GURU NANAK COLLEGE OF ARTS,SCIENCE & COMMERCE
GTB NAGAR,MUMBAI-37

DEPARTMENT OF INFORMATION TECHNOLOGY

TYBSc(IT),SEMESTER VI

Practical Journal

for

the subject

SECURITY IN COMPUTING

Submitted by

NAME- Mohit Sulendra Rajbhar

ROLL NO-22

for the academic year

2021-2022

Guru Nanak College of Arts, Science & Commerce

G.T.B.Nagar, Mumbai – 400 037.

Department of Information Technology

CERTIFICATE

This is to certify that Mr. Mohit Sulendra Rajbhar of TYBSc [Information Technology] Semester VI, Roll No. 22 has successfully completed the practicals for the subject of SECURITY IN COMPUTING as a partial fulfillment of the degree B.Sc(IT) during the academic year 2021-22.

Mr. Shahid Ansari
Mrs. Harpreet Kaur
Faculty-in-charge

BScIT-in-charge

Internal Examiner

External Examiner

Date : / /2022 College Seal

Practical no	Title	Date	Sign
1	Configure Cisco Routers for Syslog, NTP, and SSH Operations		
2	Configure AAA Authentication		
3	Configuring Extended ACLs		
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		
8	Packet Tracer - Layer 2 Security		
9	Layer 2 VLAN Security		

PRACTICAL NO 1:

Configure Cisco Routers for Syslog, NTP, and SSH Operations

OSPF, MD5 Authentication

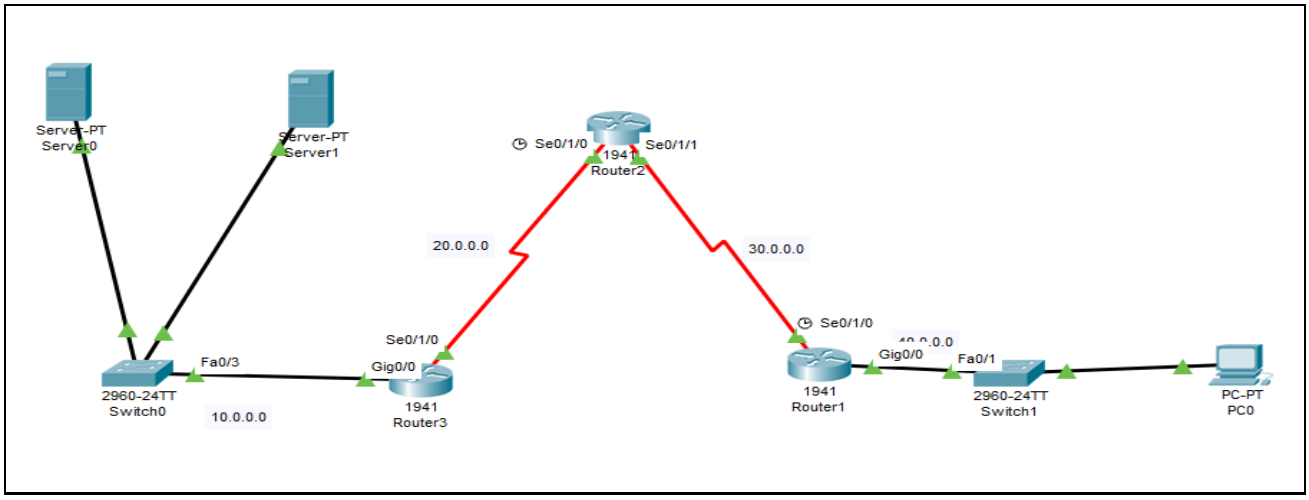
- OSPF is a routing protocol. Two routers speaking OSPF to each other exchange information about the routes they know about and the cost for them to get there.
- When many OSPF routers are part of the same network, information about all of the routes in a network are learned by all of the OSPF routers 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

