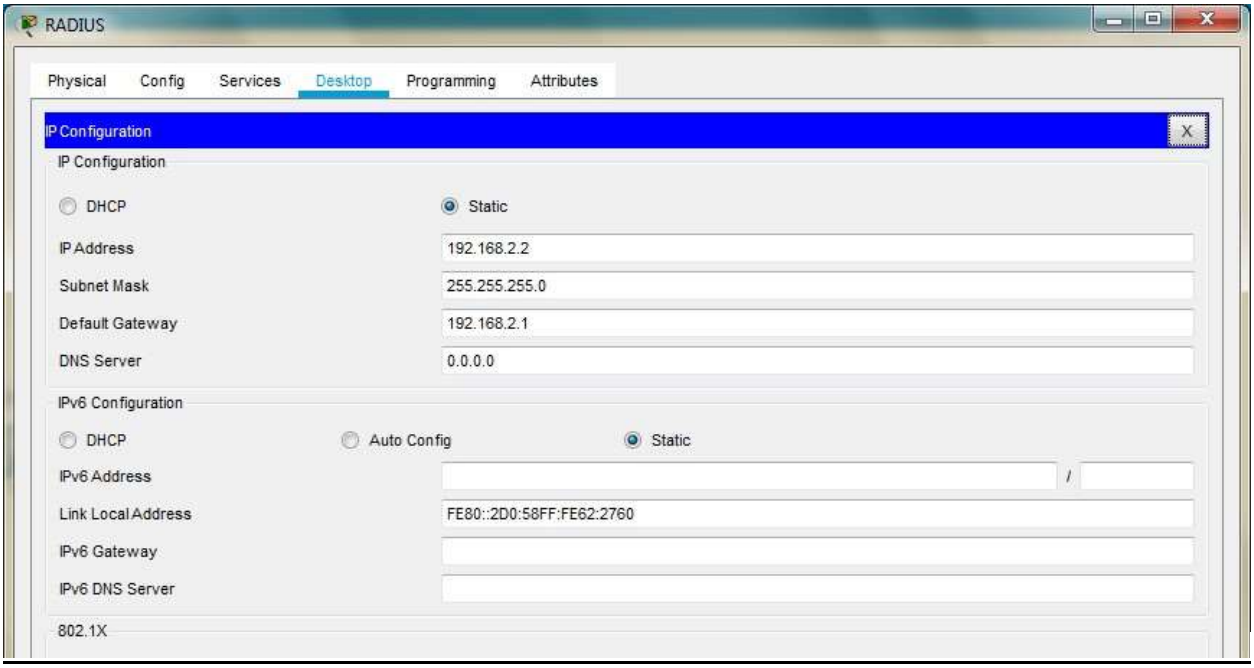
Configuring Server0 (As TACACS)

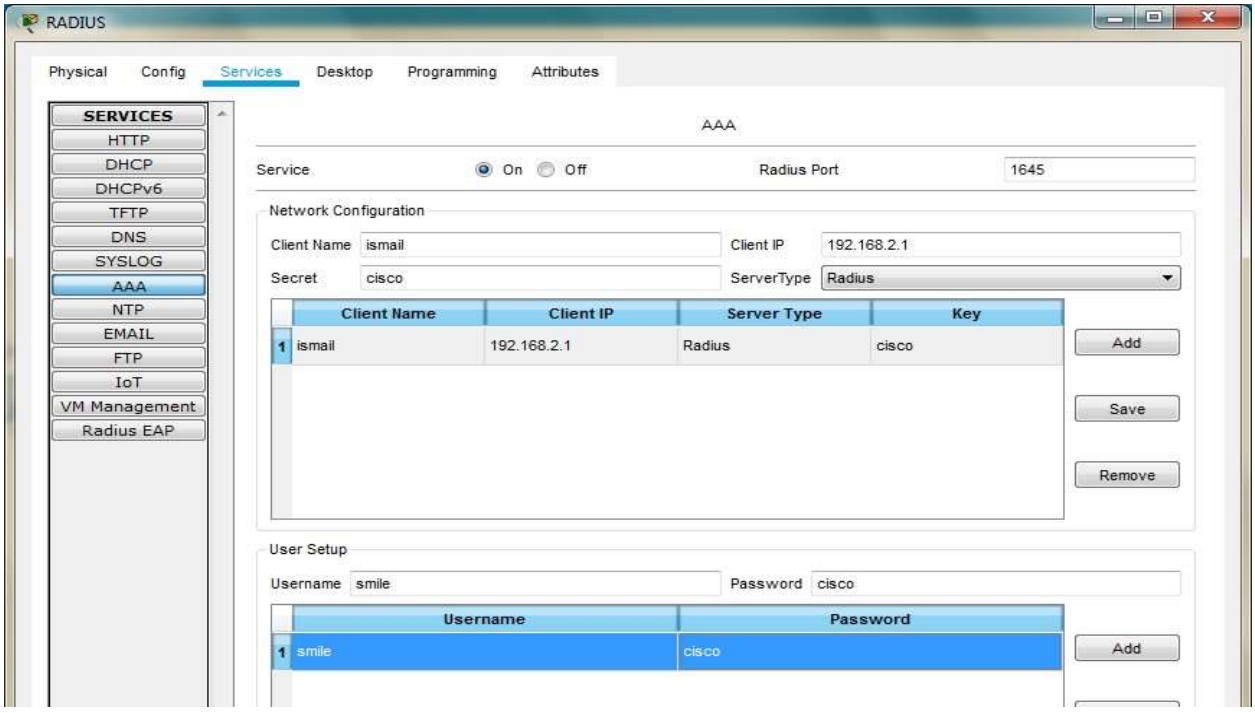
While configuring the TACACS/RADIUS server the Client IP address must be the Router IP





Configuring Server1 (As RADIUS)



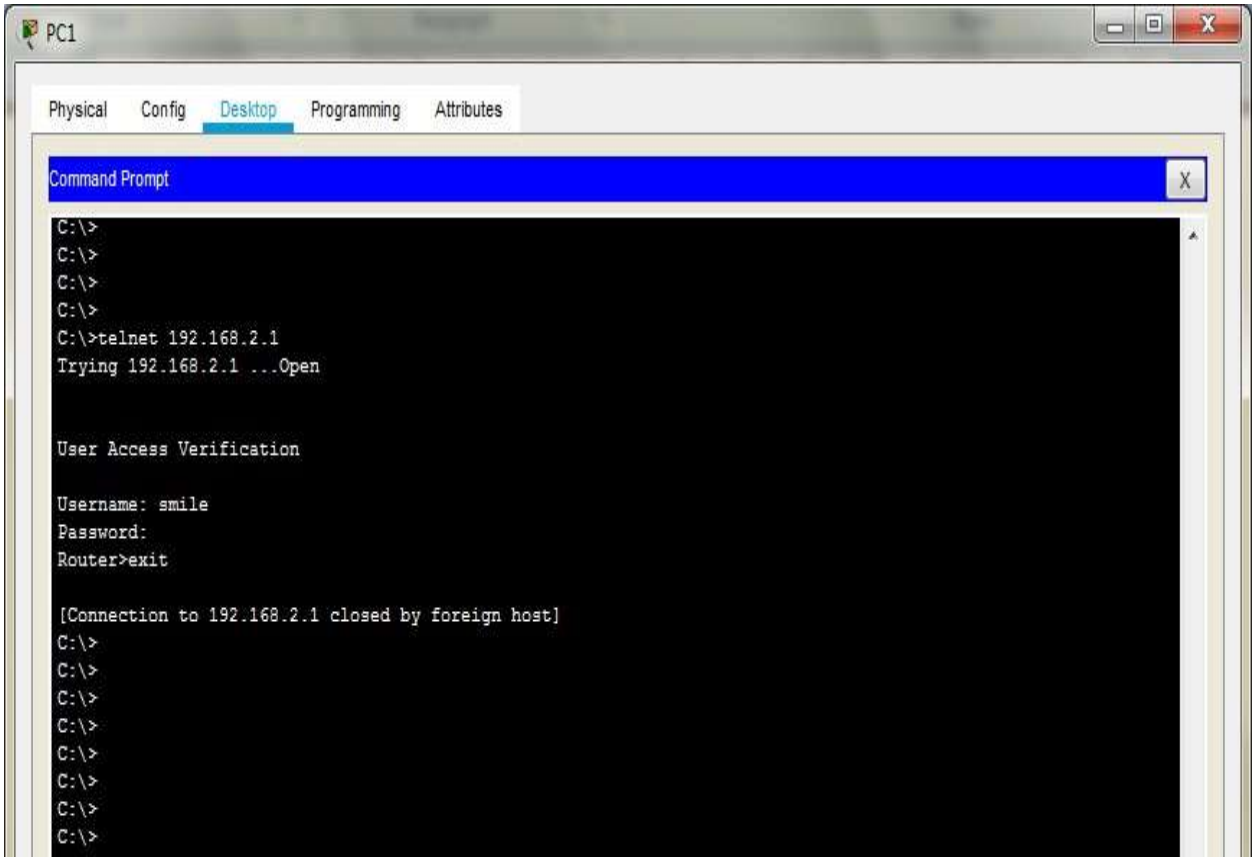


Type the following commands in the CLI mode of the Router0

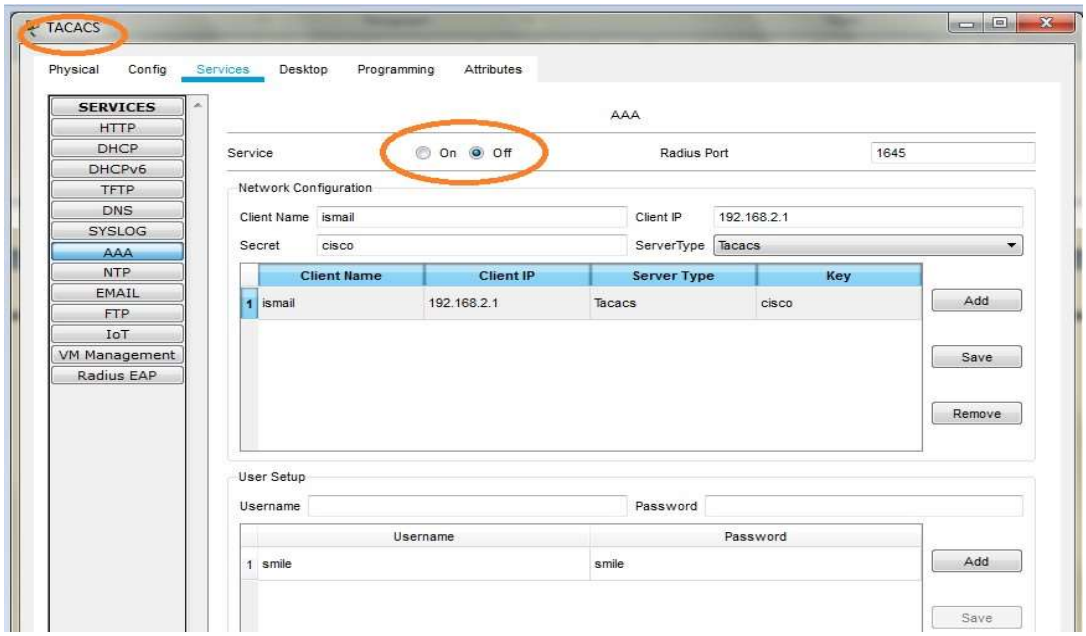
Router>enable
Router#configure terminal

Router(config)#aaa new-model
Router(config)#tacacs-server host 192.168.2.3 key cisco
Router(config)#radius-server host 192.168.2.2 key cisco
Router(config)#aaa authentication login ismail group tacacs+ group radius local
Router(config)#line vty 0 4
Router(config-line)#login authentication ismail
Router(config-line)#exit
Router(config)#

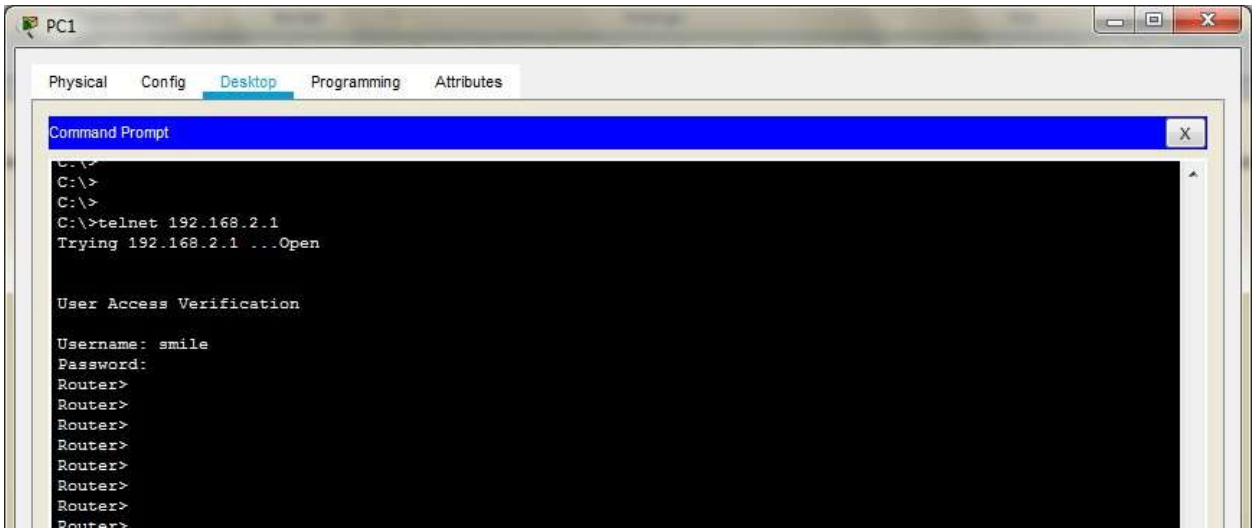
The Authentication can be done by typing the command **telnet 192.168.2.1 (**the Router IP**)** in any of the PCs
We get a prompt to type the username and password, the username and password set in TACACS are entered Username: smile
Password: smile
We get the following



In order to authenticate the RADIUS server we need to turn OFF the TACACS service



We again enter the command **telnet 192.168.2.1 (**the Router IP**)** and enter the username and password of the RADIUS server (Username: smile , Password: cisco)
We get the following



The local login can also be verified by turning OFF both TACACS and RADIUS service. The username and Password are both cisco (by default)

Hence the authentication through both TACACS and RADIUS

PRACTICAL NO 4: Configure IP ACLs to Mitigate Attacks.

Access Control Lists (ACLs)

Network administrators must figure out how to deny unwanted access to the network while allowing internal users appropriate access to necessary services. Although security tools, such as passwords, callback equipment, and physical security devices are helpful, they often lack the flexibility of basic traffic filtering and the specific controls most administrators prefer.

For example, a network administrator may want to allow users access to the Internet, but not permit external users telnet access into the LAN.

Routers provide basic traffic filtering capabilities, such as blocking Internet traffic, with access control lists (ACLs).

An ACL is a sequential list of permit or deny statements that apply to addresses or upper-layer protocols.

The router examines each packet to determine whether to forward or drop it, based on the conditions specified in the ACL.

Some ACL decision points are:

1) IP source address
2) IP destination addresses
3) UDP or TCP protocols
4) Upper-layer (TCP/UDP) port numbers

ACLs must be defined on a:

1) Per-protocol (IP, IPX, AppleTalk) 2)
Per direction (in or out)
3) Per port (interface) basis.
4) ACLs control traffic in one direction at a time on an interface. 5) A separate ACL would need to be created for each direction, one for inbound and one for outbound traffic.
6) Finally every interface can have multiple protocols and directions defined.

An ACL is a group of statements that define whether packets are accepted or rejected coming into an interface or leaving an interface.

1) ACL statements operate in sequential, logical order (top down). 2) If a condition match is true, the packet is permitted or denied and the rest of the ACL statements are not checked.

3) If all the ACL statements are unmatched, an implicit "deny any" statement is placed at the end of the list by default. (not visible)

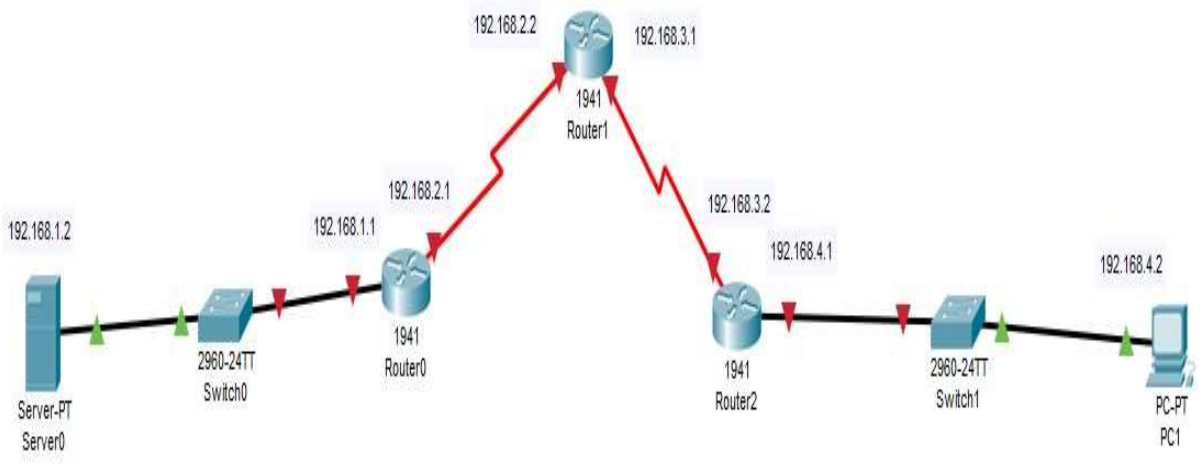
When first learning how to create ACLs, it is a good idea to add the implicit deny at the end of ACLs to reinforce the dynamic presence of the command line.

Standard IP ACLs
 Can only filter on source IP addresses

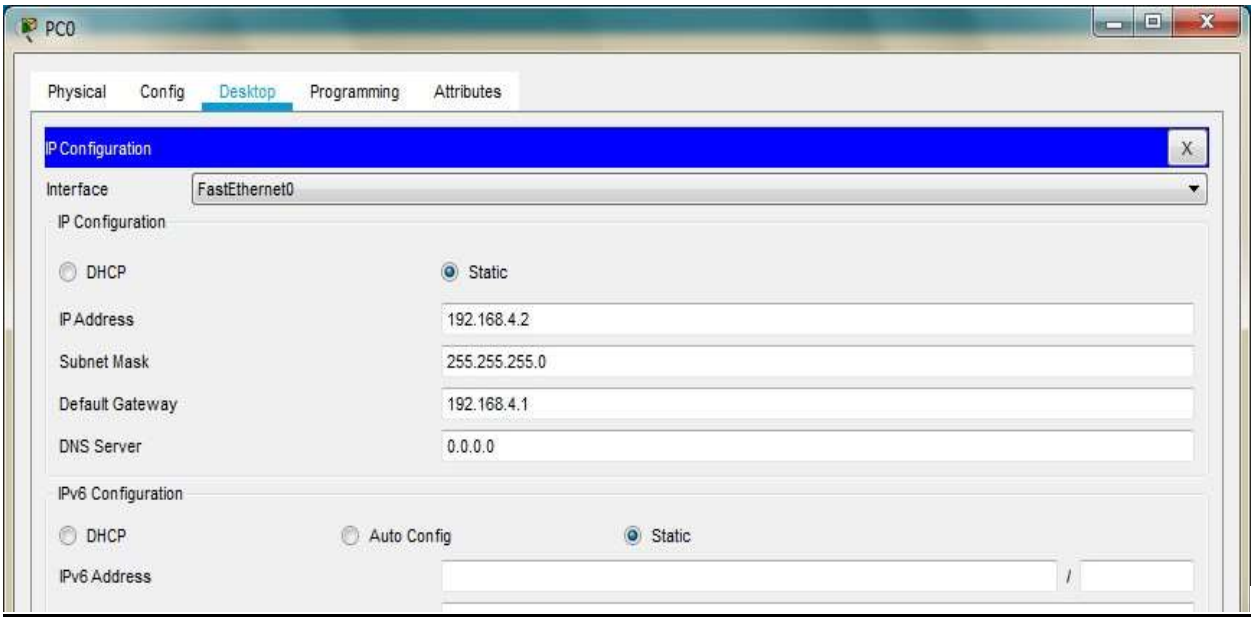
Extended IP ACLs Can filter on:
1) Source IP address
2) Destination IP address
3) Protocol (TCP, UDP)
4) Port Numbers (Telnet – 23, http – 80, etc.) and other parameters

An access list is a sequential series of commands or filters. These lists tell the router what types of packets to: accept or deny Acceptance and denial can be based on specified conditions. ACLs applied on the router's interfaces

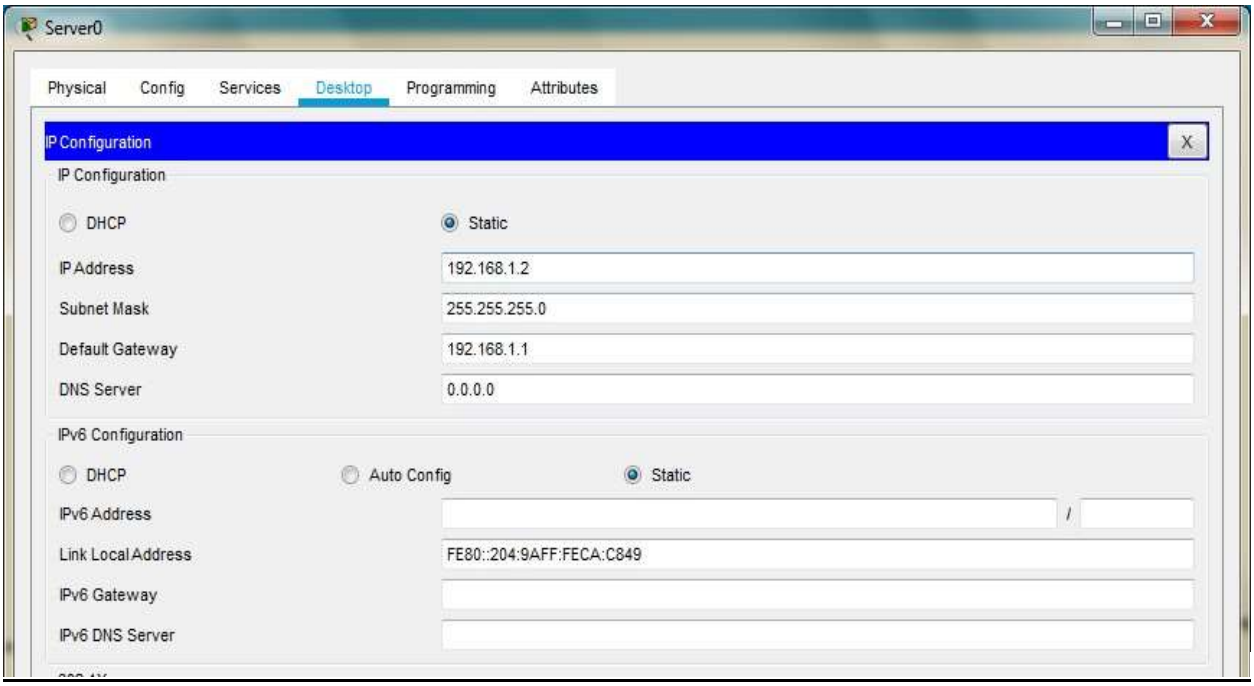
We use the following topology to study the present case



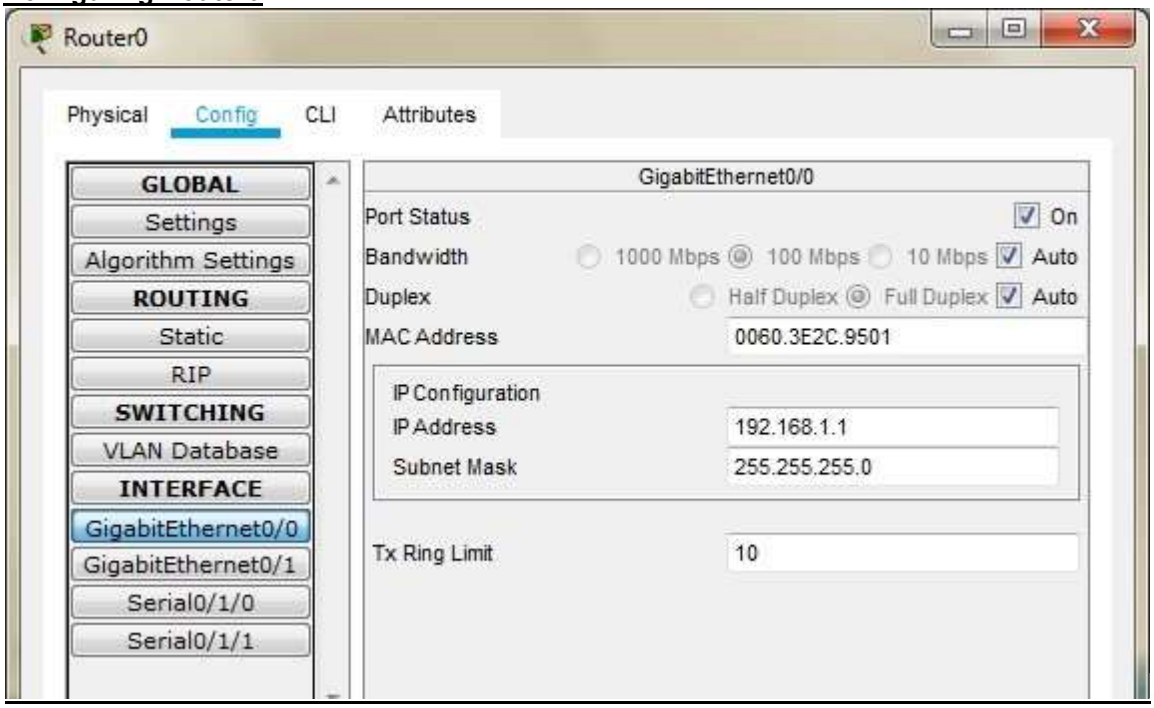
Configuring PC1

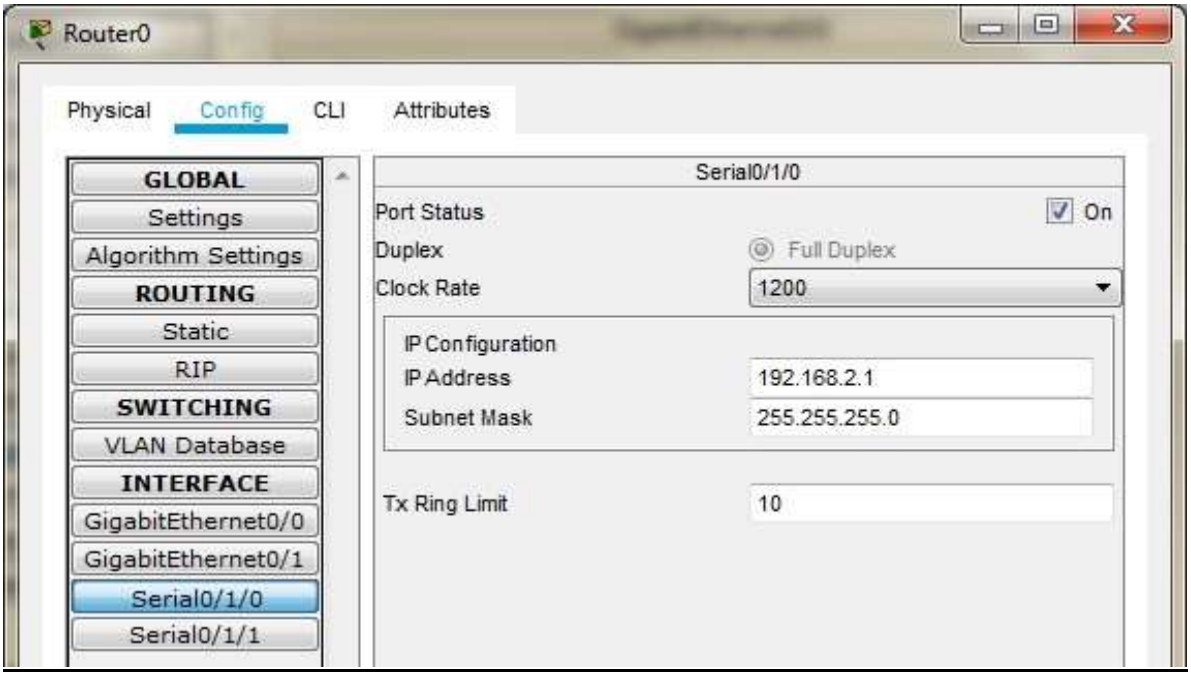


Configuring Server0

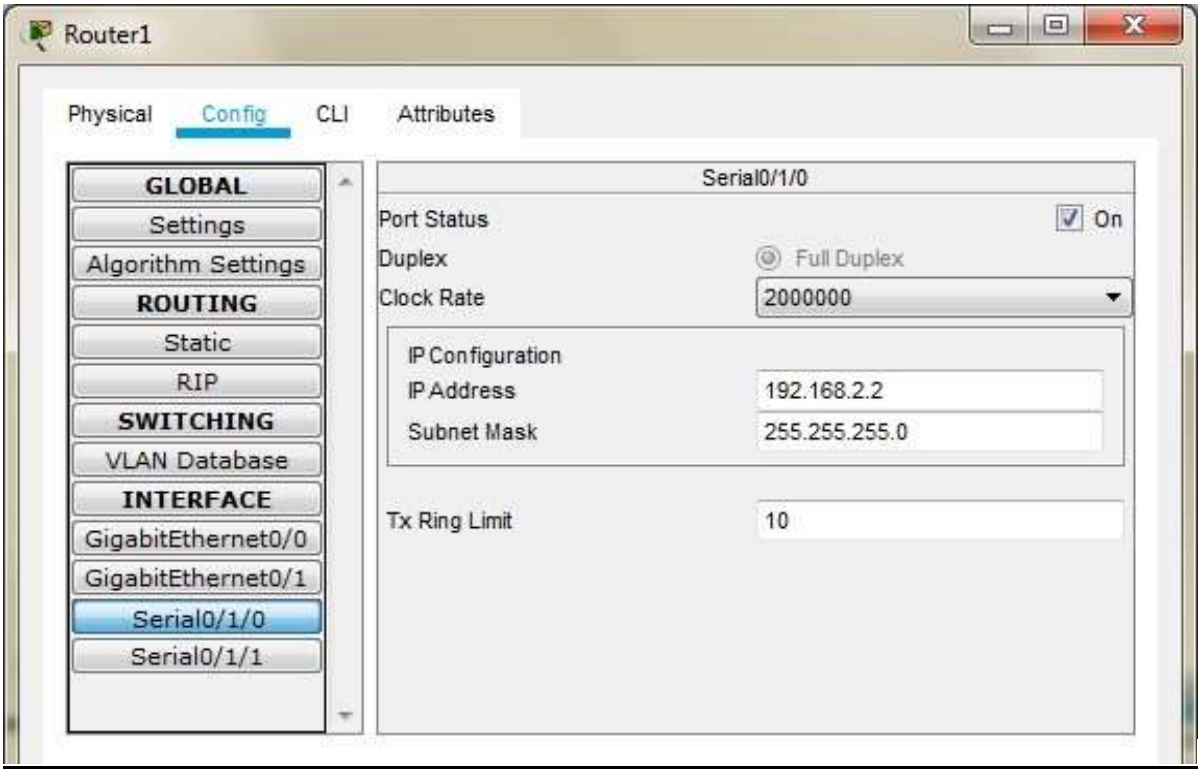


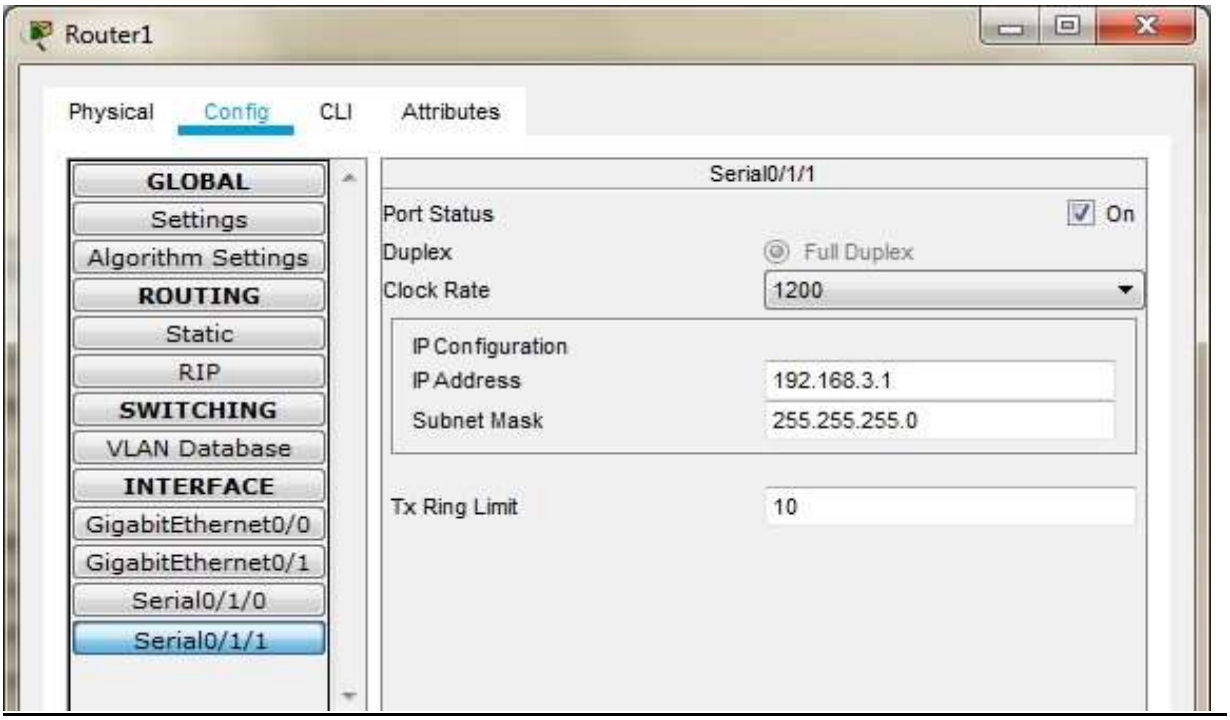
Configuring Router0



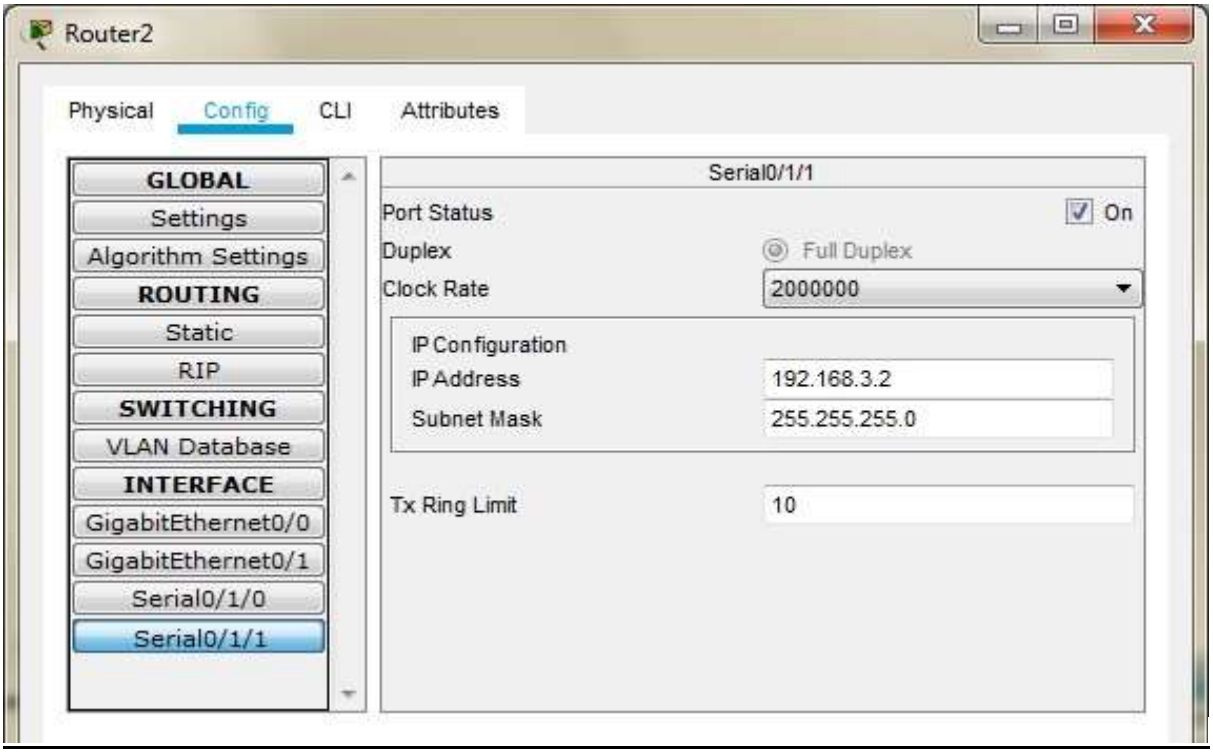


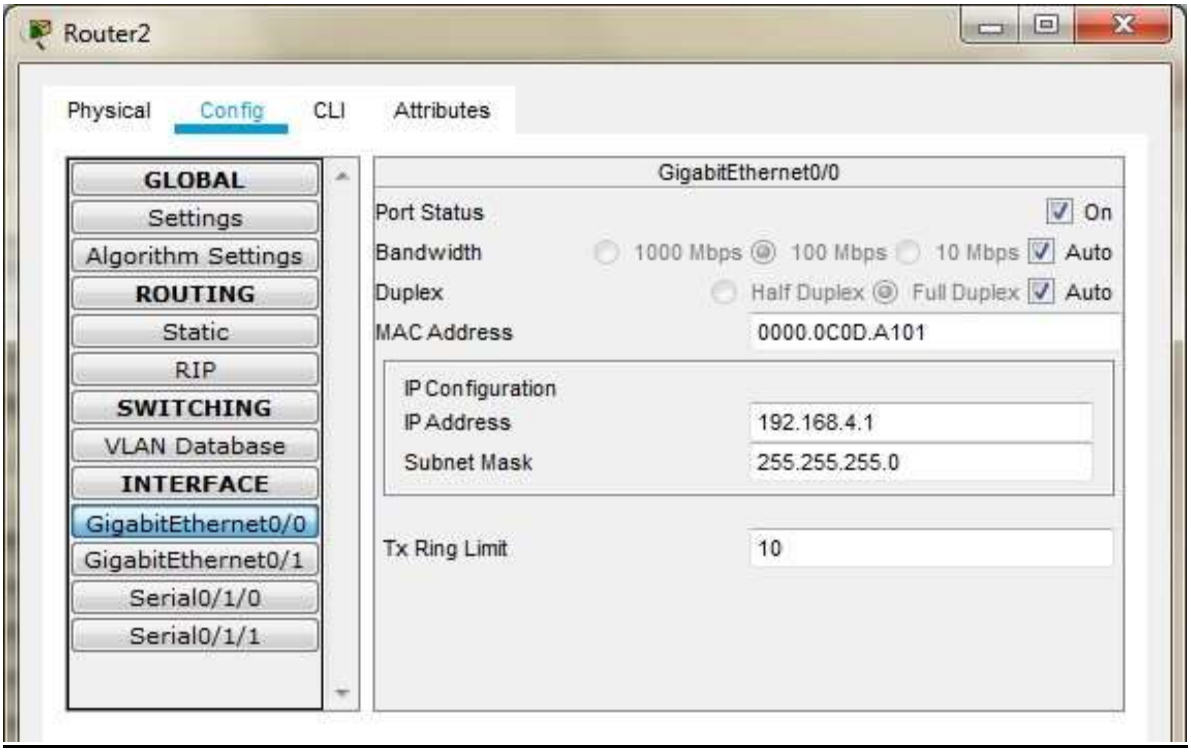
Configuring Router1



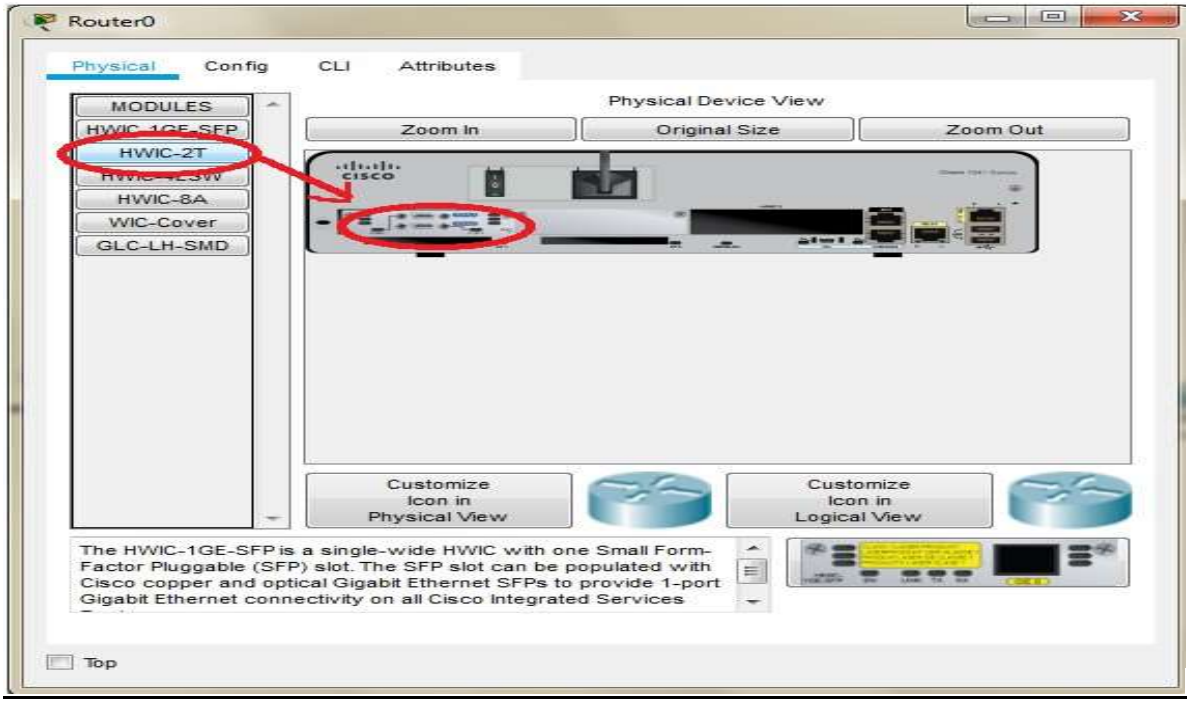


Configuring Router2

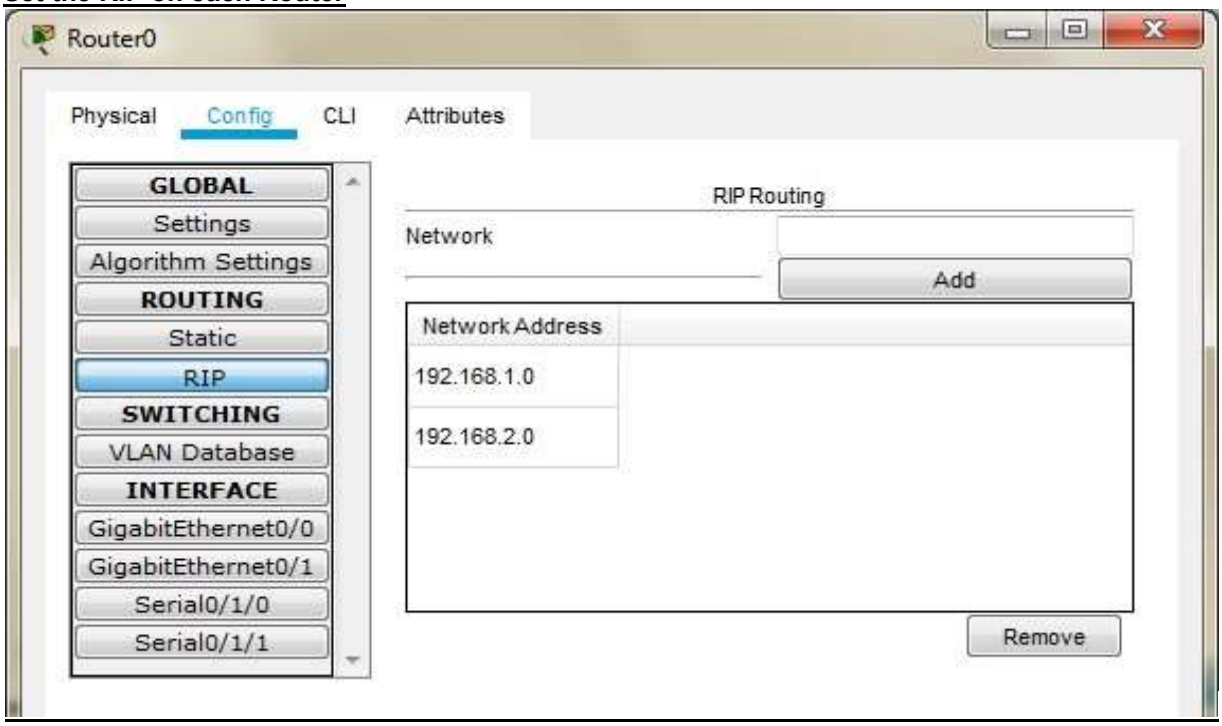

Router2
Physical
Config
CLI
Attributes
GLOBAL
Settings
Algorithm Settings
ROUTING
Static
RIP
SWITCHING
VLAN Database
INTERFACE
GigabitEthernet0/0
GigabitEthernet0/1
Serial0/1/0
Serial0/1/1
Serial0/1/1
Port Status
On
Duplex
Full Duplex
Clock Rate
2000000
IP Configuration
IP Address
192.168.3.2
Subnet Mask
255.255.255.0
Tx Ring Limit
10

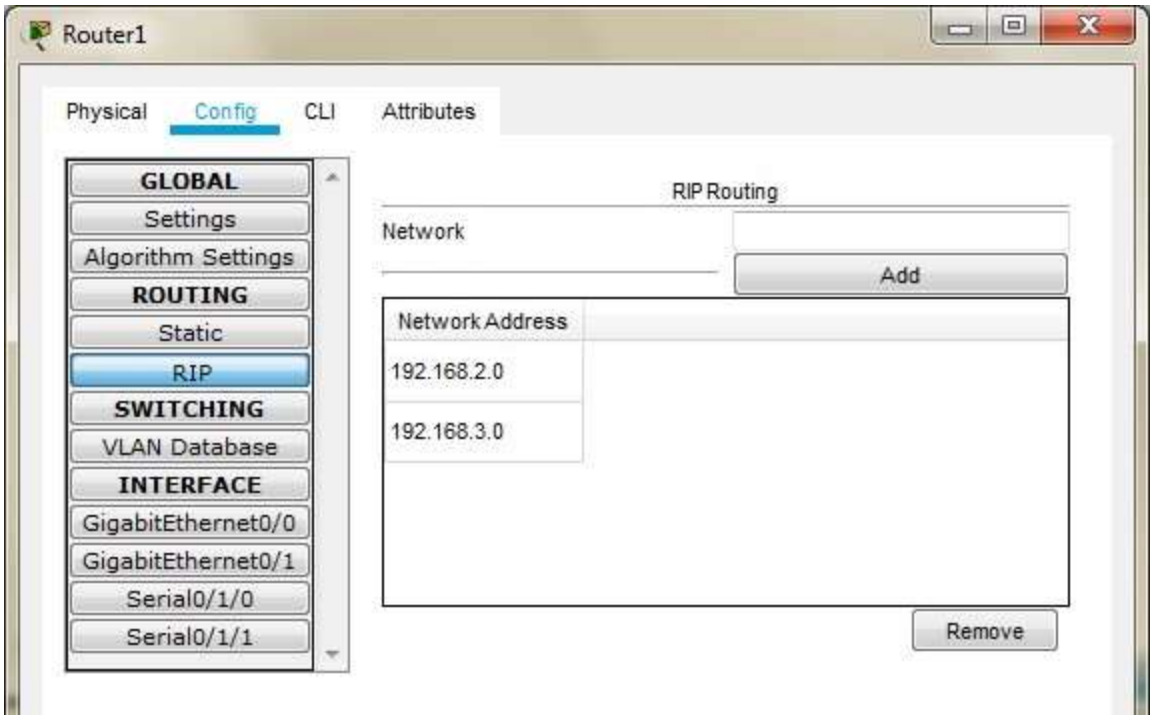

Router2
Physical
Config
CLI
Attributes
GLOBAL
Settings
Algorithm Settings
ROUTING
Static
RIP
SWITCHING
VLAN Database
INTERFACE
GigabitEthernet0/0
GigabitEthernet0/1
Serial0/1/0
Serial0/1/1
GigabitEthernet0/0
Port Status
On
Bandwidth
1000 Mbps
100 Mbps
10 Mbps
Auto
Duplex
Half Duplex
Full Duplex
Auto
MAC Address
0000.0C0D.A101
IP Configuration
IP Address
192.168.4.1
Subnet Mask
255.255.255.0
Tx Ring Limit
10

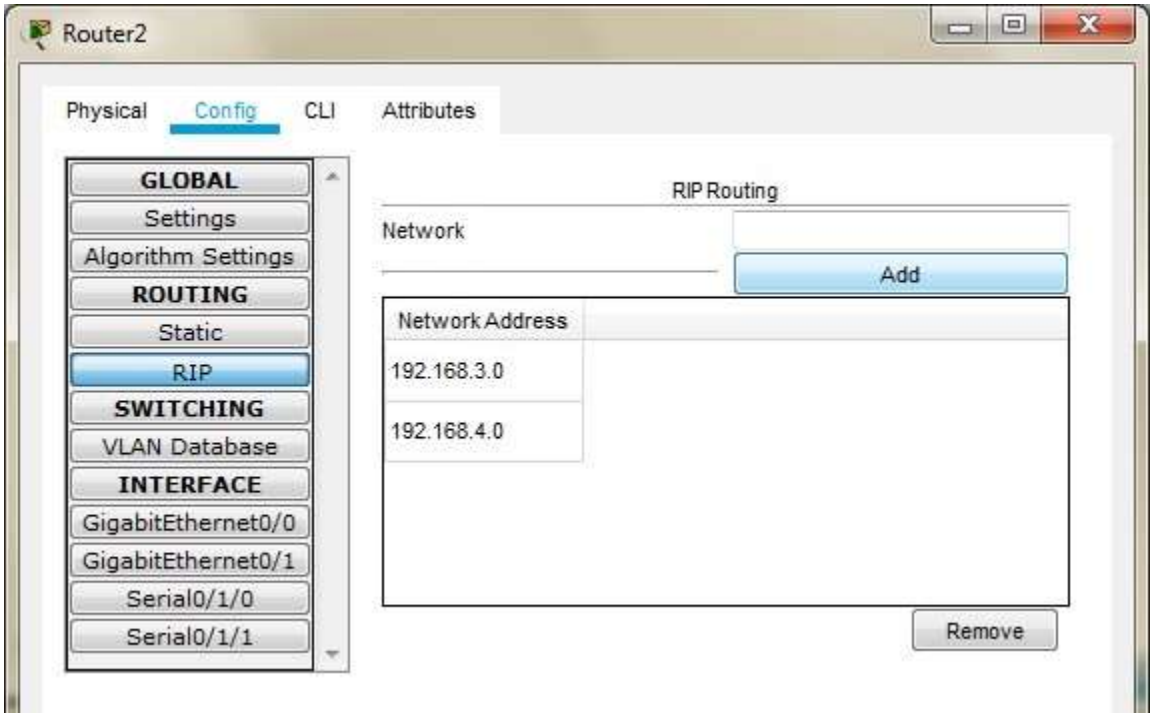
The serial interface in each Router are added as follows