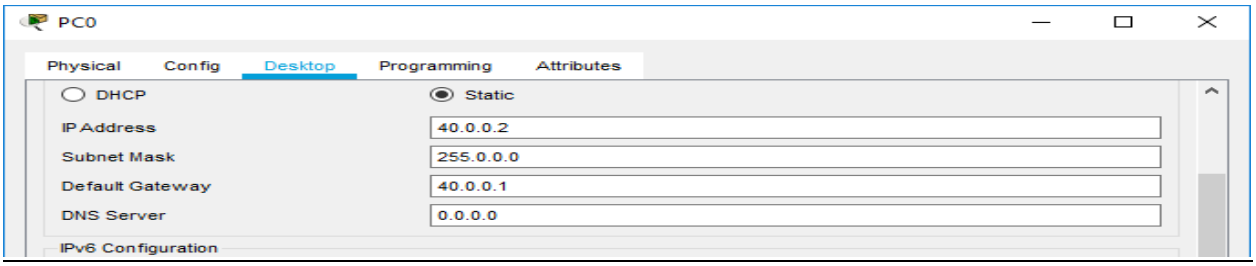
- MD5 authentication provides higher security than plain text authentication.
- This method uses the MD5 algorithm to compute a hash value from the contents of the OSPF packet and a password (or key).
- This hash value is transmitted in the packet, along with a key ID and a non-decreasing sequence number.
- 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