Set the RIP on each Router

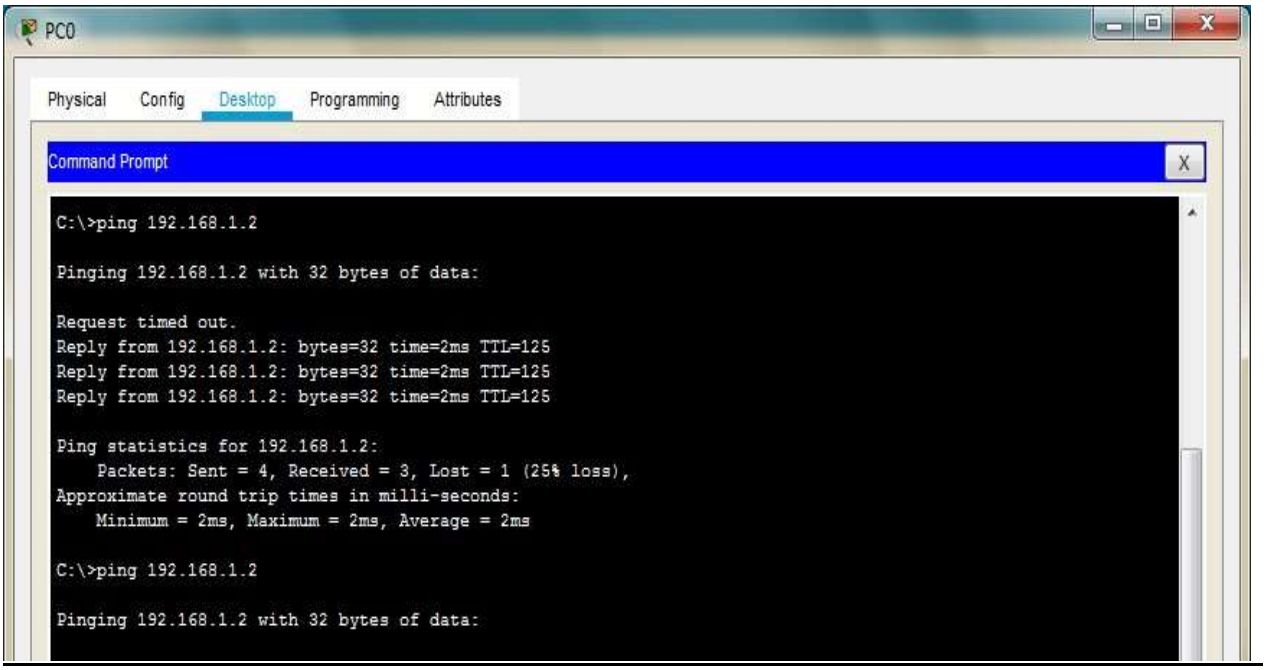



Router1
Physical
Config
CLI
Attributes
GLOBAL
Settings
Algorithm Settings
ROUTING
Static
RIP
SWITCHING
VLAN Database
INTERFACE
GigabitEthernet0/0
GigabitEthernet0/1
Serial0/1/0
Serial0/1/1
RIP Routing
Network
Add
Network Address
192.168.2.0
192.168.3.0
Remove

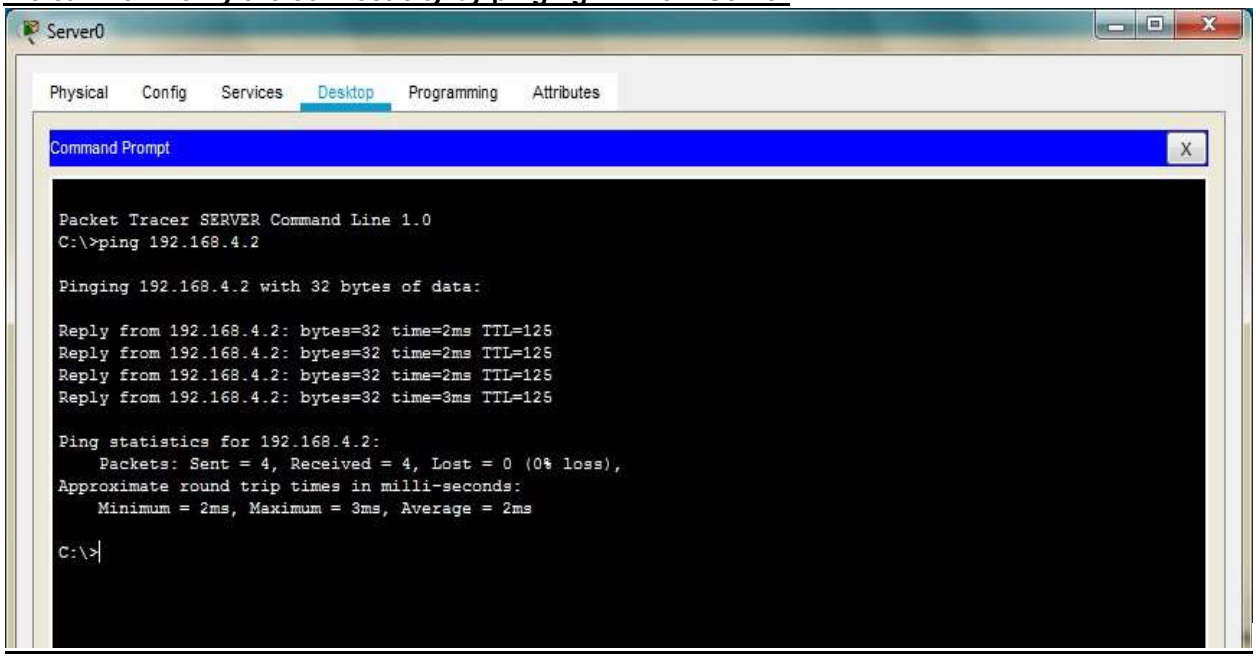

Router2
Physical
Config
CLI
Attributes
GLOBAL
Settings
Algorithm Settings
ROUTING
Static
RIP
SWITCHING
VLAN Database
INTERFACE
GigabitEthernet0/0
GigabitEthernet0/1
Serial0/1/0
Serial0/1/1
RIP Routing
Network
Add
Network Address
192.168.3.0
192.168.4.0
Remove

Part 1: Verify Basic Connectivity

We can now verify the connectivity by pinging Server from PC



We can now verify the connecticity by pinging PC from Server



Part 2: Secure Access to Routers

We configure ACL 10 to block all remote access to the Routers and allow remote access only from PC. We type the following commands in all the Routers (Router0, Router1, and Router2). This part is divided in 2 subparts

Part a) Set up the SSH protocol

Enter the following commands in CLI mode of all Routers

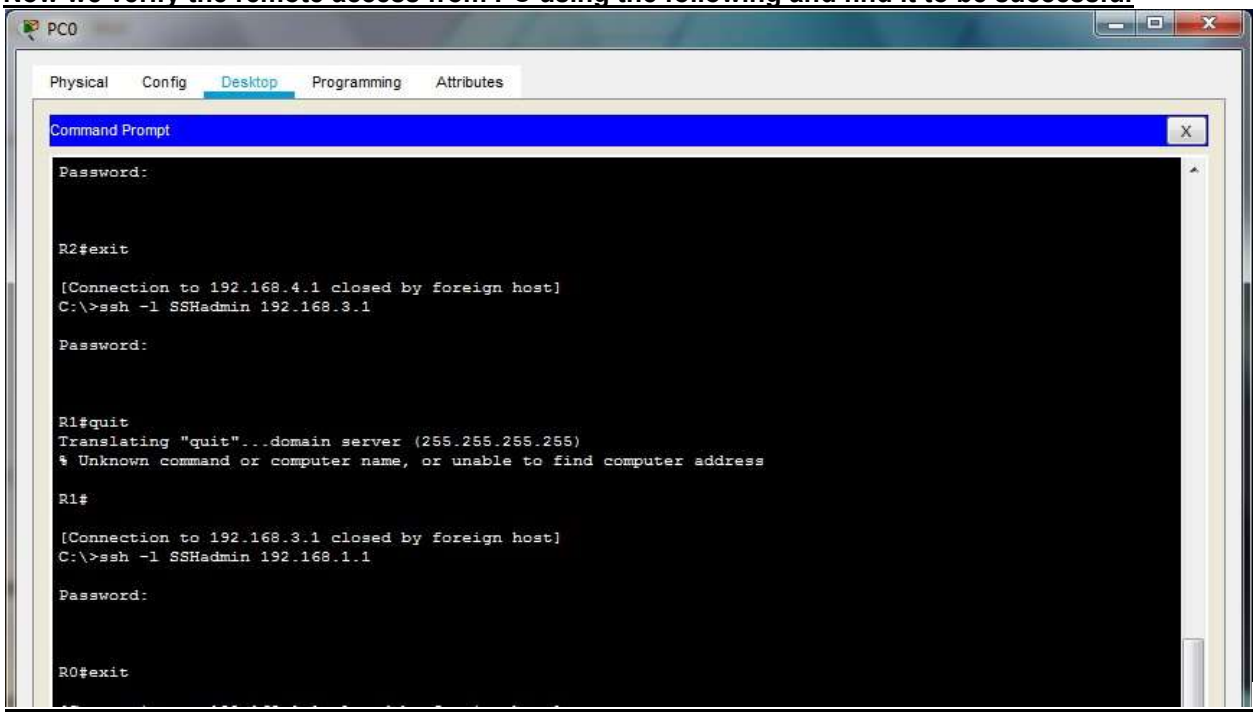
```
Router>enable
Router#configure t
Router(config)#ip domain-name ismail.com
Router(config)#hostname R0
R0(config)#
R0(config)#crypto key generate rsa
R0(config)#line vty 0 4
R0(config-line)#transport input ssh
R0(config-line)#login local
R0(config-line)#exit
R0(config)#username SSHadmin privilege 15 password ismail
R0(config)#exit
R0#
```

Part b) Create an ACL 10 to permit remote access to PC only

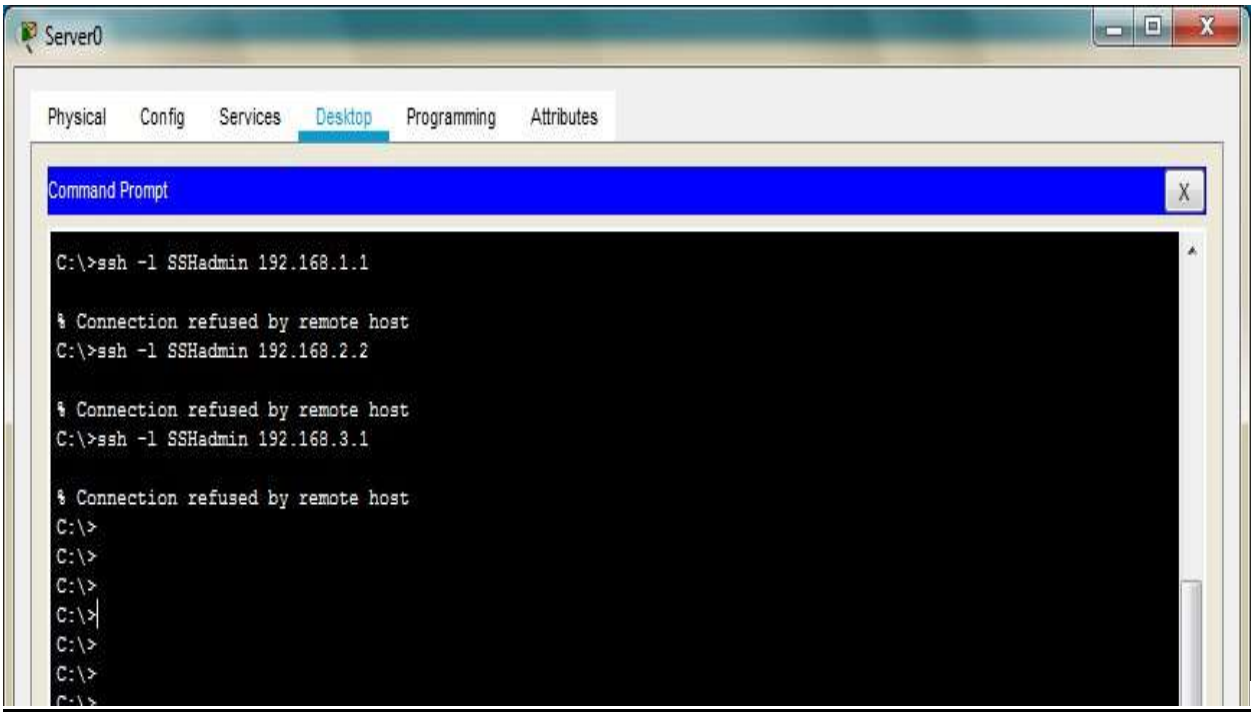
Enter the following commands in CLI mode of all Routers

```
Router>enable
Router#configure terminal
Router(config)#access-list 10 permit host 192.168.4.2
Router(config)#line vty 0 4
Router(config-line)#access-class 10 in
```

Now we verify the remote access from PC using the following and find it to be successful



Now we verify the remote access from Server using the following and find it to be failure



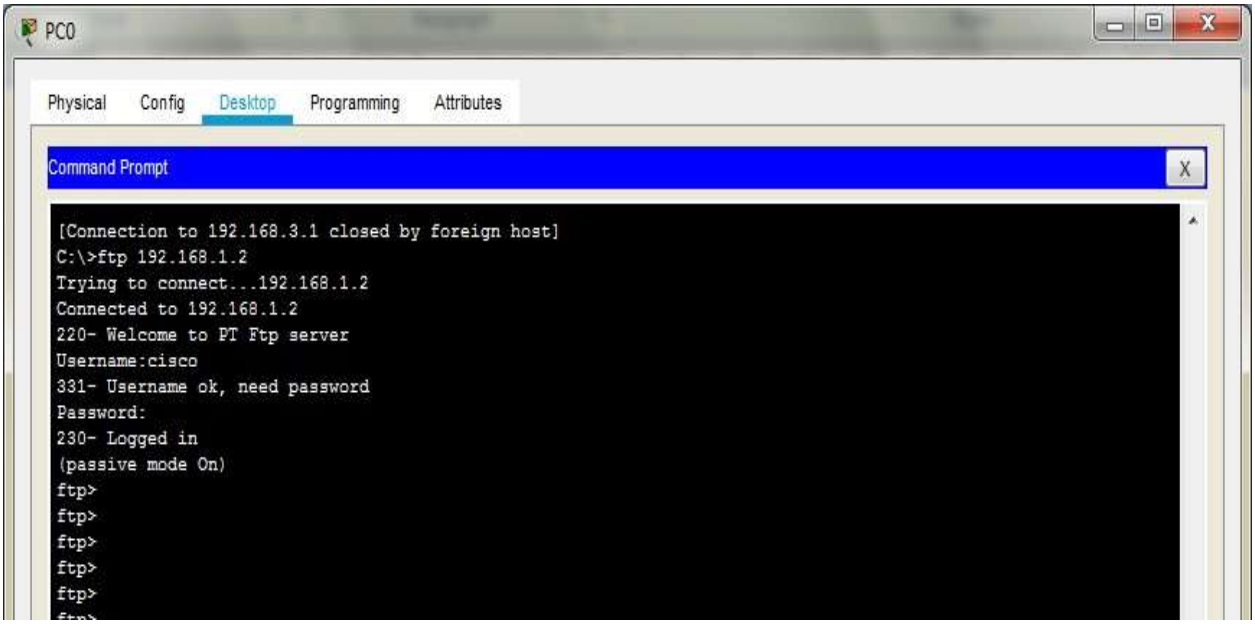
Part 3: Create a Numbered IP ACL 120 on R1

We need to perform the following in this part

1) Create an IP ACL numbered 120 on R1 using the following rules
2) Permit any outside host to access DNS, SMTP, and FTP services on server
3) Deny any outside host access to HTTPS services on **server 4)** Permit **PC to** access **R1** via SSH. (done in previous part)

Enter the following commands in the CLI mode of Router1

R1>enable
R1#
R1#configure terminal
R1(config)#access-list 120 permit udp any host 192.168.1.2 eq domain
R1(config)#access-list 120 permit tcp any host 192.168.1.2 eq smtp
R1(config)#access-list 120 permit tcp any host 192.168.1.2 eq ftp
R1(config)#access-list 120 deny tcp any host 192.168.1.2 eq 443
R1(config)#exit
R1#configure terminal
R1(config)#interface Serial0/1/1
R1(config-if)#ip access-group 120 in
Verify the above entering the following commands in the PC



Hence we have applied and verified all the required ACLs

PRACTICAL NO 5: Configuring IPv6 ACLs

Access Control Lists for IPv6 Traffic Filtering

The standard ACL functionality in IPv6 is similar to standard ACLs in IPv4. Access lists determine what traffic is blocked and what traffic is forwarded at device interfaces and allow filtering based on source and destination addresses, inbound and outbound to a specific interface. Each access list has an implicit deny statement at the end. IPv6 ACLs are defined and their deny and permit conditions are set using the **ipv6 access-list** command with the deny and **permit** keywords in global configuration mode.

IPv6 extended ACLs augments standard IPv6 ACL functionality to support traffic filtering based on IPv6 option headers and optional, upper-layer protocol type information for finer granularity of control (functionality similar to extended ACLs in IPv4).

IPv6 Packet Inspection

Access Class Filtering in IPv6

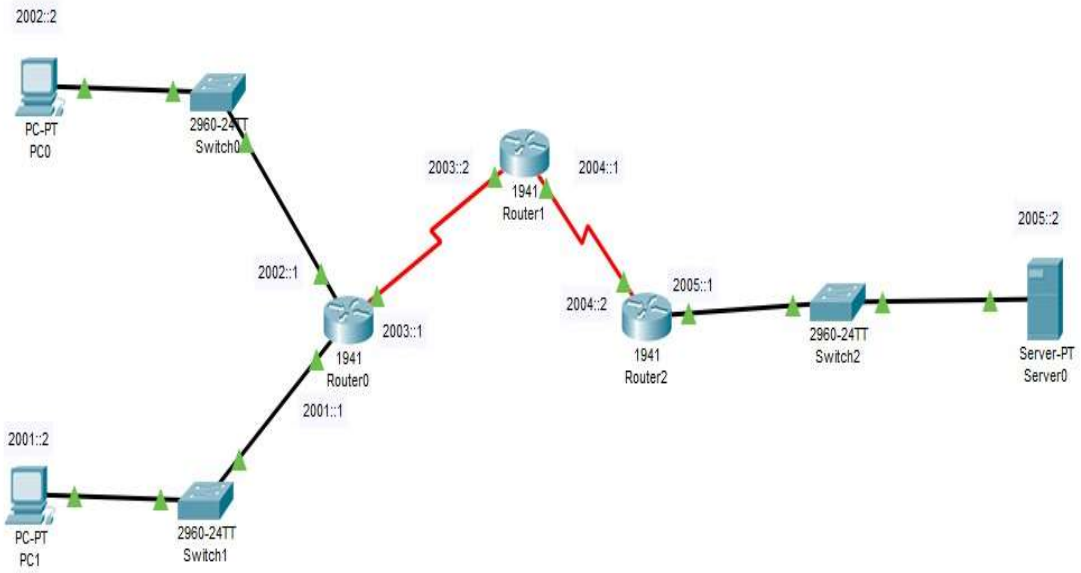
IPv6 Packet Inspection

The following header fields are used for IPv6 inspection: traffic class, flow label, payload length, next header, hop limit, and source or destination IP address. For further information on and descriptions of the IPv6 header fields, see RFC 2474.

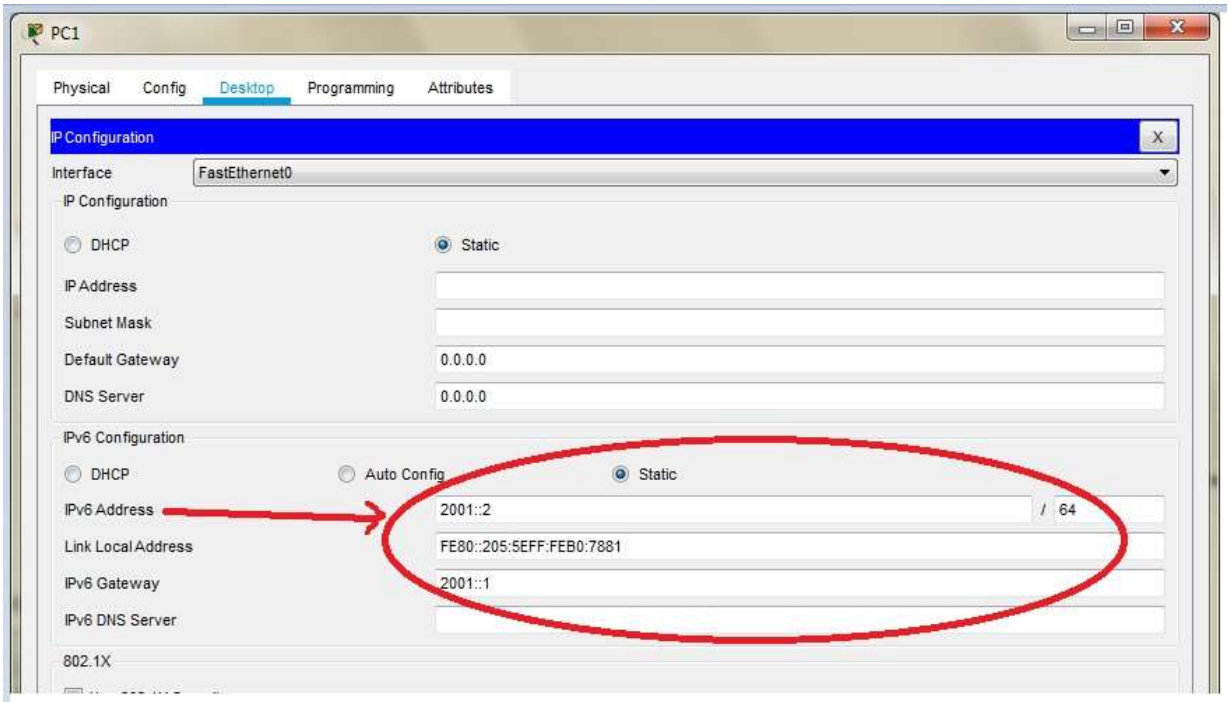
Access Class Filtering in IPv6

Filtering incoming and outgoing connections to and from the device based on an IPv6 ACL is performed using the **ipv6 access-class** command in line configuration mode. The **ipv6 accessclass** command is similar to the **access-class** command, except the IPv6 ACLs are defined by a name. If the IPv6 ACL is applied to inbound traffic, the source address in the ACL is matched against the incoming connection source address and the destination address in the ACL is matched against the local device address on the interface. If the IPv6 ACL is applied to outbound traffic, the source address in the ACL is matched against the local device address on the interface and the destination address in the ACL is matched against the outgoing connection source address. We recommend that identical restrictions are set on all the virtual terminal lines because a user can attempt to connect to any of them.

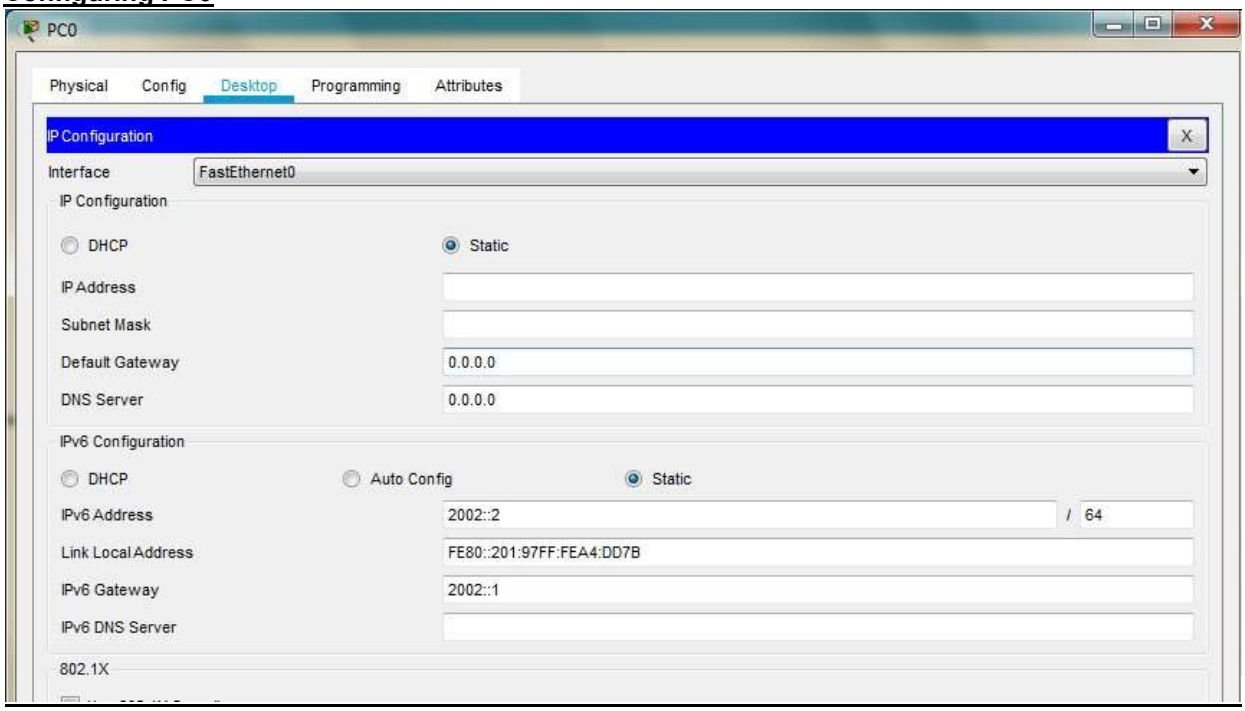
We use the following topology



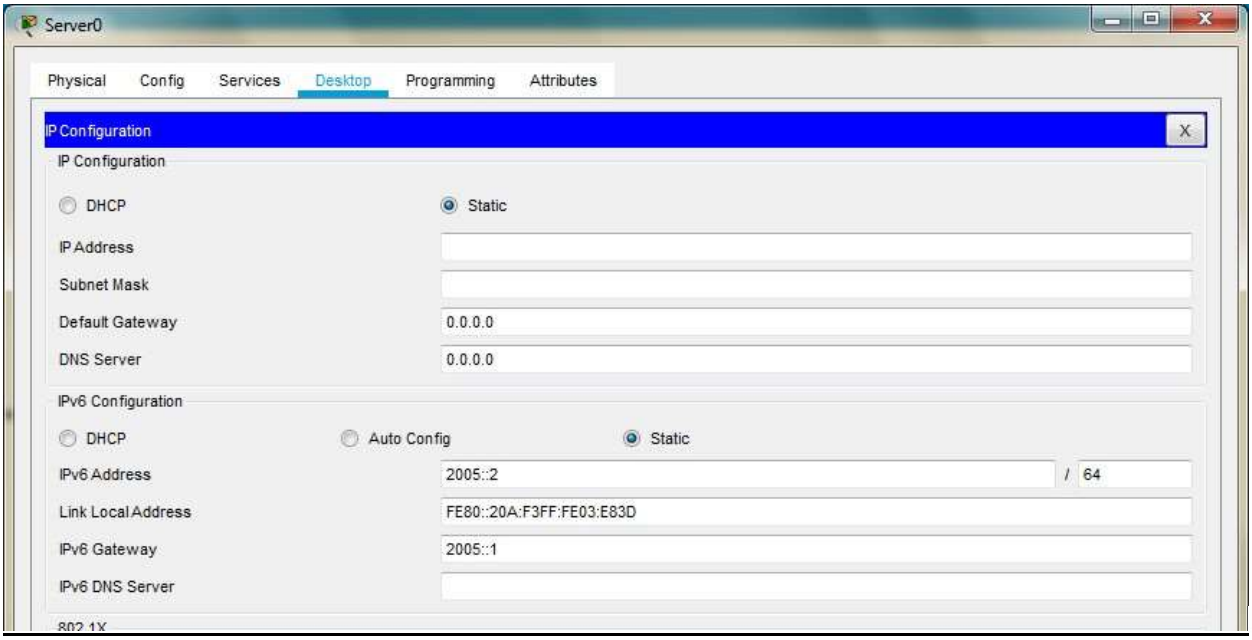
Configuring PC1



Configuring PC0



Configuring Server0



For setting the ipv6 addresses we need to use the CLI mode for each Router as follows

Configuring Router0

```
Router>
Router>enable
Router#
Router#configure terminal
Router(config)#ipv6 unicast-routing

Router(config)#interface GigabitEthernet0/0
Router(config-if)#ipv6 address 2002::1/64
Router(config-if)#ipv6 rip a enable
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#

Router(config)#interface GigabitEthernet0/1
Router(config-if)#ipv6 address 2001::1/64
Router(config-if)#ipv6 rip a enable
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#

Router(config)#interface Serial0/1/0
Router(config-if)#ipv6 address 2003::1/64
Router(config-if)#ipv6 rip a enable
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#
```

Configuring Router1

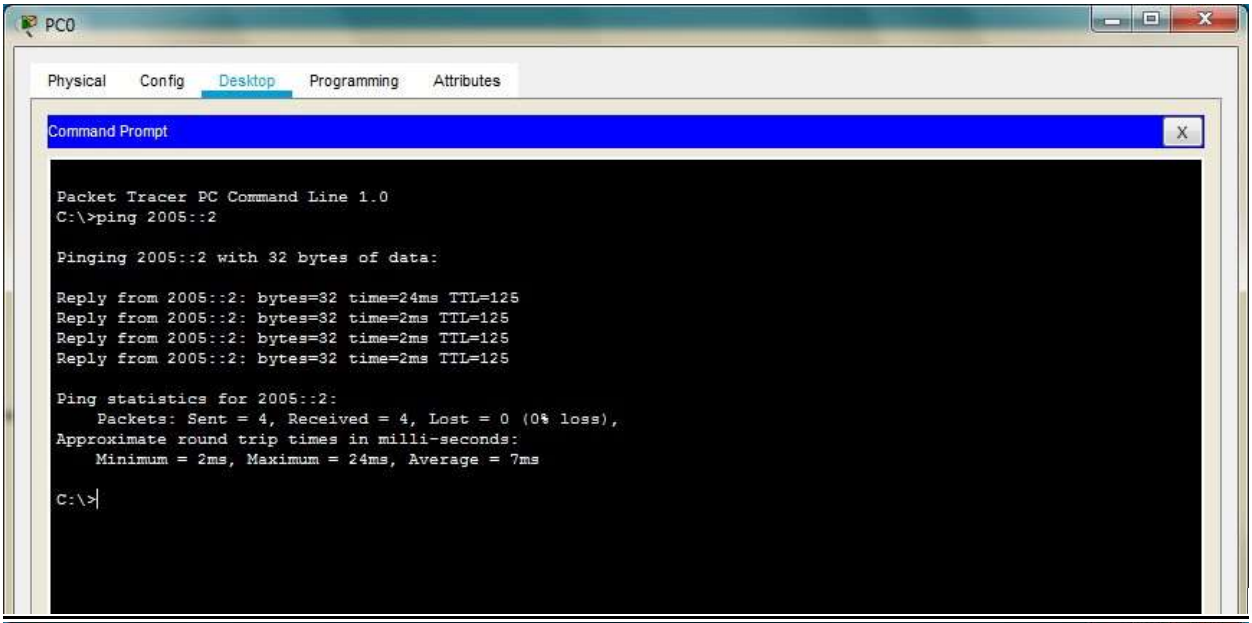
```
Router>enable
Router#configure terminal
Router(config)#ipv6 unicast-routing
Router(config)#

Router(config)#interface Serial0/1/0
Router(config-if)#ipv6 address 2003::1/64
Router(config-if)#ipv6 rip a enable
Router(config-if)#no shutdown
Router(config-if)#
Router(config-if)#exit
```

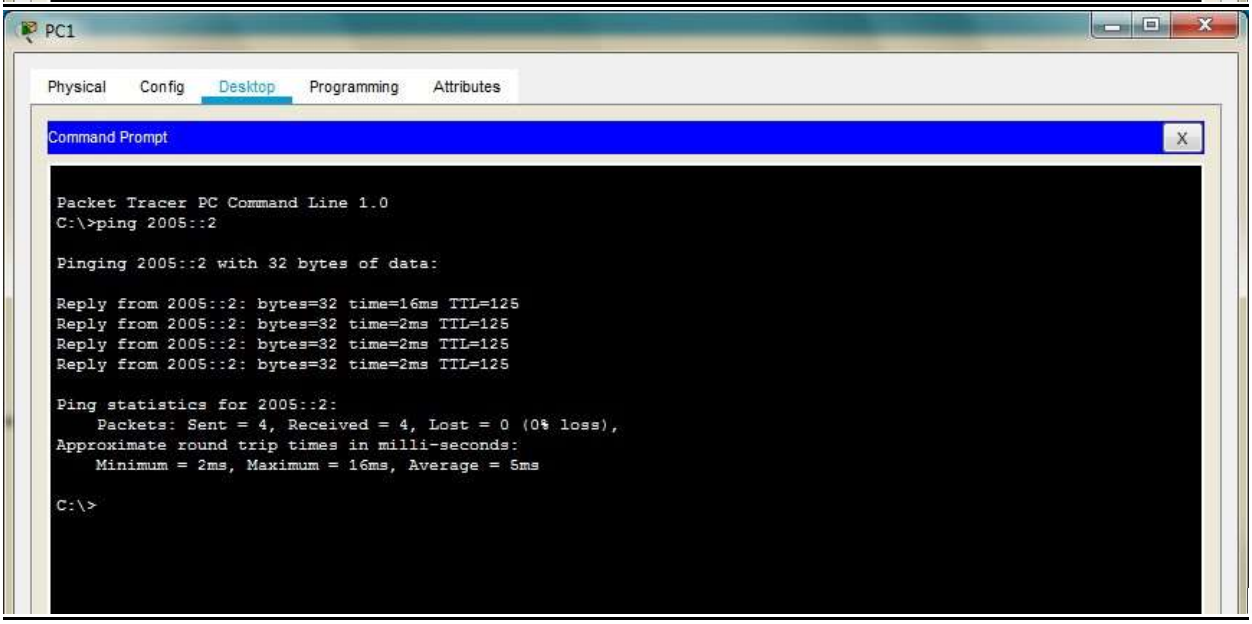
```
Router(config)#
Router(config)#interface Serial0/1/1
Router(config-if)#ipv6 address 2004::1/64
Router(config-if)#ipv6 rip a enable
Router(config-if)#no shutdown
Router(config-if)#exit Router(config)#
```

Configuring Router2

```
Router>enable
Router#configure terminal
Router(config)#ipv6 unicast-routing
Router(config)#

Router(config)#interface Serial0/1/1
Router(config-if)#ipv6 address 2004::2/64
Router(config-if)#ipv6 rip a enable
Router(config-if)#no shutdown
Router(config-if)#exit

Router(config)#interface GigabitEthernet0/0
Router(config-if)#ipv6 address 2005::1/64
Router(config-if)#ipv6 rip a enable
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#
```

Check the connectivity by pinging from PCs to Server





And we see that the connectivity is established

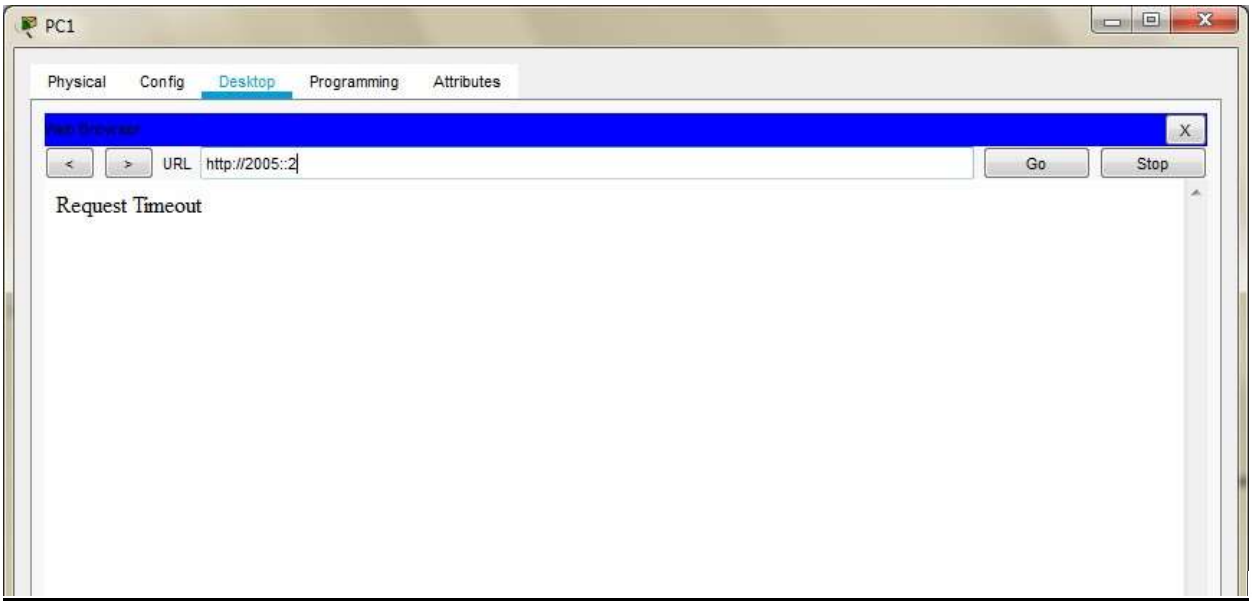
We configure the ACL and apply it to the Router1 with the following conditions

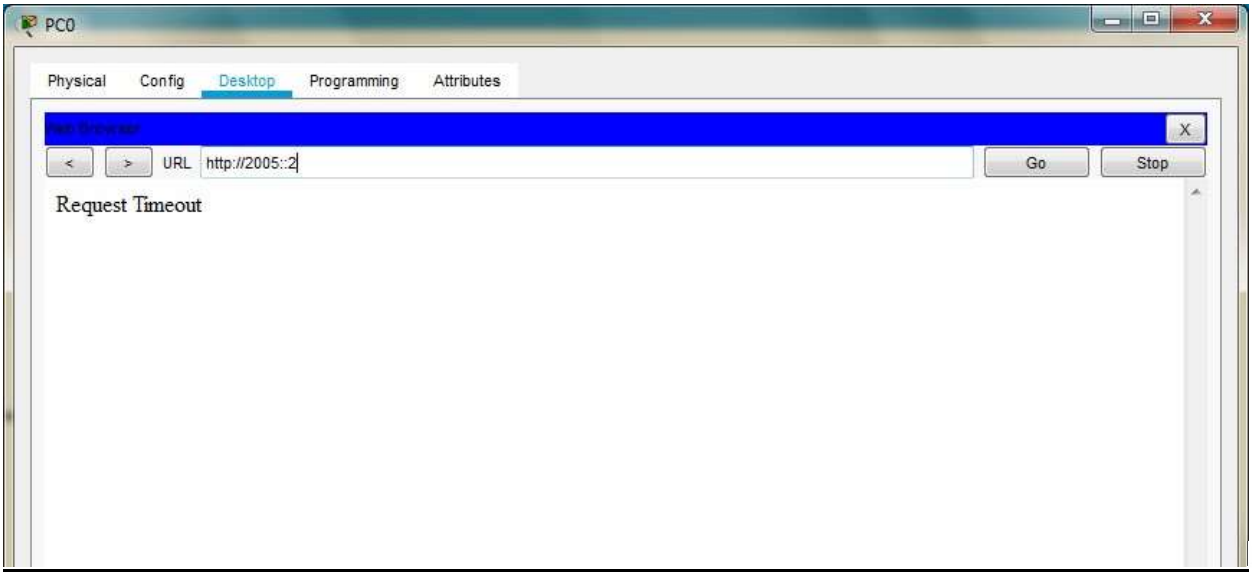
1) No HTTP or HTTPS allowed on server by any host
2) No www service accessible on the server by any host
3) Only ipv6 packets allowed towards the server

We enter the following commands in the CLI mode of the Router1 and apply it at the proper interface

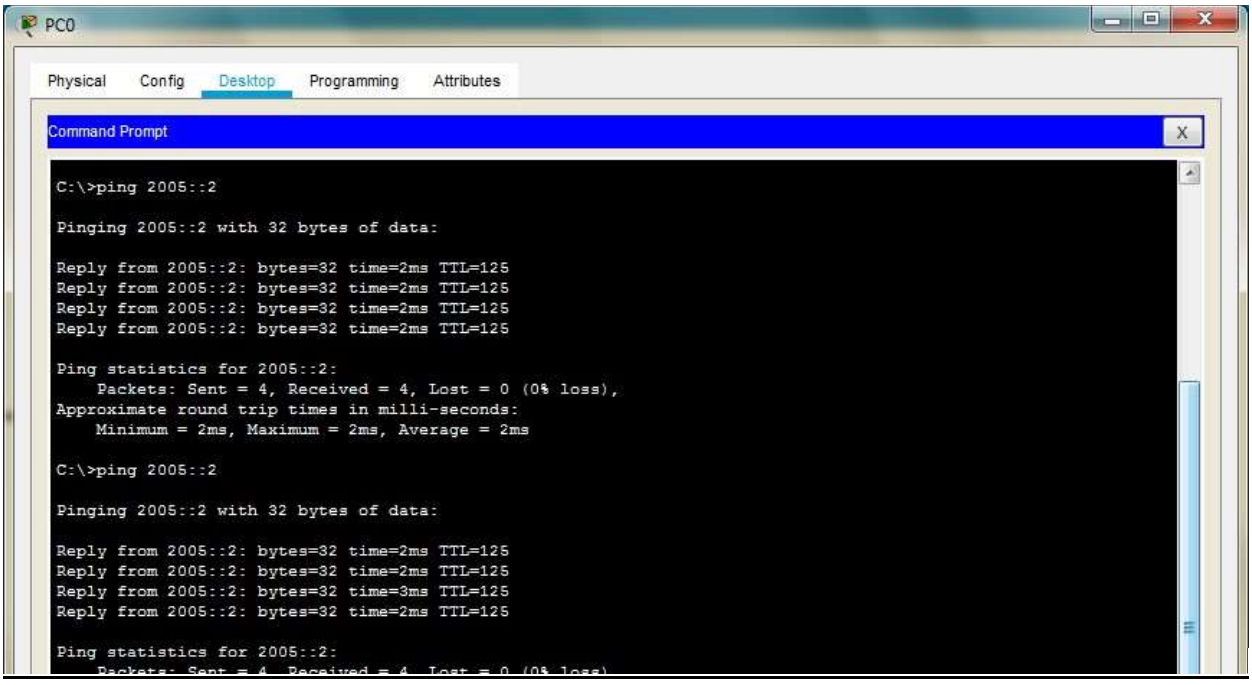
```
Router>
Router>enable
Router#configure terminal
Router(config)#ipv6 access-list smile
Router(config-ipv6-acl)#deny tcp any host 2005::2 eq www
Router(config-ipv6-acl)#deny tcp any host 2005::2 eq 443
Router(config-ipv6-acl)#permit ipv6 any any
Router(config-ipv6-acl)#
Router(config-ipv6-acl)#exit

Router(config)#
Router(config)#interface Serial0/1/1
Router(config-if)#ipv6 traffic-filter smile in
Router(config-if)#exit
Router(config)#
```

We verify the configuration by first accessing the www service from the browser of both PCs and get failure





Next we verify whether the ipv6 protocol works by pinging server from any of the PC (it must be successful)



Hence the given ACLs have been applied and verified on host running on ipv6 protocol

PRACTICAL NO 6: Configuring a Zone-Based Policy Firewall (ZPF)

Cisco IOS® Software Release 12.4(6)T introduced Zone-Based Policy Firewall (ZFW), a new configuration model for the Cisco IOS Firewall feature set. This new configuration model offers intuitive policies for multiple-interface routers, increased granularity of firewall policy application, and a default deny-all policy that prohibits traffic between firewall security zones until an explicit policy is applied to allow desirable traffic.

Nearly all classic Cisco IOS Firewall features implemented before Cisco IOS Software Release 12.4(6)T are supported in the new zone-based policy inspection interface:

1) Stateful packet inspection
2) VRF-aware Cisco IOS Firewall
3) URL filtering
4) Denial-of-Service (DoS) mitigation

Cisco IOS Software Release 12.4(9)T added ZFW support for per-class session/connection and throughput limits, as well as application inspection and control:

1) HTTP
2) Post Office Protocol (POP3),
3) Internet Mail Access Protocol (IMAP),
4) Simple Mail Transfer Protocol/Enhanced Simple Mail Transfer Protocol (SMTP/ESMTP) 5) Sun Remote Procedure Call (RPC)
6) Instant Messaging (IM) applications:
   i) Microsoft Messenger ii) Yahoo! Messenger iii) AOL Instant Messenger
7) Peer-to-Peer (P2P) File Sharing:
   i) Bittorrent ii) KaZaA
   iii) Gnutella
   iv) eDonkey

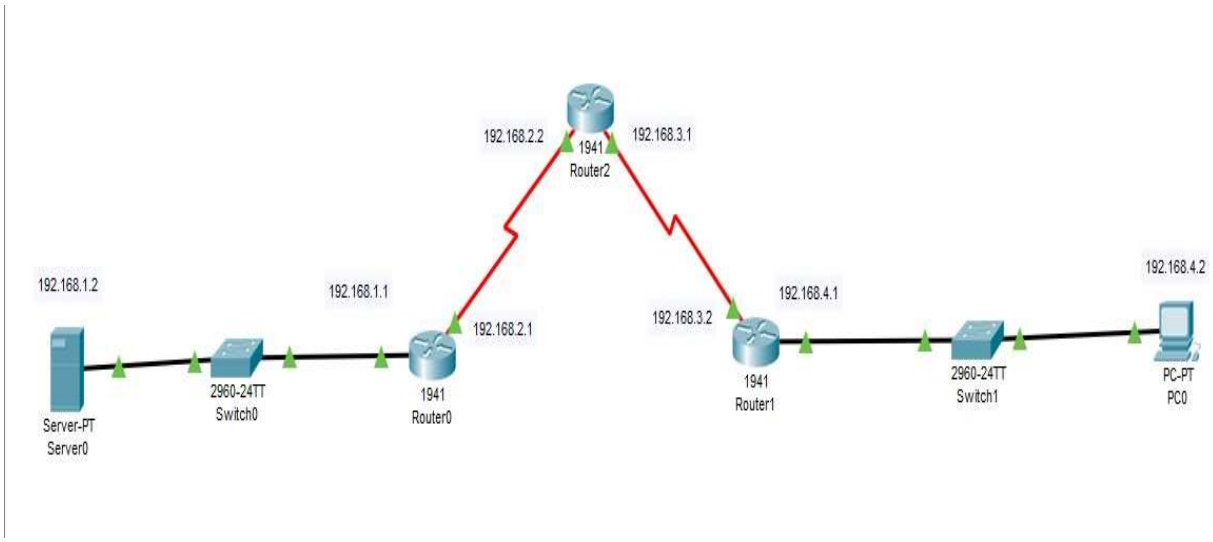
Cisco IOS Software Release 12.4(11)T added statistics for easier DoS protection tuning.

Some Cisco IOS Classic Firewall features and capabilities are not yet supported in a ZFW in Cisco IOS Software Release 12.4(15)T:

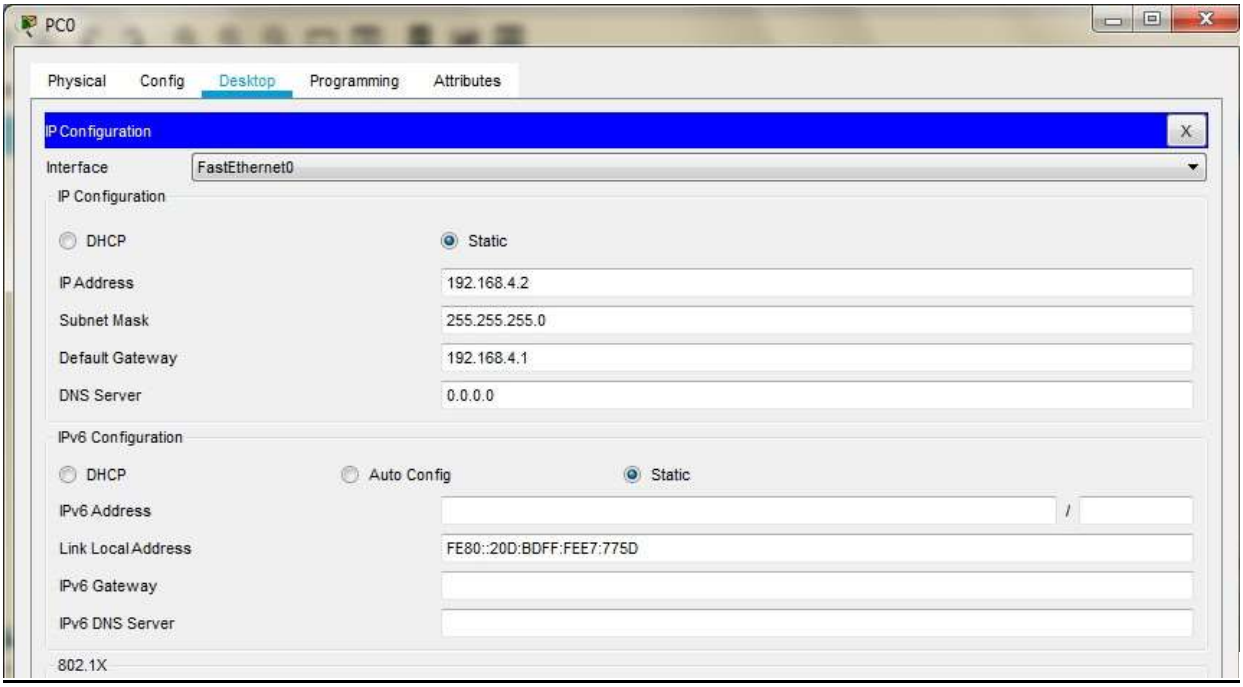
i) Authentication proxy ii) Stateful firewall failover iii) Unified firewall MIB iv) IPv6 stateful inspection
v) TCP out-of-order support

ZFW generally improves Cisco IOS performance for most firewall inspection activities. Neither Cisco IOS ZFW or Classic Firewall include stateful inspection support for multicast traffic.