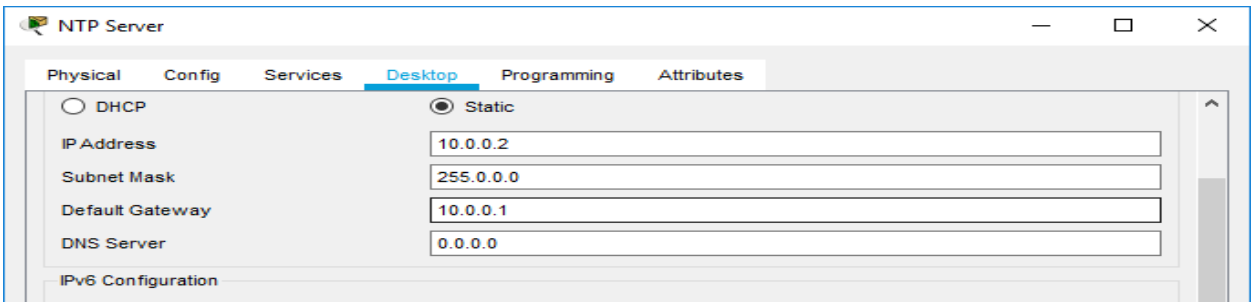
Consider the following topology



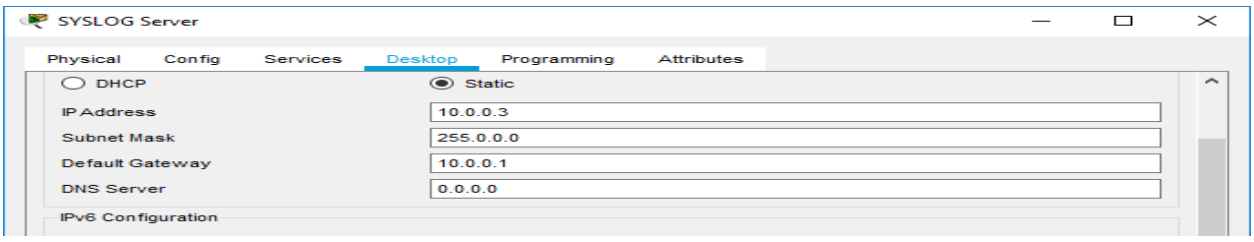
Configuring PC0



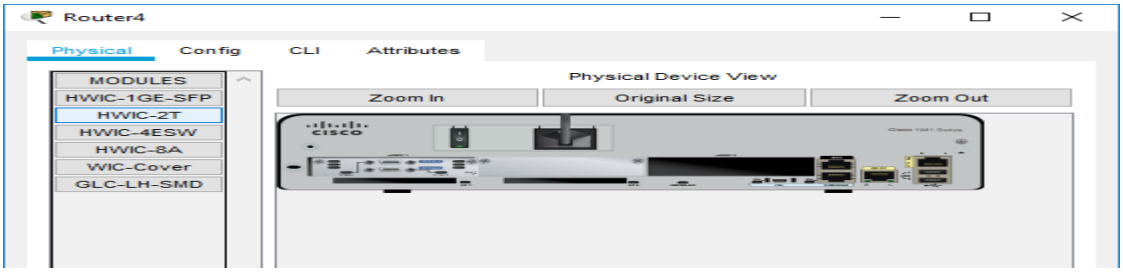
Configuring NTP Server



Configuring SYSLOG Server



Note : Adding Serial interface to all Routers



Part 1: Configure OSPF MD5 Authentication

ROUTER 3: Type the following command in the CLI mode

```
Router>enable
Router#
Router#configure terminal
Router(config)#interface GigabitEthernet0/0
Router(config-if)#ip address 10.0.0.1 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#interface Serial0/1/0
Router(config-if)#ip address 20.0.0.1 255.0.0.0
Router(config-if)# no shutdown
Router(config-if)#exit
```

The following Command is for setting the OSPF configuration

```
Router(config)#router ospf 1
Router(config-router)#network 10.0.0.0 0.255.255.255 area 1
Router(config-router)#network 20.0.0.0 0.255.255.255 area 1
Router(config-router)#exit
Router(config)#exit
Router#
```

ROUTER 2: Type the following command in the CLI mode