We use the following Topology for the current case

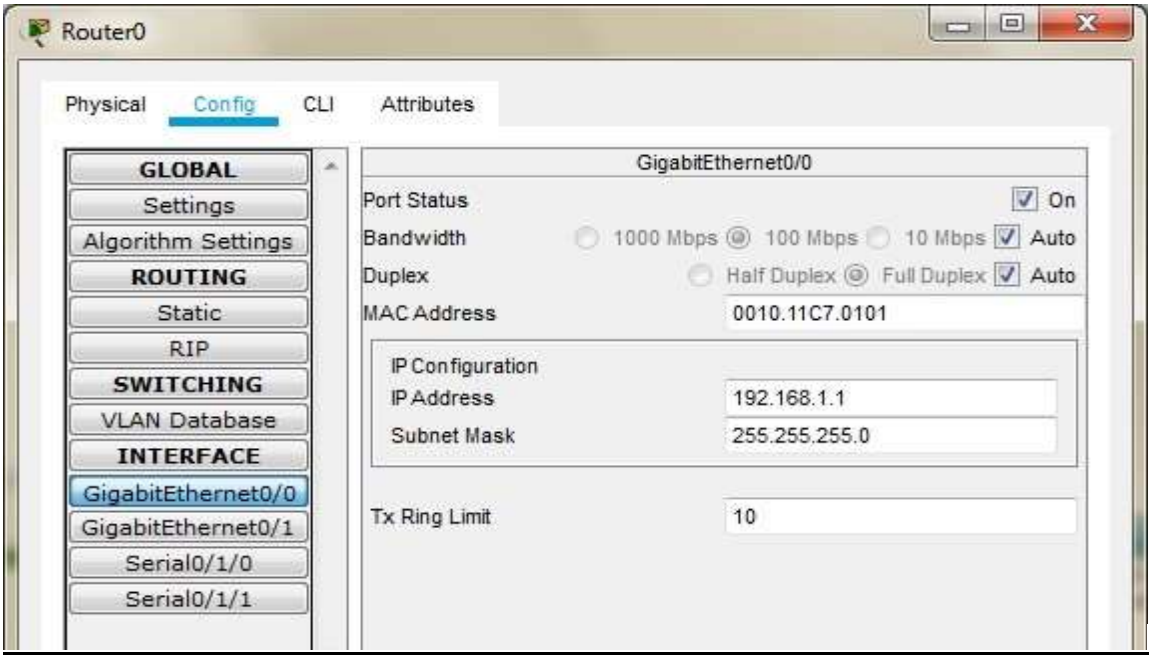


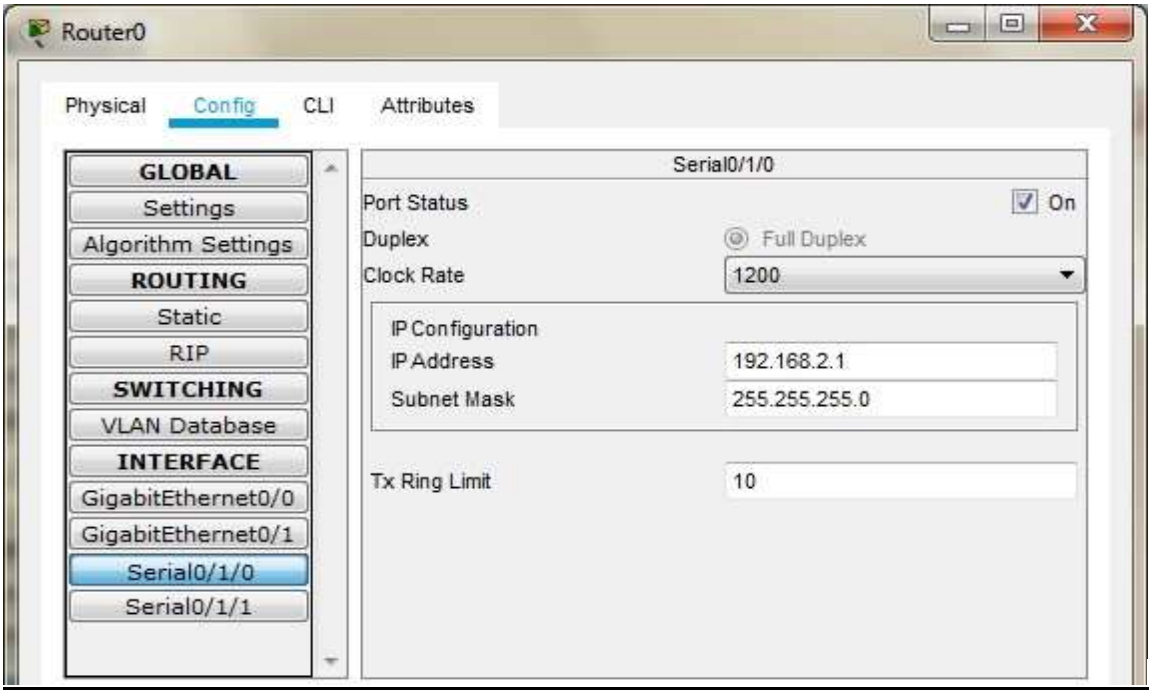
Configuring PC0



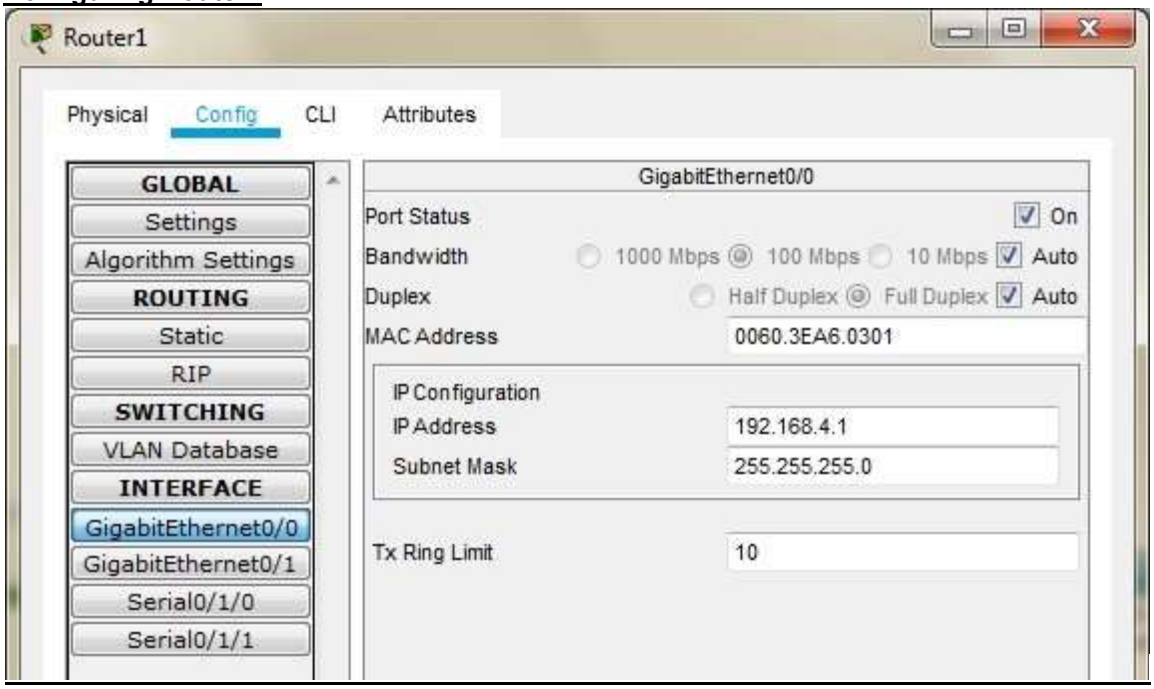
Serial Interface must be added in each Router before configuring it

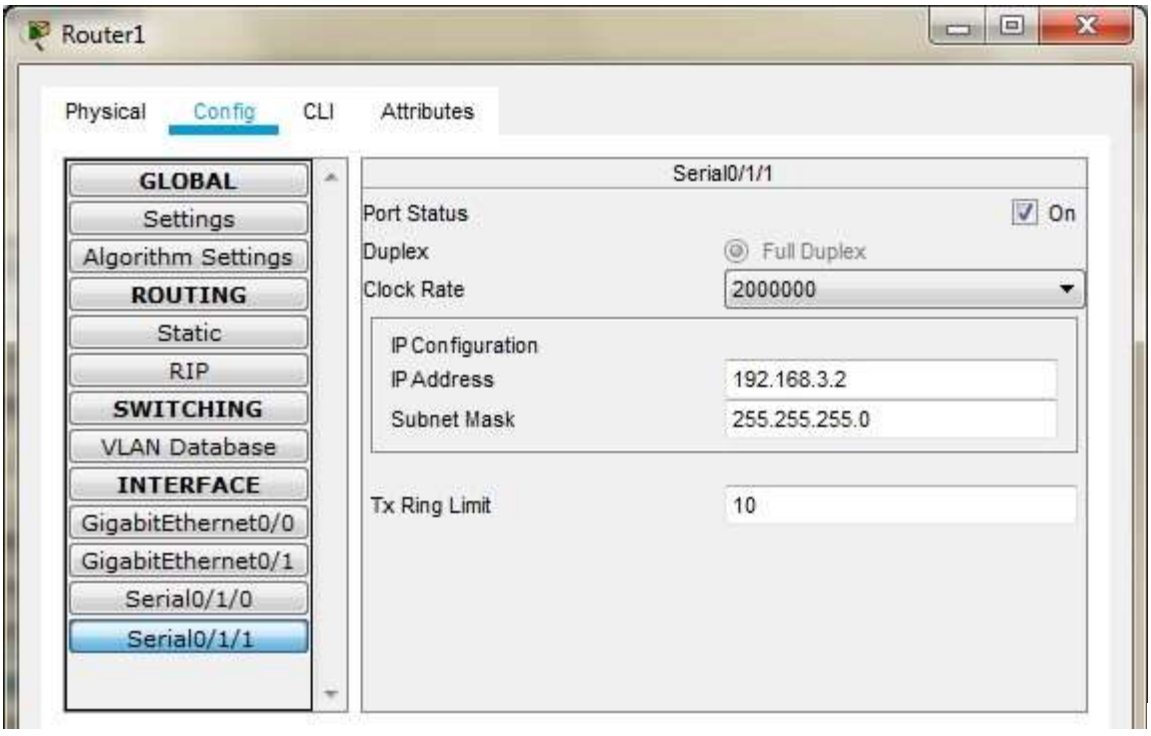
Configuring Router0



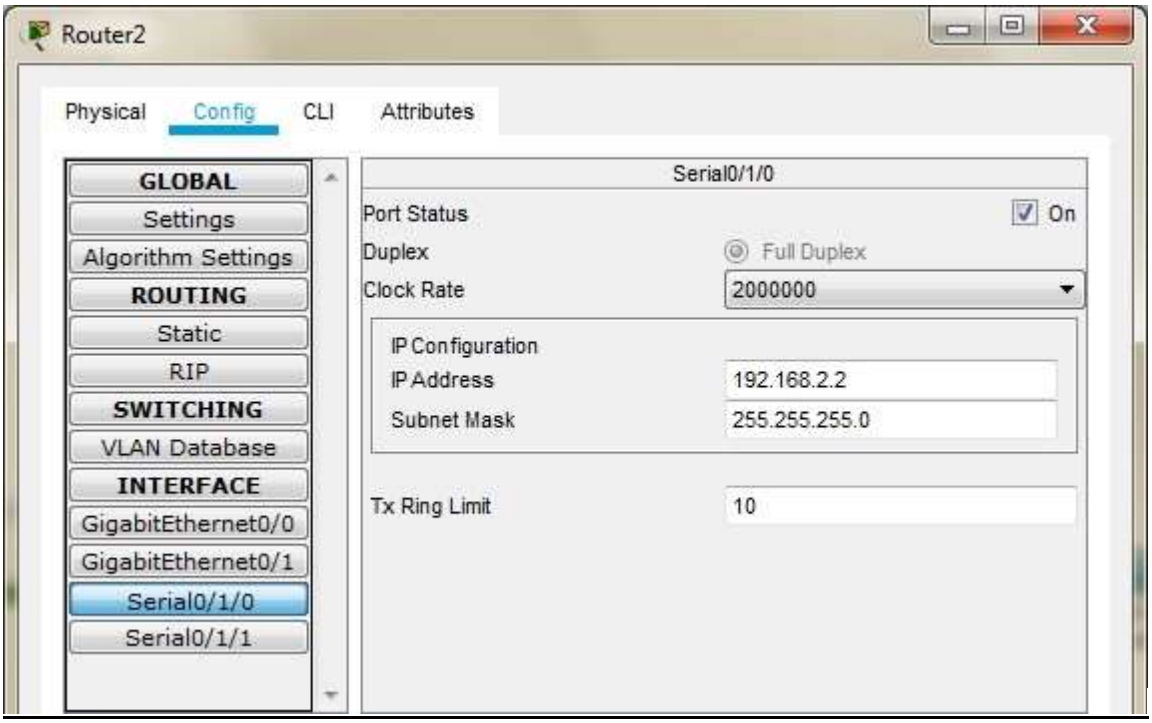


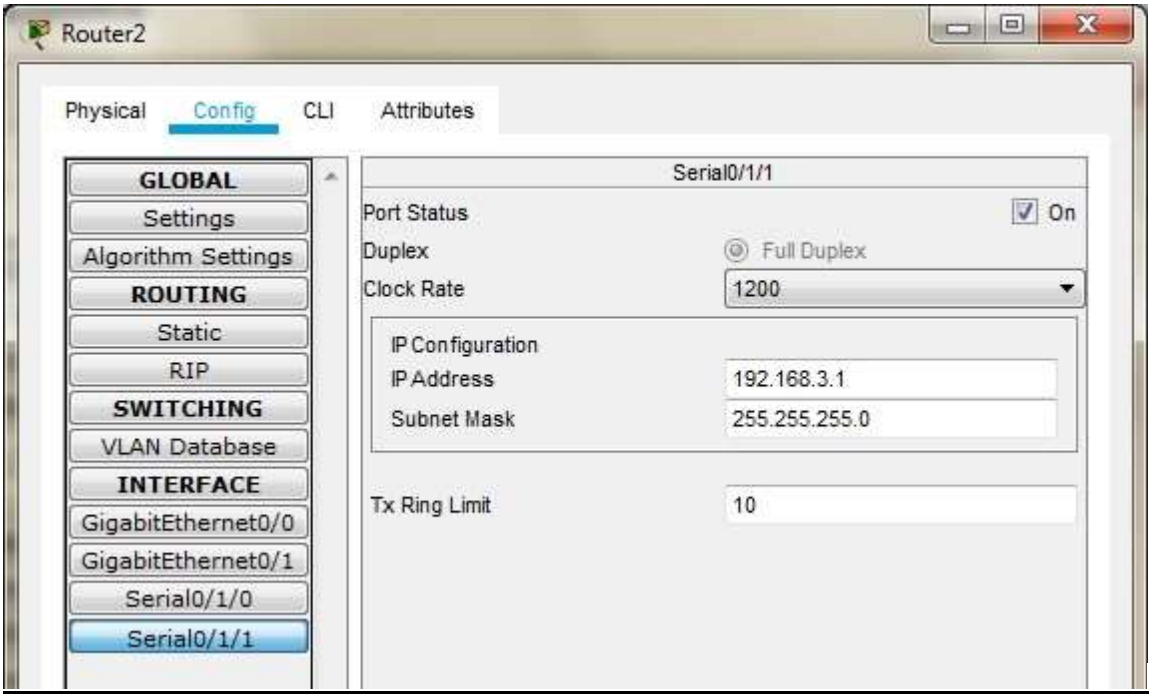
Configuring Router1



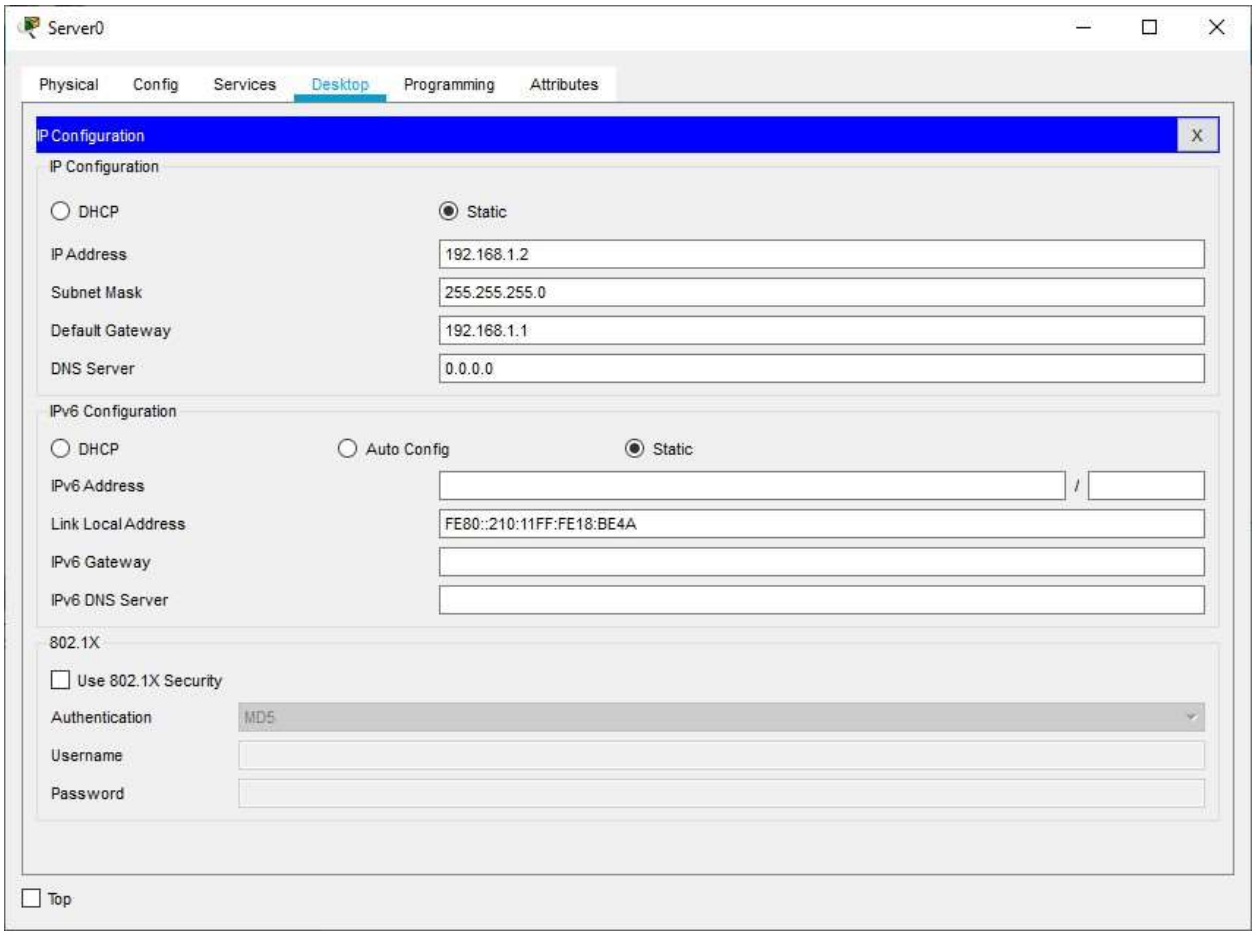


Configuring Router2





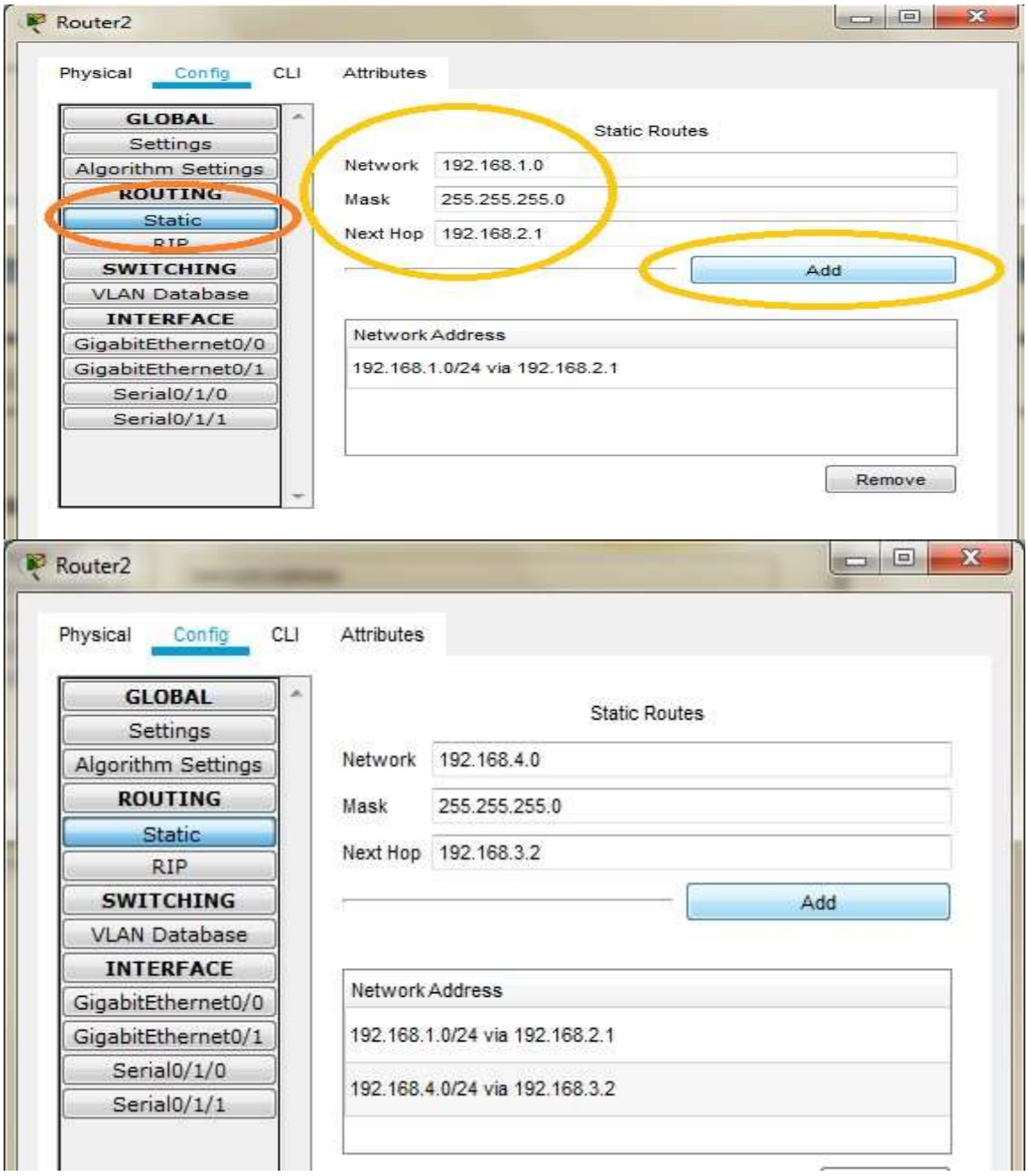
Configuring Server0



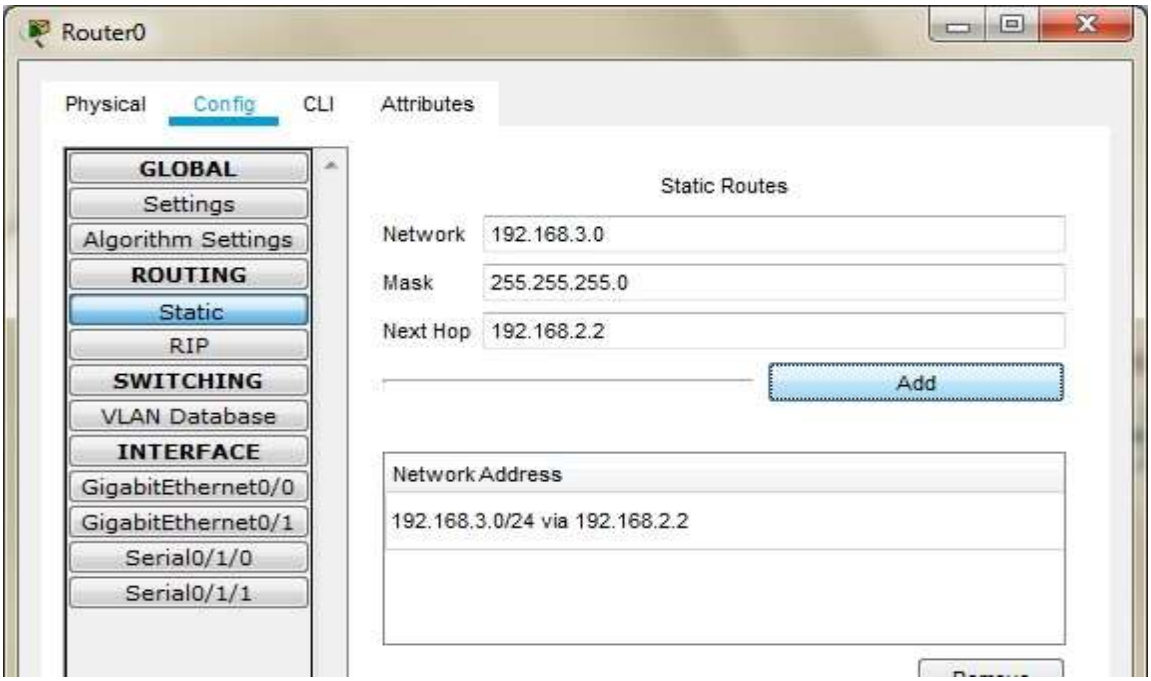
Part 1: Static Routing

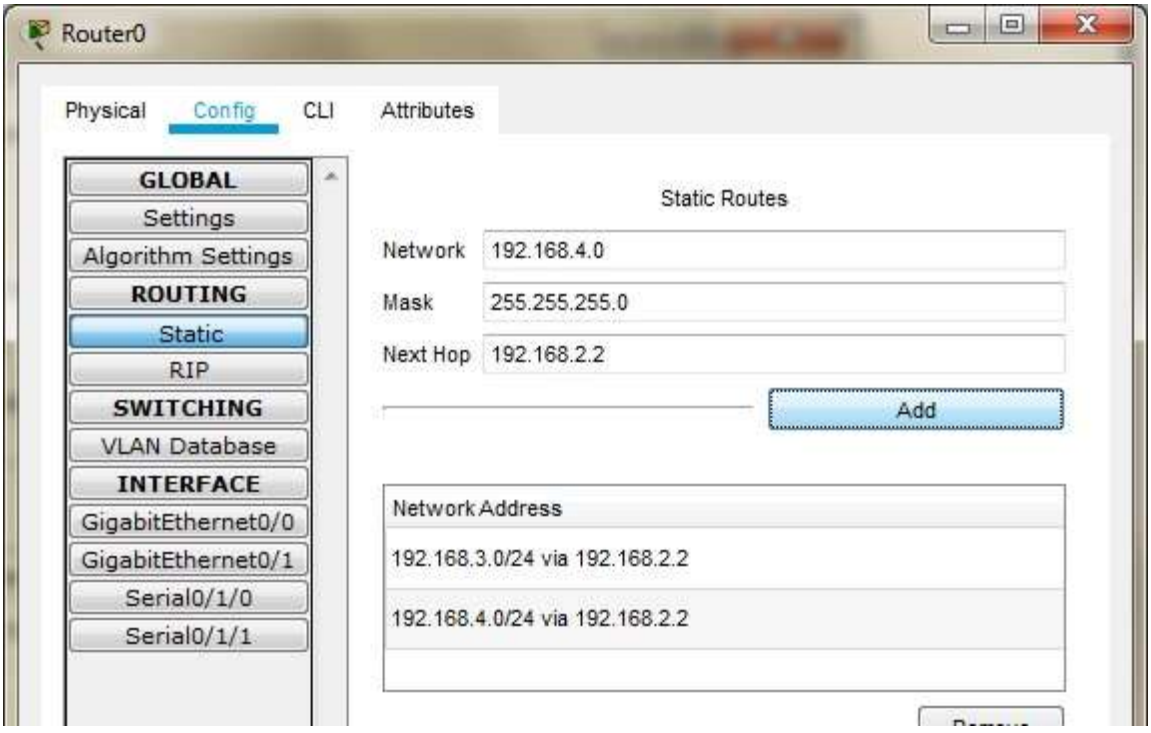
Static Routing is done using the following procedure for each Router

Router 2: Add the following Routes in the Static mode

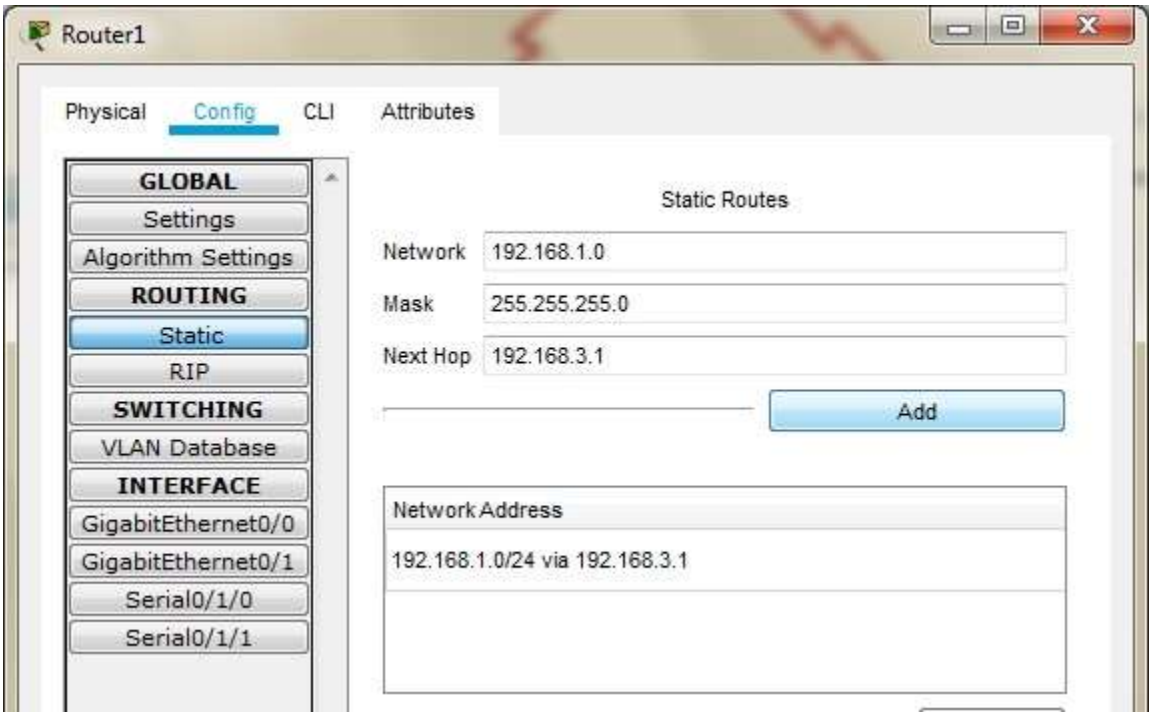


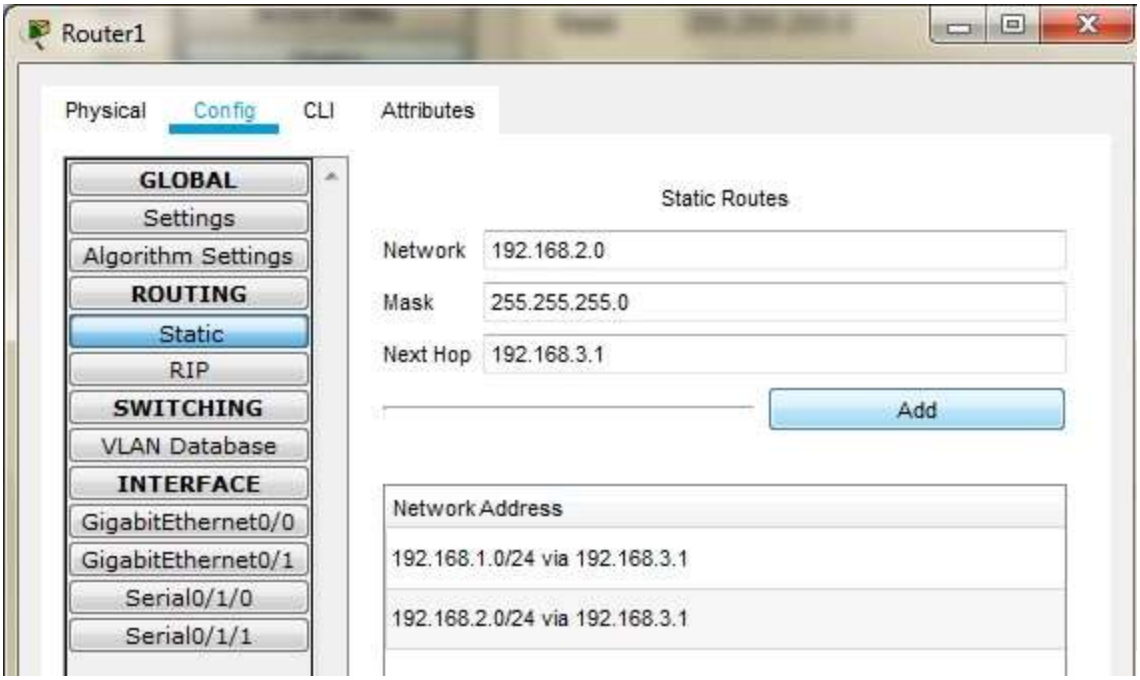
Router 0: Add the following Routes in the Static mode



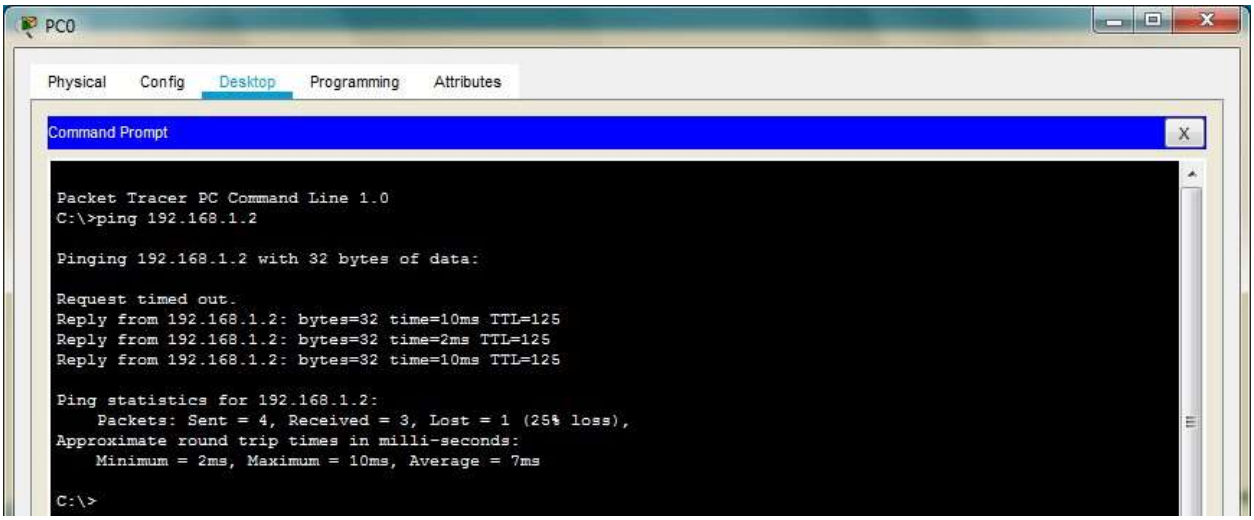


Router 1: Add the following Routes in the Static mode


Router1
Physical
Config
CLI
Attributes
GLOBAL
Settings
Algorithm Settings
ROUTING
Static
RIP
SWITCHING
VLAN Database
INTERFACE
GigabitEthernet0/0
GigabitEthernet0/1
Serial0/1/0
Serial0/1/1
Static Routes
Network 192.168.1.0
Mask 255.255.255.0
Next Hop 192.168.3.1
Add
Network Address
192.168.1.0/24 via 192.168.3.1


Router1
Physical
Config
CLI
Attributes
GLOBAL
Settings
Algorithm Settings
ROUTING
Static
RIP
SWITCHING
VLAN Database
INTERFACE
GigabitEthernet0/0
GigabitEthernet0/1
Serial0/1/0
Serial0/1/1
Static Routes
Network 192.168.2.0
Mask 255.255.255.0
Next Hop 192.168.3.1
Add
Network Address
192.168.1.0/24 via 192.168.3.1
192.168.2.0/24 via 192.168.3.1

Now we check the connectivity by pinging the Server from the PC



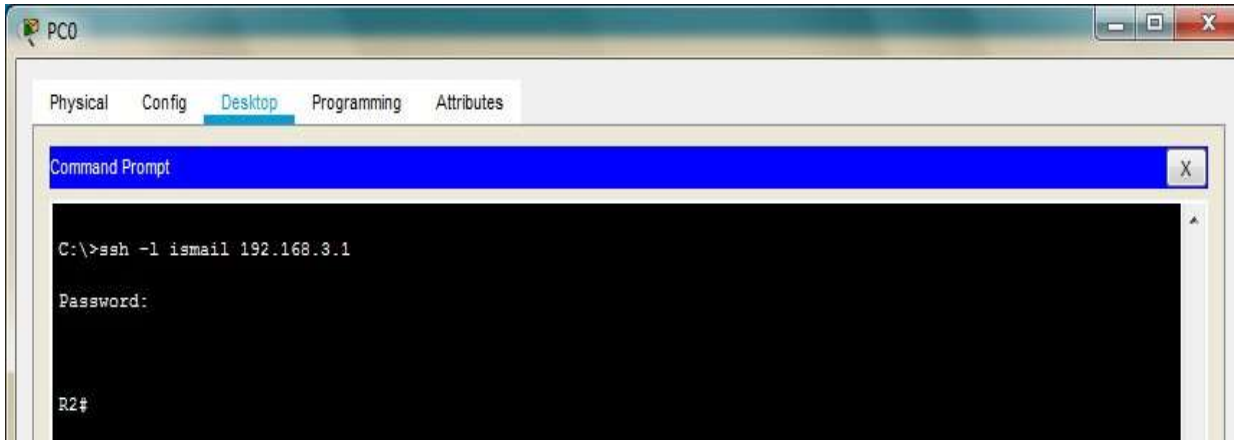
Part 2: Configuring SSH on Router 2

Type the following commands in the CLI mode of Router2

Router>en
Router>enable
Router#configure terminal
Router(config)#ip domain-name ismail.com
Router(config)#hostname R2
R2(config)#cryp
R2(config)#crypto k
R2(config)#crypto key g
R2(config)#crypto key generate r
R2(config)#crypto key generate rsa

R2(config)#line vty 0 4
R2(config-line)#transport input ssh
R2(config-line)#login local
R2(config-line)#exit
R2(config)#username ismail privilege 15 password cisco

Now we verify the SSH using PC as follows



Next we access the web services of the Server using the web browser of PC using the following

Part 3: Create the Firewall Zones on Router1

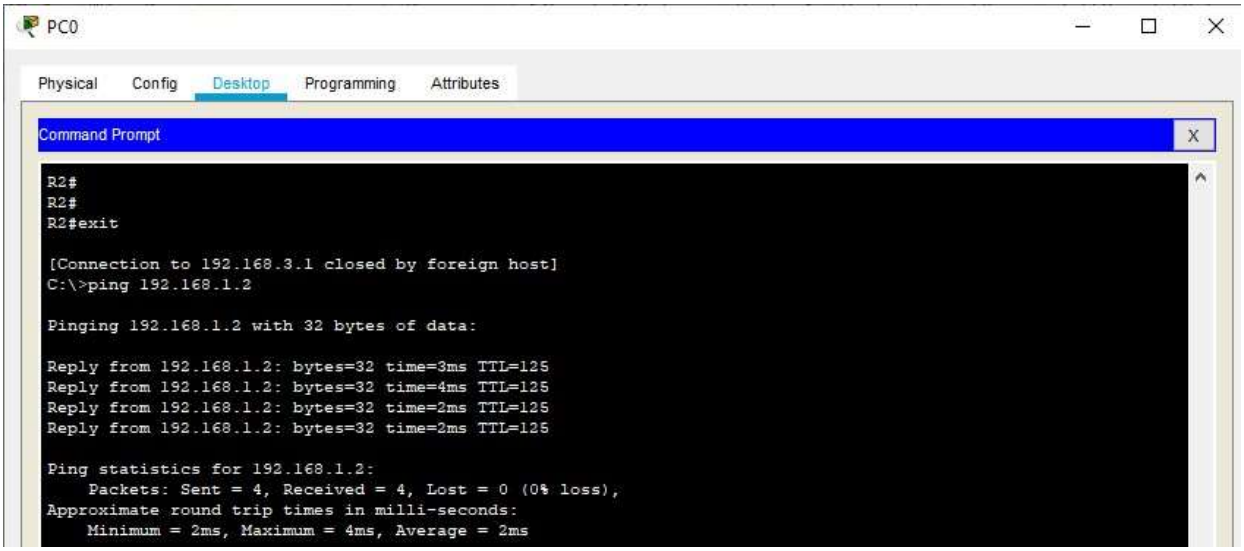
Type the following commands in the CLI mode of Router1

```
Router#
Router#configure terminal

Router(config)#zone security in-zone
Router(config-sec-zone)#exit

Router(config)#zone security out-zone
Router(config-sec-zone)#exit

Router(config)#access-list 101 permit ip 192.168.4.0 0.0.0.255 any
Router(config)#class-map type inspect match-all in-map
Router(config-cmap)#match access-group 101
Router(config-cmap)#exit

Router(config)#policy-map type inspect in-out
Router(config-pmap)#class type inspect in-map
Router(config-pmap-c)#inspect
Router(config-pmap-c)#exit
Router(config-pmap)#exit
Router(config)#

Router(config)#zone-pair security in-out-zone source in-zone destination out-zone
Router(config-sec-zone-pair)#service-policy type inspect in-out
Router(config-sec-zone-pair)#exit
Router(config)#

Router(config)#interface GigabitEthernet0/0
Router(config-if)#zone-member security in-zone
Router(config-if)#exit
Router(config)#

Router(config)#interface Serial0/1/1
Router(config-if)#zone-member security out-zone
Router(config-if)#exit
Router(config)#exit
```

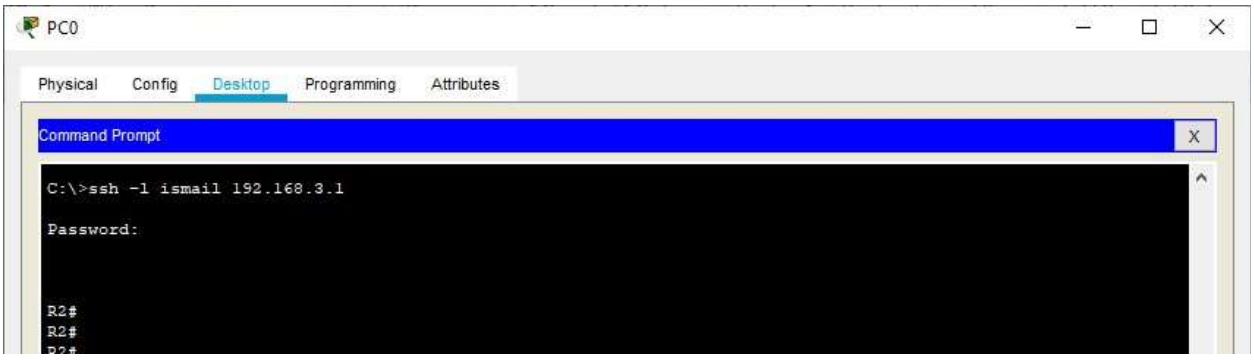
Router#copy running-config startup-config

Part 4: Testing the Firewall Functionality (from in-zone to out-zone)by the following steps

Step 1: Pinging SERVER from the PC (it will succeed)



Step 2: Start an SSH session from PC to Router 2 (ip 192.168.1.2)

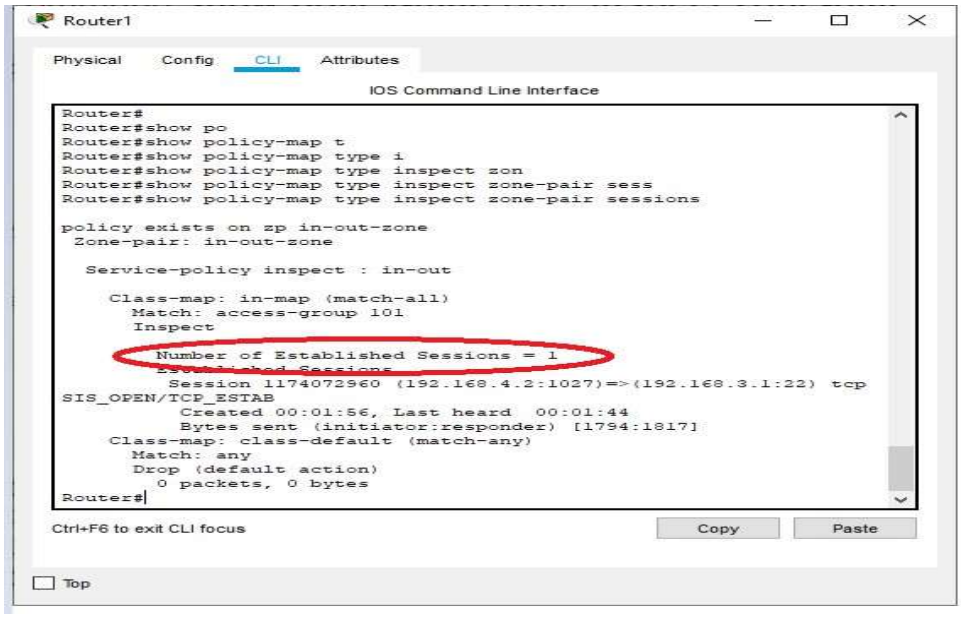


As seen above the session becomes active and we get access to Router2 (Do not exit and the session and continue to Step 3)

Step 3: Type the following command in the CLI mode of Router1

Router#show policy-map type inspect zone-pair sessions

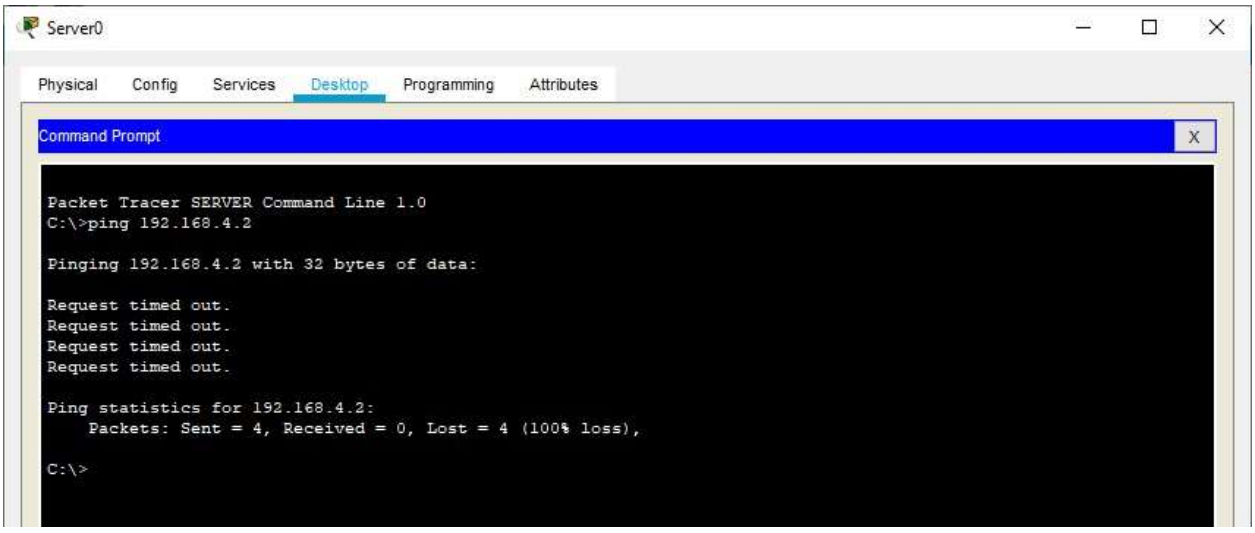
We will get the following output



Step 4: We close the SSH connection and open the web browser and access the server address (192.168.1.2) and get the following

Part 5: Testing the Firewall Functionality (from out-zone to in-zone)by the following steps

Step 1: Ping PC0 from the SERVER (it will result in Failure)



Hence the Firewall functionality has been verified

PRACTICAL NO 7: Configure IOS Intrusion Prevention System (IPS) Using the CLI

The Cisco IOS IPS acts as an in-line intrusion prevention sensor, watching packets and sessions as they flow through the router and scanning each packet to match any of the Cisco IOS IPS signatures. When it detects suspicious activity, it responds before network security can be compromised and logs the event through Cisco IOS syslog messages or Security Device Event Exchange (SDEE). The network administrator can configure Cisco IOS IPS to choose the appropriate response to various threats. The Signature Event Action Processor (SEAP) can dynamically control actions that are to be taken by a signature event on the basis of parameters such as fidelity, severity, or target value rating. These parameters have default values but can also be configured through CLI. When packets in a session match a signature, Cisco IOS IPS can take any of the following actions, as appropriate:

1) Send an alarm to a syslog server or a centralized management interface
2) Drop the packet
3) Reset the connection
4) Deny traffic from the source IP address of the attacker for a specified amount of time
5) Deny traffic on the connection for which the signature was seen for a specified amount of time

Cisco developed its Cisco IOS software-based intrusion-prevention capabilities and Cisco IOS Firewall with flexibility in mind, so that individual signatures could be disabled in case of false positives. Generally, it is preferable to enable both the firewall and Cisco IOS IPS to support network security policies. However, each of these features may be enabled independently and on different router interfaces.