```
Router>enable
Router#
Router#configure terminal
Router(config)#interface GigabitEthernet0/0
```

```
Router(config-if)#ip address 20.0.0.2 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#interface Serial0/1/0
Router(config-if)#ip address 30.0.0.1 255.0.0.0
Router(config-if)# no shutdown
Router(config-if)#exit
```

The following Command is for setting the OSPF configuration

```
Router(config)#router ospf 1
Router(config-router)#network 30.0.0.0 0.255.255.255 area 1
Router(config-router)#network 20.0.0.0 0.255.255.255 area 1
Router(config-router)#exit
Router(config)#exit
Router#
```

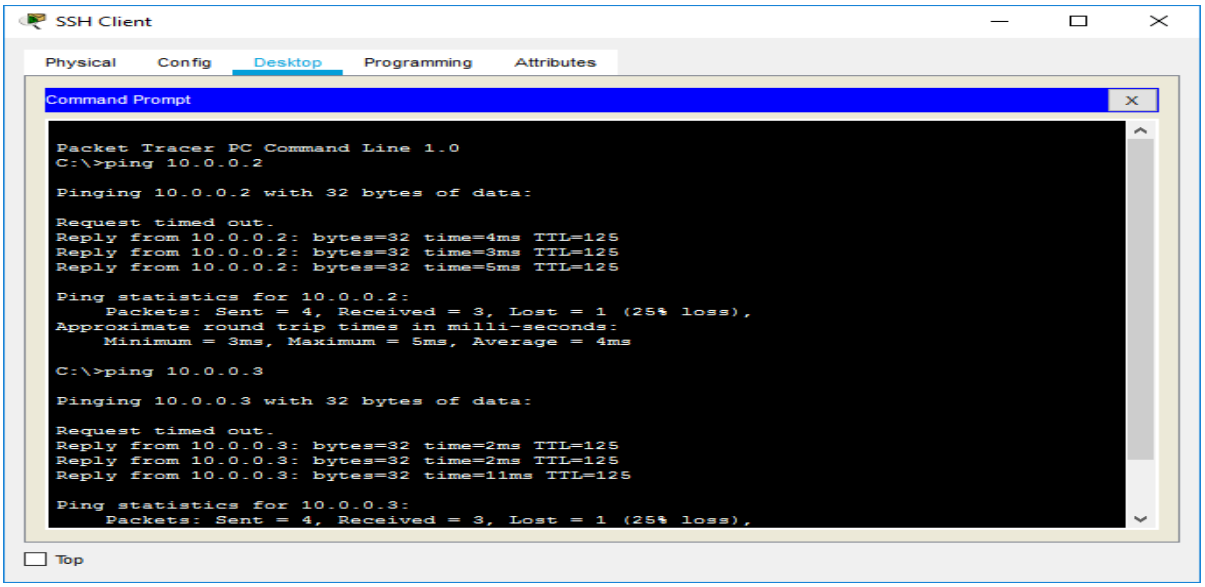
ROUTER 1 : Type the following command in the CLI mode

```
Router>enable
Router#
Router#configure terminal
Router(config)#interface GigabitEthernet0/0
Router(config-if)#ip address 40.0.0.1 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#interface Serial0/1/0
Router(config-if)#ip address 30.0.0.2 255.0.0.0
Router(config-if)# no shutdown
Router(config-if)#exit
```