Signatures:

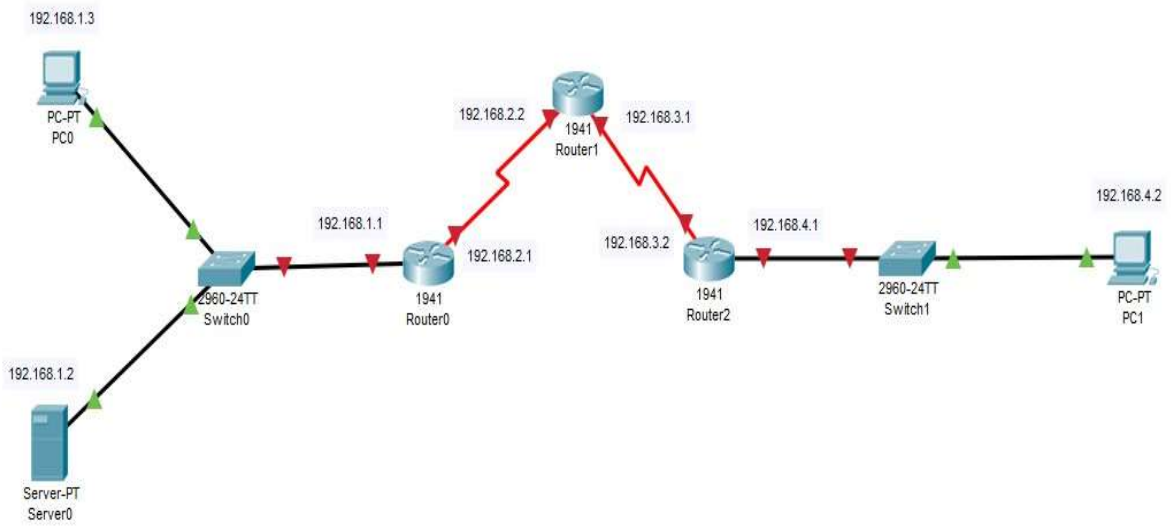
A signature is a set of rules that an IDS and an IPS use to detect typical intrusive activity, such as DoS attacks. We can easily install signatures using IDS and IPS management software such as Cisco IDM. Sensors enables us to modify existing signatures and define new ones. As sensors scan network packets, they use signatures to detect known attacks and respond with predefined actions. A malicious packet flow has a specific type of activity and signature, and an IDS or IPS sensor examines the data flow using many different signatures. When an IDS or IPS sensor matches a signature with a data flow, the sensor takes action, such as logging the event or sending an alarm to IDS or IPS management software, such as the Cisco SDM

We define some of the commands which will be used while configuring the Router for IPS

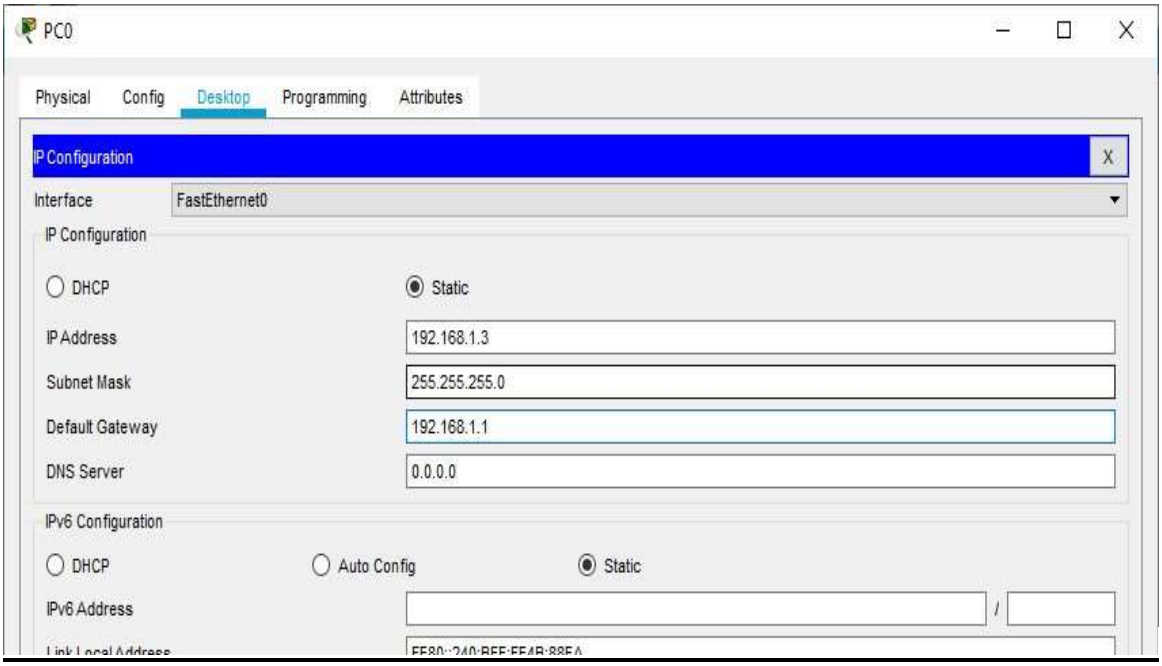
Commands	Function	Example
ip ips signaturecategory	Enters IPS category configuration mode.	Router(config)# ip ips signature-category
category	Specifies that all categories (and all signatures) are retired in the following step and enters IPS category action configuration mode Specifies the basic category (and a set of signatures) that are to be "unretired" in the following step.	Router(config-ips-category)# category all **Example:** Router(config-ips-category)# category ios_ips basic
retired {**true** | **false**}	Specifies that the device should retire all categories (and all signatures). **true** -- Retires all signatures within a given category. **false** --"Unretires" all signatures within a given category.	Router(config-ips-category-action)# retired true
mkdir flash:/ips5	Create a directory for which Cisco IOS IPS saves signature information.	**Example:** Device# mkdir flash:/ips5
ip ips name *ipsname*		**Example:** Device(config)# ip ips name myips

ip ips *ipsname* {**in** | **out**}	Applies an IPS rule at an interface and automatically loads the signatures and builds the signature engines.	**Example:** Device(config-if)# ip ips MYIPS in

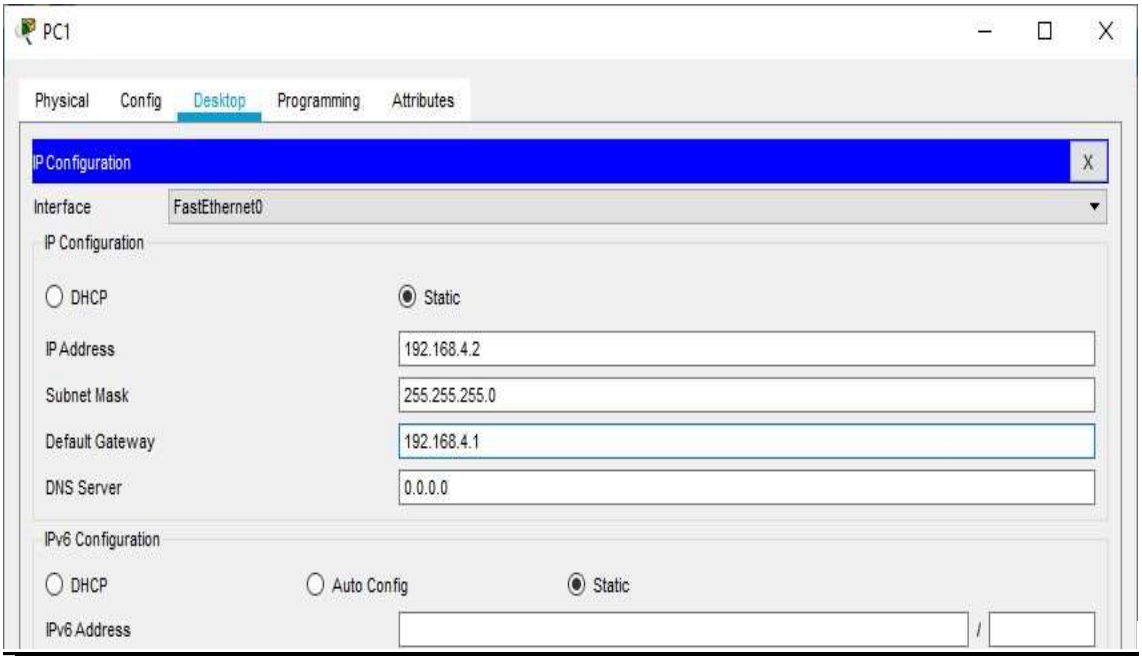
We us the following topology for the present case



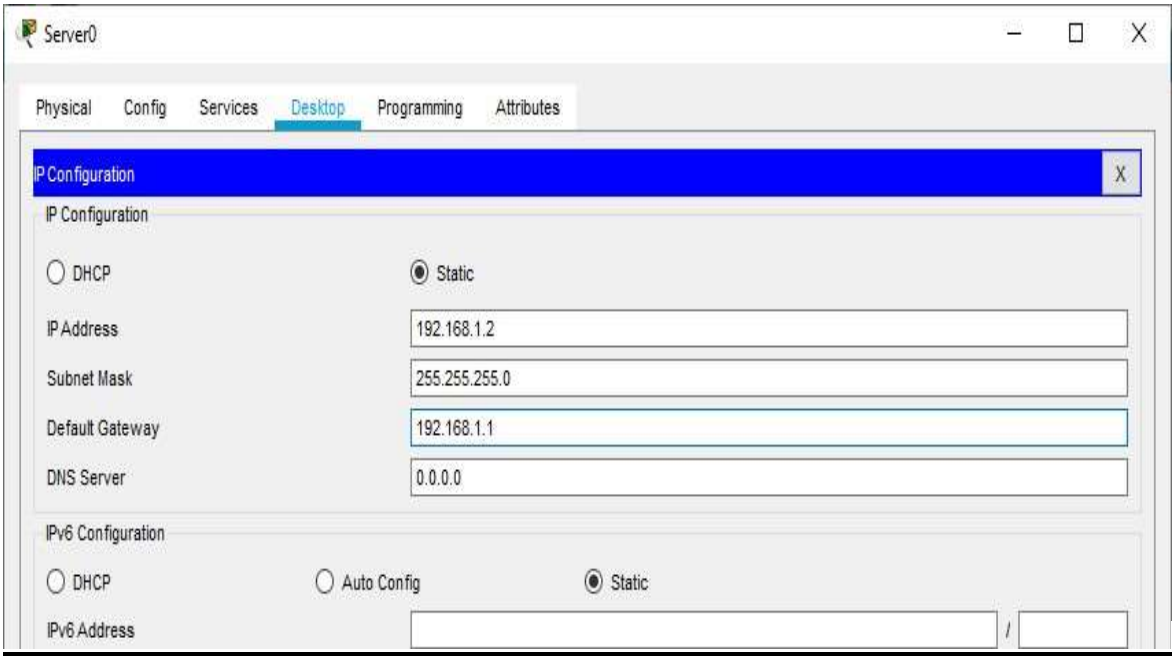
Configuring PC0



Configuring PC1

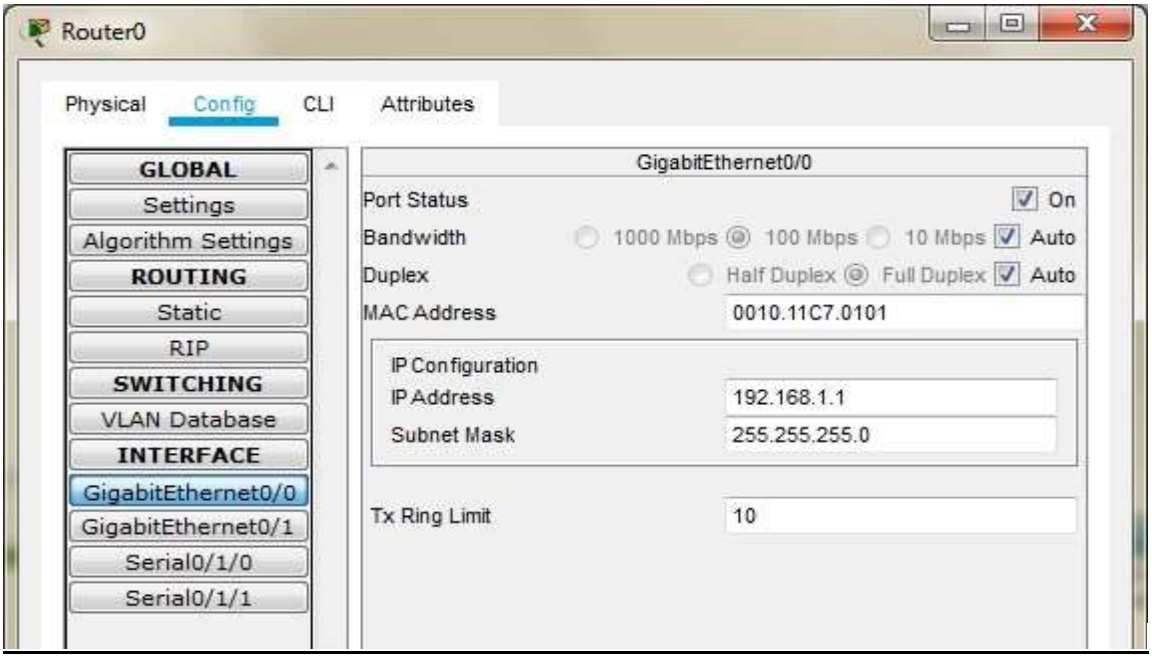


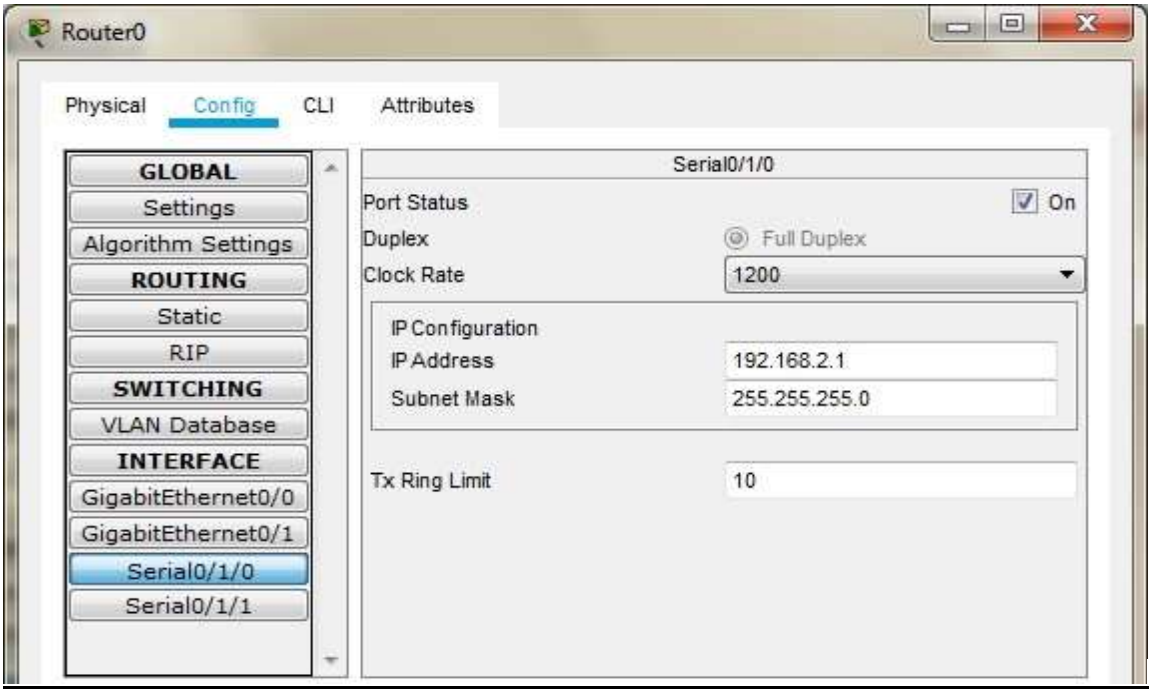
Configuring SERVER0



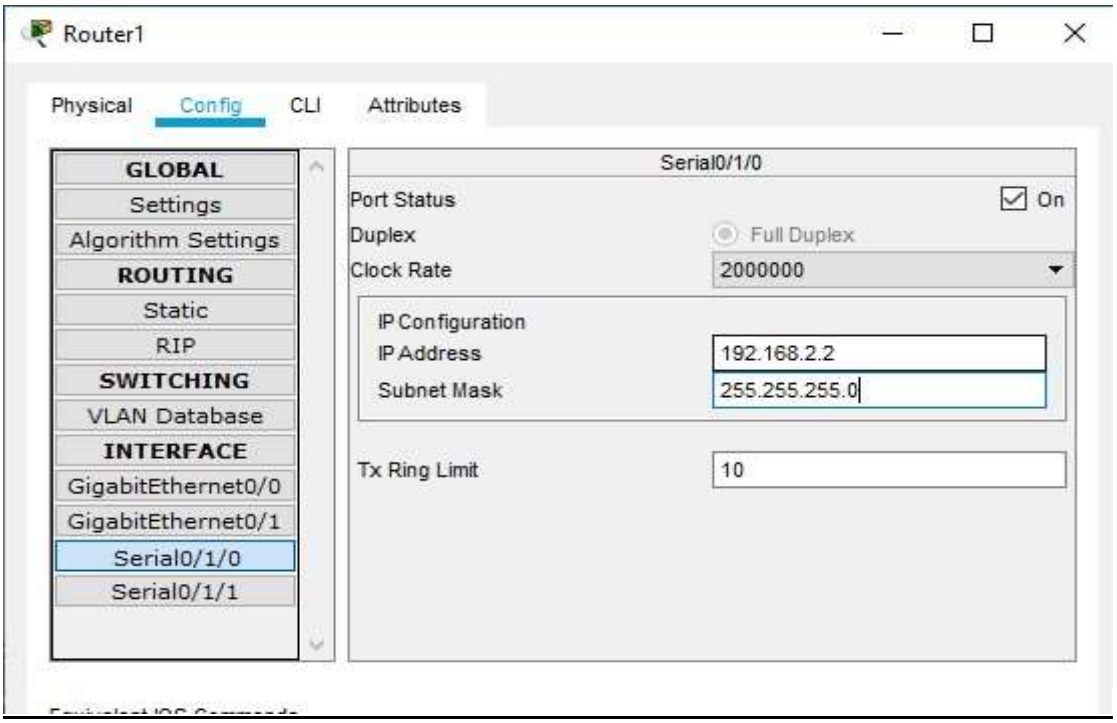
Serial Interface must be added in each Router before configuring it