The following Command is for setting the OSPF configuration

```
Router(config)#router ospf 1
Router(config-router)#network 30.0.0.0 0.255.255.255 area 1
Router(config-router)#network 40.0.0.0 0.255.255.255 area 1
Router(config-router)#exit
Router(config)#exit
Router#
```

Now we verify the connectivity by using the following



MD5 Authentication

For Router 3

Router(config)#router ospf 1
Router(config-router)#area 1 authentication message-digest
Router(config-router)#exit
Router(config)#interface Serial0/1/0
Router(config-if)#ip ospf message-digest-key 1 md5 admin
Router(config-if)#exit

For Router 2

Router(config)#router ospf 1
Router(config-router)#area 1 authentication message-digest
Router(config-router)#exit
Router(config)#interface Serial0/1/0
Router(config-if)#ip ospf message-digest-key 1 md5 admin
Router(config-if)#exit

Router(config)#router ospf 1
Router(config-router)#area 1 authentication message-digest
Router(config-router)#exit
Router(config)#interface Serial0/1/1
Router(config-if)#ip ospf message-digest-key 1 md5 admin
Router(config-if)#exit

For Router 1

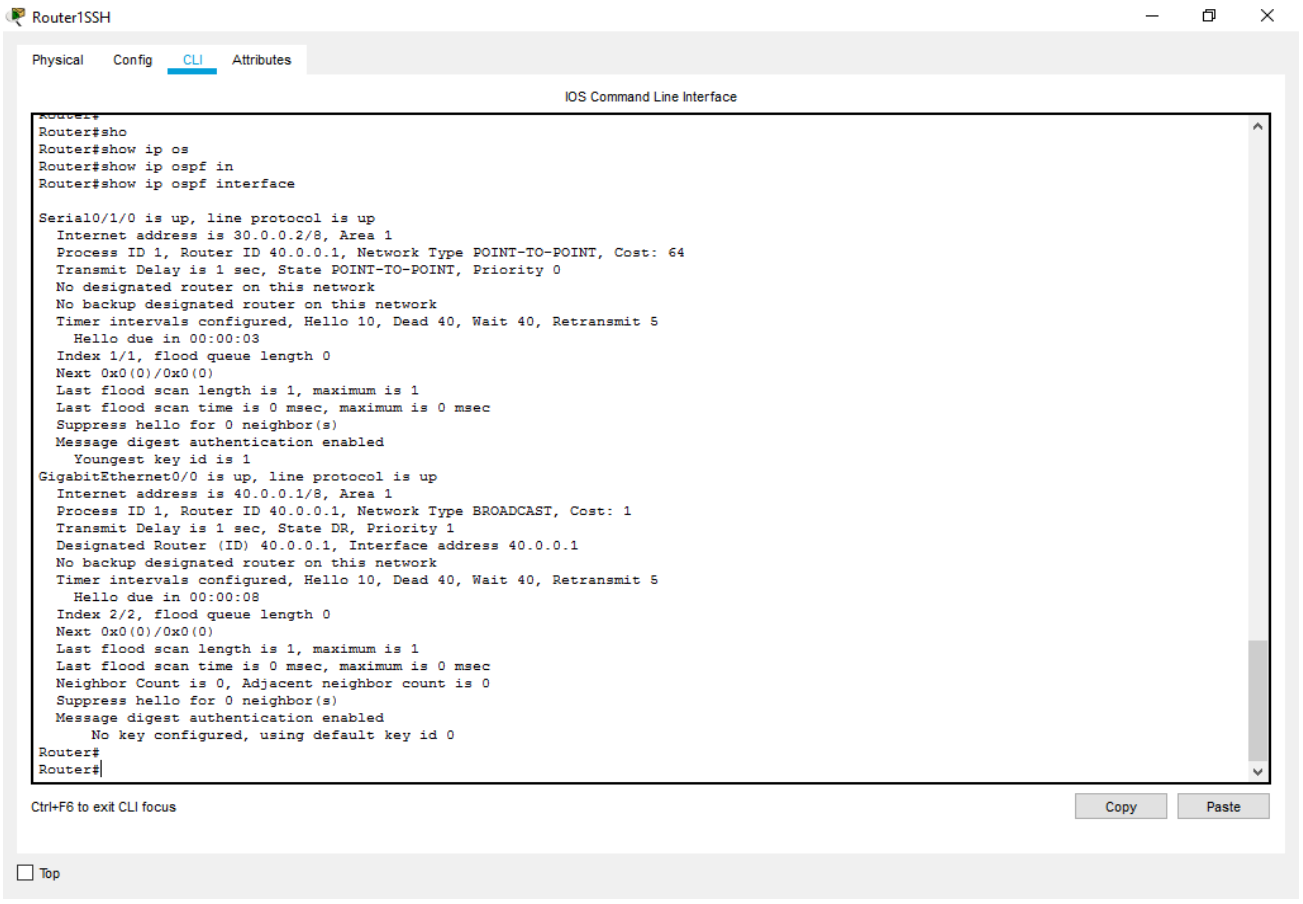
Router(config)#router ospf 1
Router(config-router)#area 0 authentication message-digest

Router(config-router)#exit
Router(config)#interface Serial0/1/0
Router(config-if)#ip ospf message-digest-key 1 md5 admin
Router(config-if)#exit

Verify the authentication using the following command on any Router

Router#show ip ospf interface

The following output is obtained



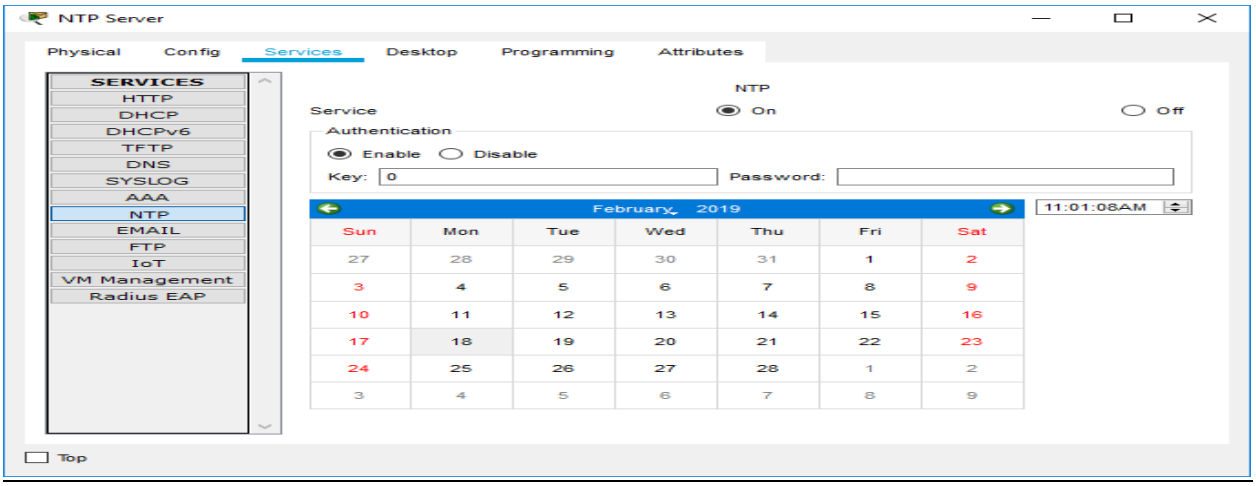
b) NTP

- 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

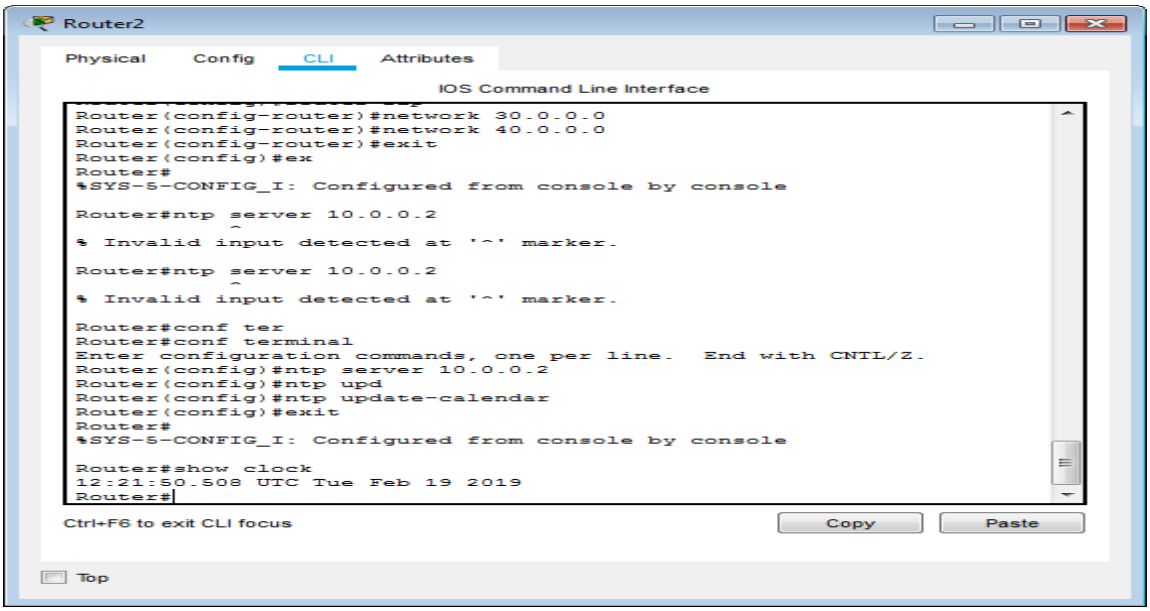
Configure NTP Server and enable the NTP service



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

```
Router>en
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#ntp server 10.0.0.2
Router(config)#ntp update-calendar
Router(config)#exit
Router#show clock
16:14:55.13 UTC Fri Dec 7 2018
```