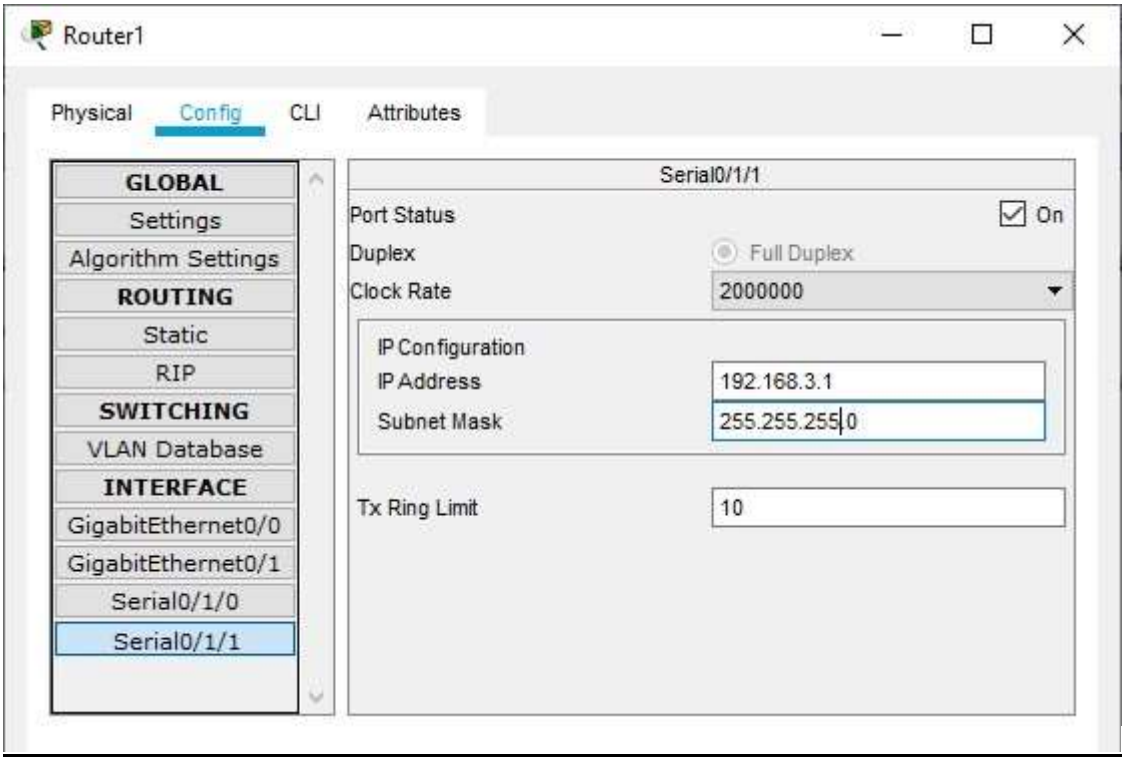
Configuring Router0



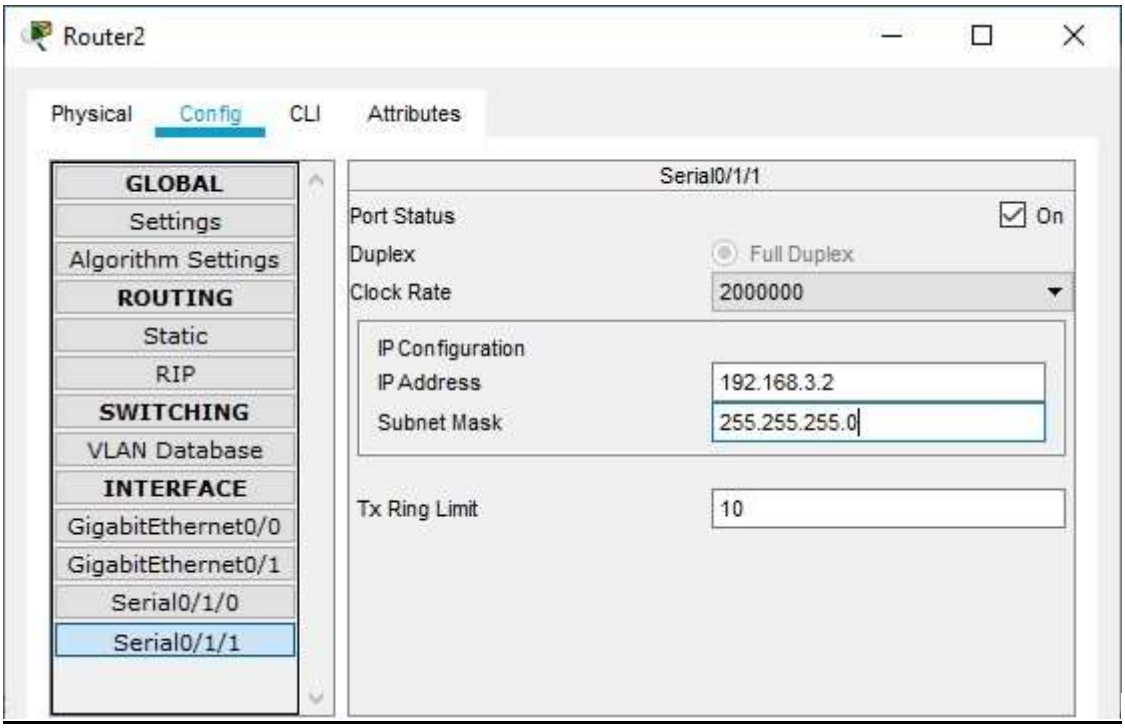


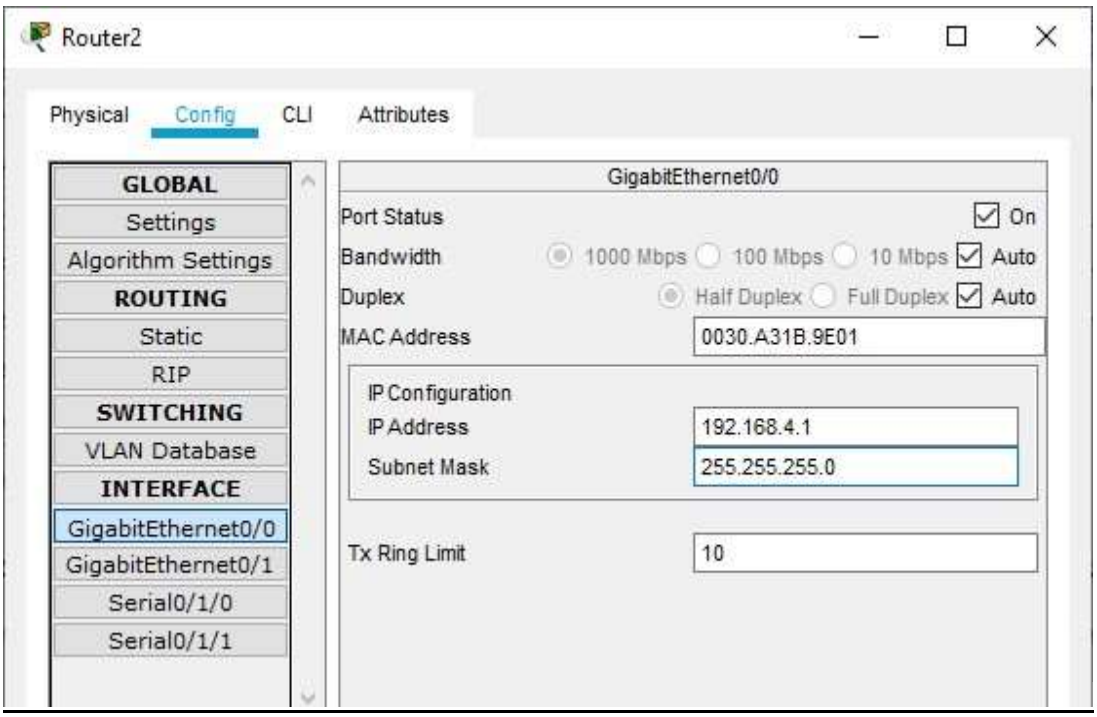
Configuring Router1





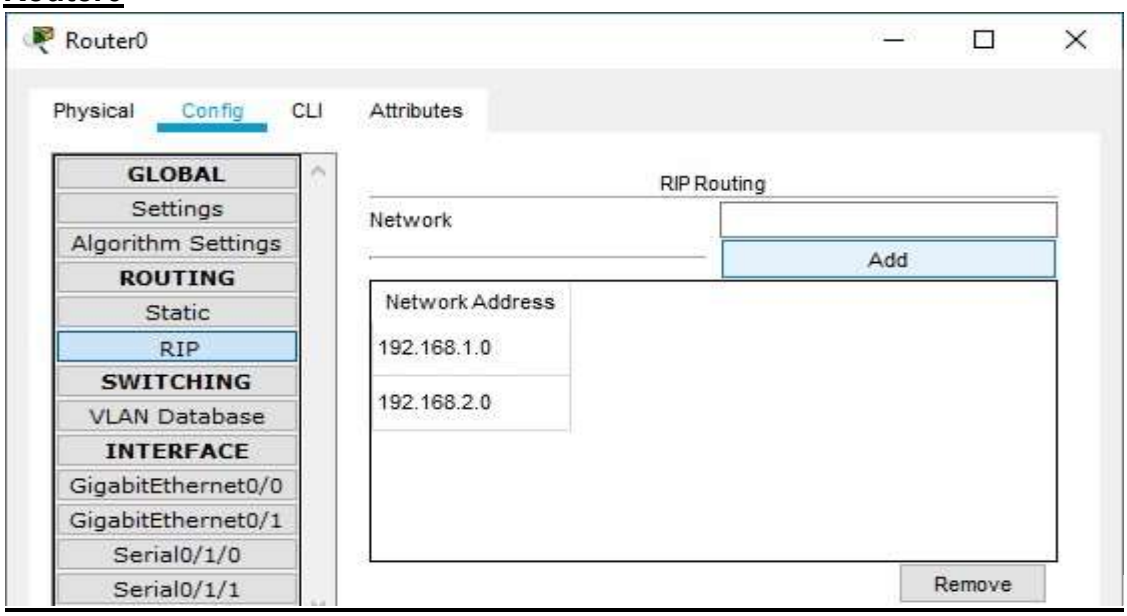
Configuring Router2


Router2
Physical
Config
CLI
Attributes
GLOBAL
Settings
Algorithm Settings
ROUTING
Static
RIP
SWITCHING
VLAN Database
INTERFACE
GigabitEthernet0/0
GigabitEthernet0/1
Serial0/1/0
Serial0/1/1
Serial0/1/1
Port Status
On
Duplex
Full Duplex
Clock Rate
2000000
IP Configuration
IP Address
192.168.3.2
Subnet Mask
255.255.255.0
Tx Ring Limit
10

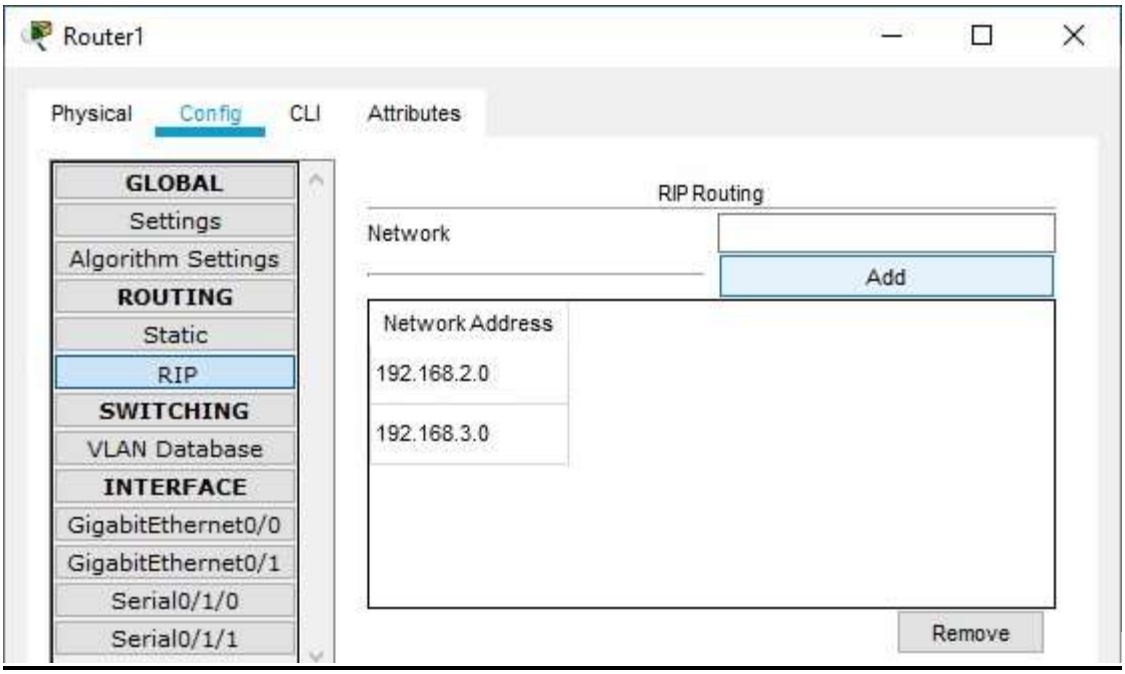

Router2
Physical
Config
CLI
Attributes
GLOBAL
Settings
Algorithm Settings
ROUTING
Static
RIP
SWITCHING
VLAN Database
INTERFACE
GigabitEthernet0/0
GigabitEthernet0/1
Serial0/1/0
Serial0/1/1
GigabitEthernet0/0
Port Status
On
Bandwidth
1000 Mbps
100 Mbps
10 Mbps
Auto
Duplex
Half Duplex
Full Duplex
Auto
MAC Address
0030.A31B.9E01
IP Configuration
IP Address
192.168.4.1
Subnet Mask
255.255.255.0
Tx Ring Limit
10

We need to set the Routing table in all the Routers so that each node could send and receive packets from others (RIP is set in all the Routers as follows)

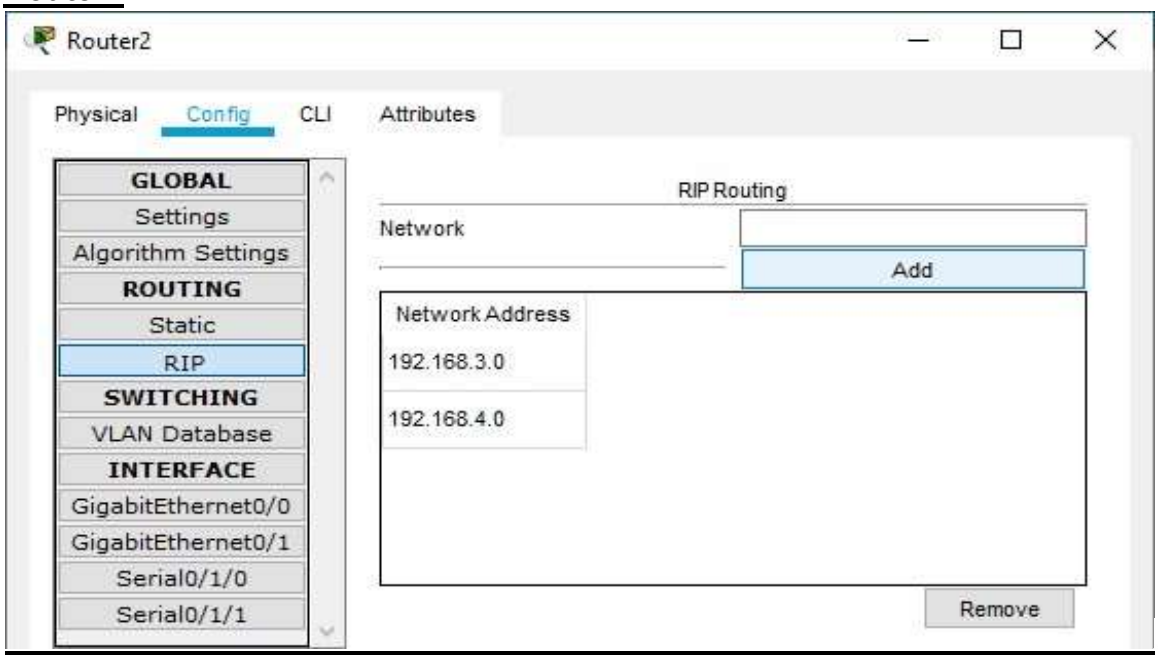
Router0



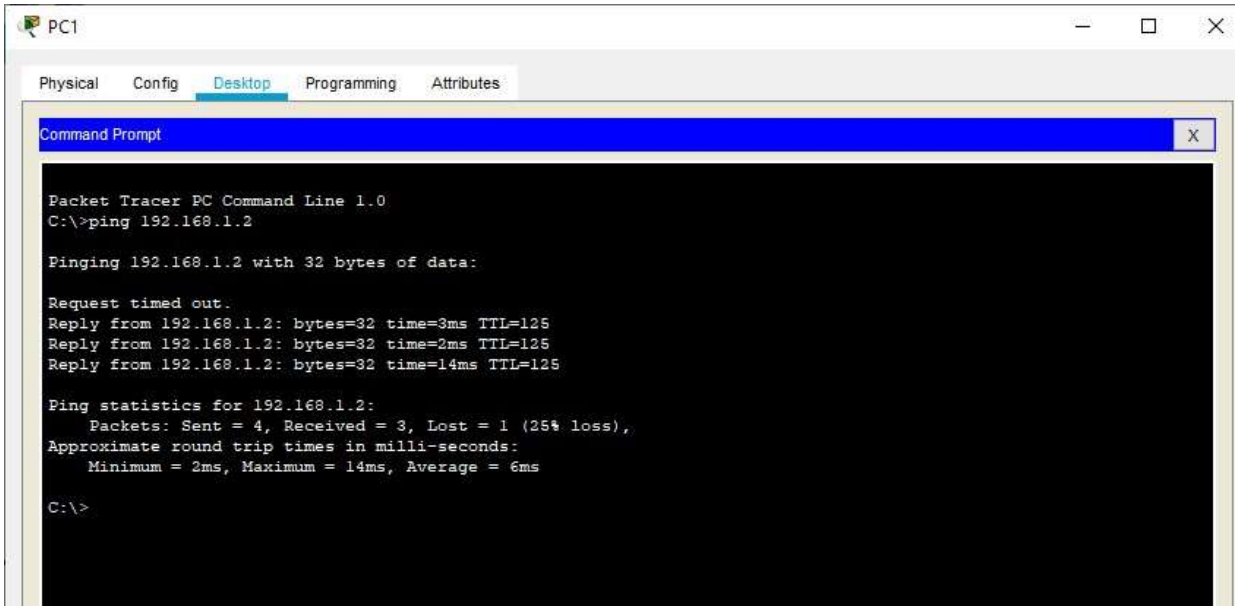
Router1



Router2



Now we can check the connectivity by sending ping commands from any node to any other node

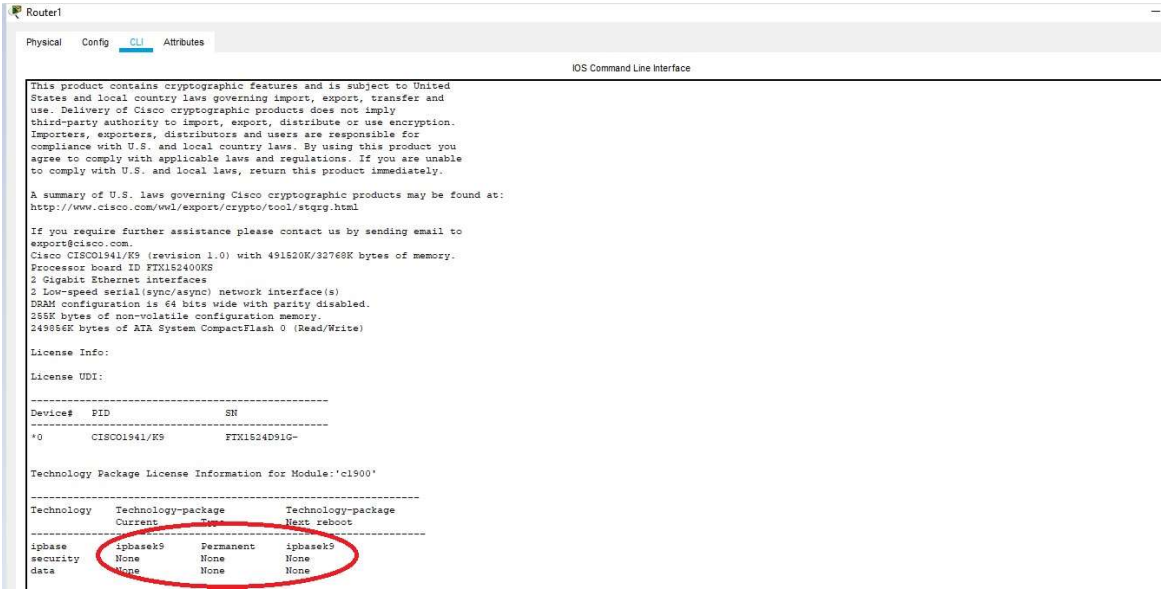


So we conclude that the connectivity has been established

PART1: Enable the IOS IPS (on Router1) Type the following command in the CLI mode of Router1

Router#show version

We will get a message informing whether the security Package is enabled or not

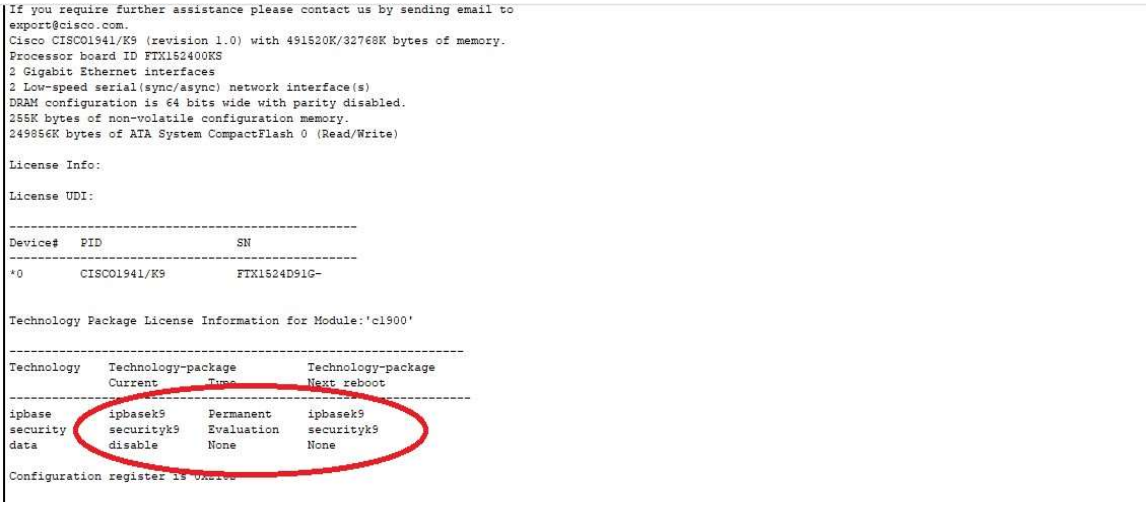


As seen above the security package is not enabled, to enable the security feature, type the following command in Router1

Router(config)#license boot module c1900 technology-package securityk9
Router(config)#exit
Router#
Router#reload

Router>enable
Router#
Router#show version

We will get a message informing whether the security package is enabled or not



As seen above now the security package has been enabled Now type the following commands in the CLI mode of Router1

Router#
Router#
Router#clock set 11:47:56 MARCH 3 2020

Router#mkdir smile
Router#configure terminal
Router(config)#ip ips config location flash:smile
Router(config)#ip ips name iosips
Router(config)#ip ips notify log
Router(config)#ip ips signature-category
Router(config-ips-category)#category all
Router(config-ips-category-action)#retired true
Router(config-ips-category-action)#exit

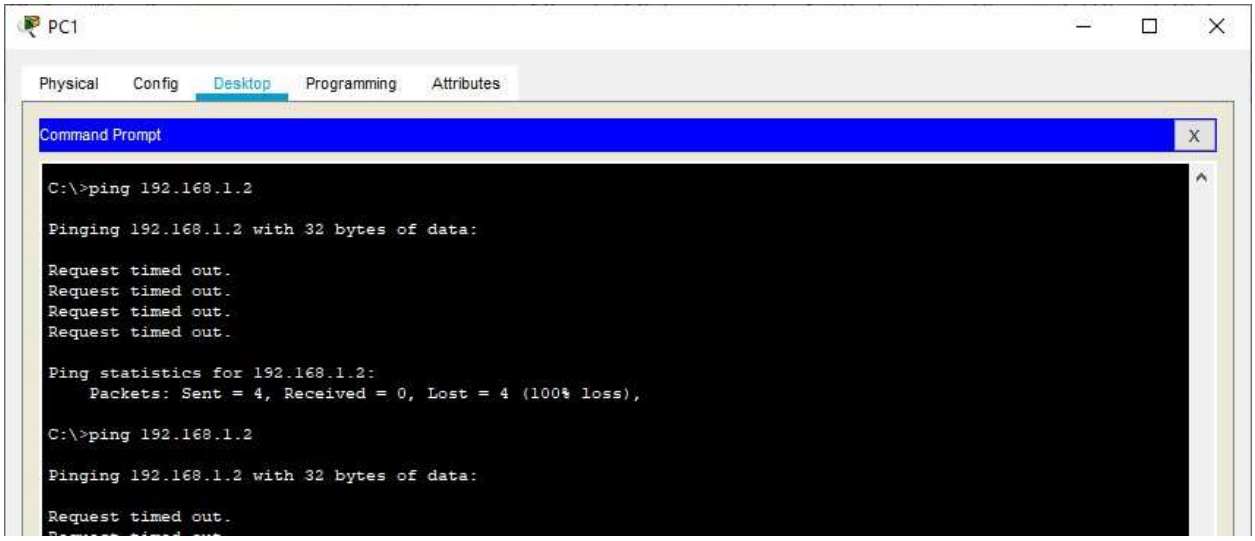
Router(config-ips-category)#category ios_ips basic
Router(config-ips-category-action)#retired false
Router(config-ips-category-action)#exit
Router(config-ips-category)#exit

Router(config)#interface Serial0/1/0
Router(config-if)#ip ips iosips out
Router(config-if)# Router(config)#

Part 2: Modify the Signature Type the following commands in the CLI mode of Router1

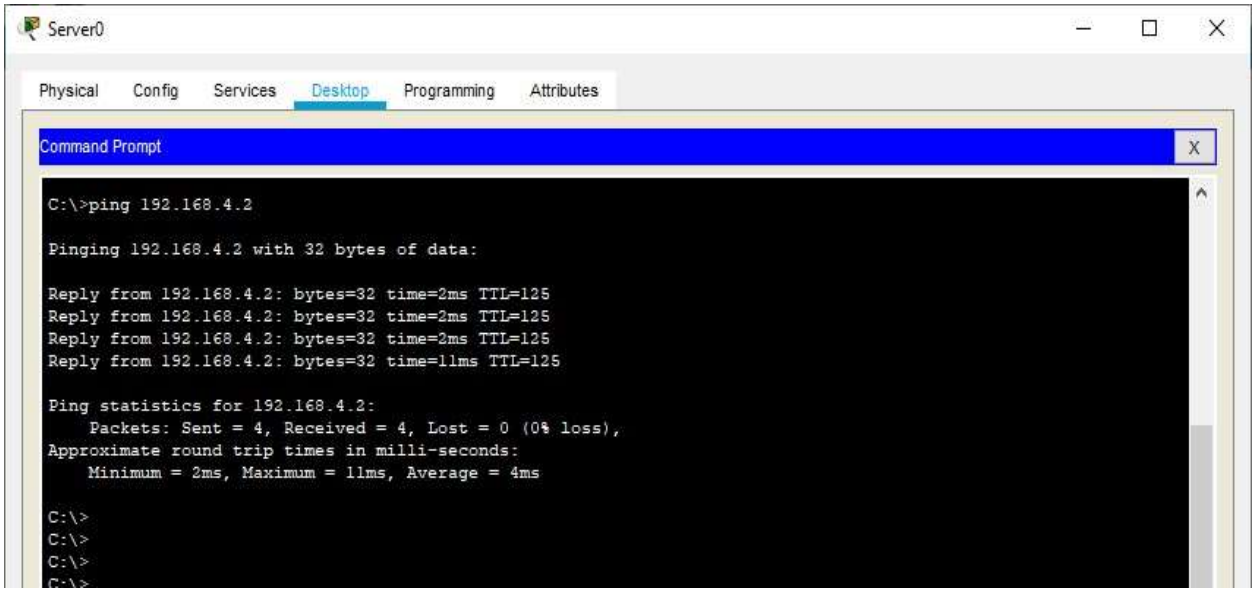
```
Router(config)#
Router(config)#ip ips signature-definition
Router(config-sigdef)#signature 2004 0
Router(config-sigdef-sig)#status
Router(config-sigdef-sig-status)#retired false
Router(config-sigdef-sig-status)#enabled true
Router(config-sigdef-sig-status)#exit
Router(config-sigdef-sig)#engine
Router(config-sigdef-sig-engine)#event-action produce-alert
Router(config-sigdef-sig-engine)#event-action deny-packet-inline
Router(config-sigdef-sig-engine)#exit
Router(config-sigdef-sig)#exit
Router(config-sigdef)#exit
Router(config)#
```

Now we need to verify the above IPS configuration, we do it first by pinging PC1 to SERVER and then from SERVER to PC1 PC1 to SERVER

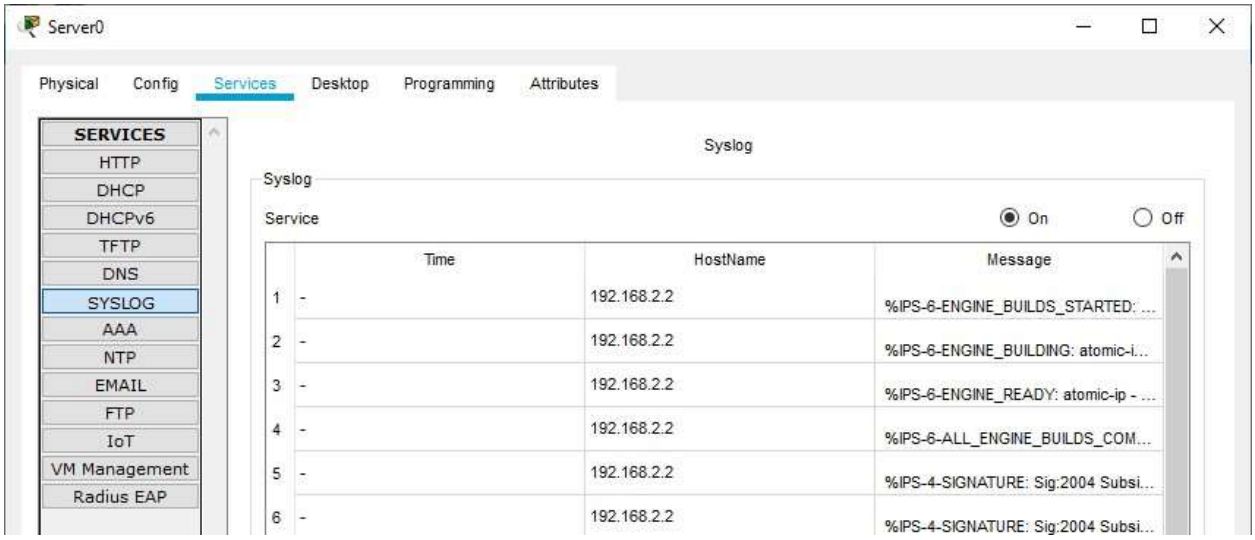


The ping FAILS

SERVER to PC1



Also we can observe the Syslog service in the SERVER to check the log activities



Hence we set the IPS and also verified it on Router1