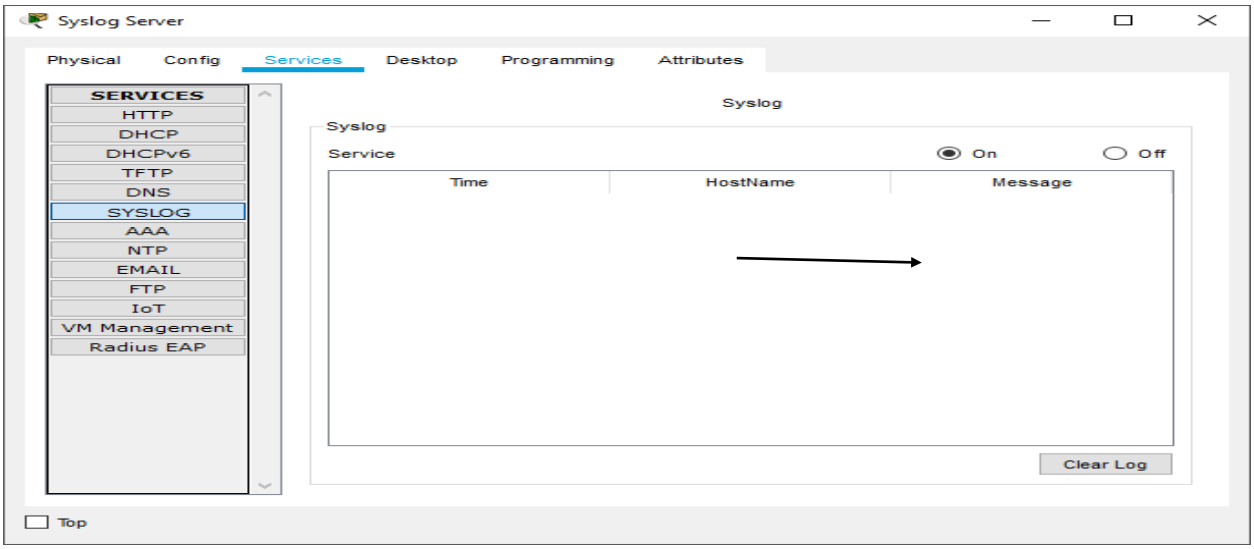
Output



c) To log messages to the syslog server

Configure SYSLOG Server and enable the service

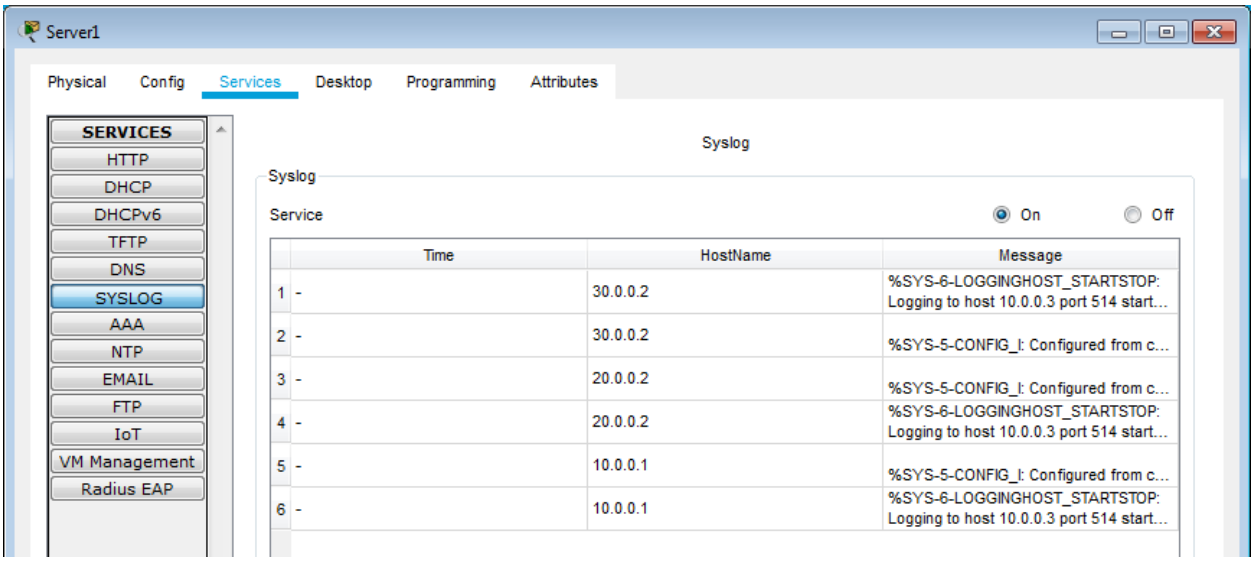
- Syslog is a way for network devices to send event messages to a logging server – usually known as a Syslog server.
- The Syslog **protocol** is supported by a wide range of devices and can be used to log different types of events.
- For example, a router might send messages about users logging on to console sessions, while a web-server might log access-denied events.
- **tart The syslog service on the server (10.0.0.3)**



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

```
Router>enable
Router#ping 10.0.0.3
Router#configure terminal
Router(config)#logging 10.0.0.3
```

Output:



d) To support SSH connections.

- 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.

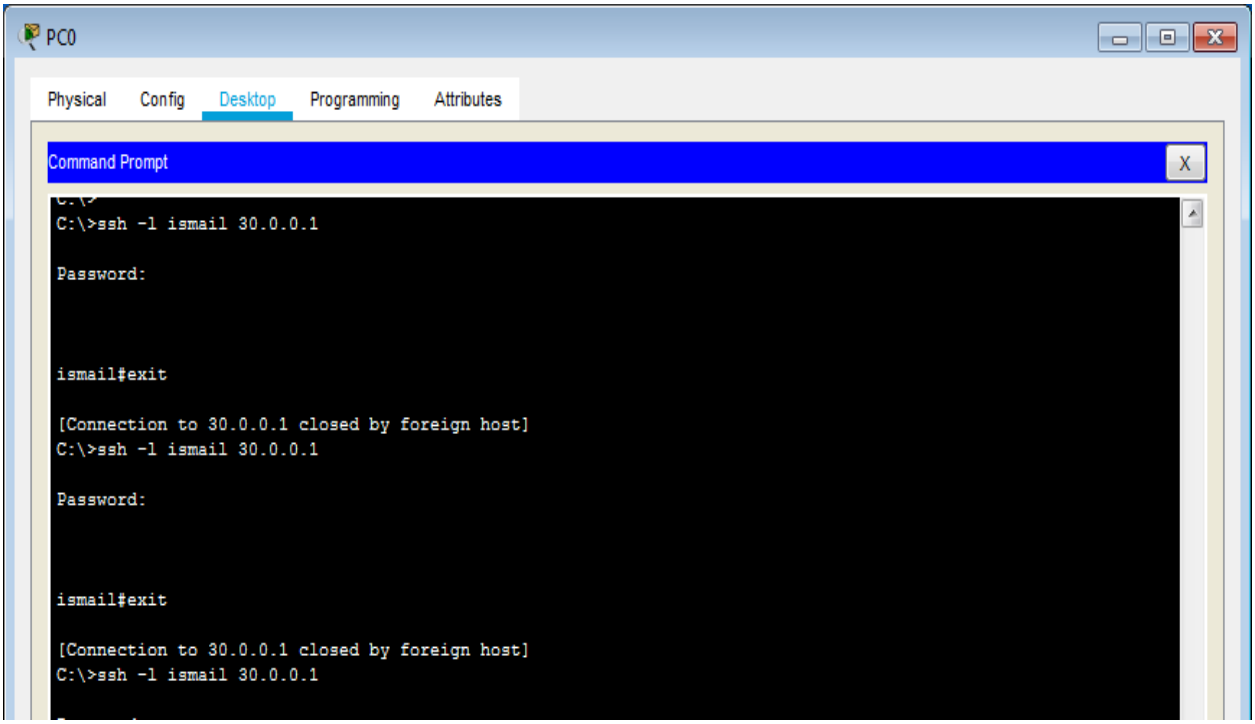
```
Router#configure terminal
Router(config)#ip domain-name admin.com
```

Router(config)#hostname admin
admin(config)#crypto key generate rsa
The name for the keys will be: admin.admin.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]

admin(config)#line vty 0
*Feb 19 12:58:22.61: %SSH-5-ENABLED: SSH 1.99 has been enabled
admin(config)#line vty 0 4
admin(config-line)# transport input ssh
admin(config-line)#ip ssh ver 2
admin(config-line)#login local
admin(config)#username admin privilege 15 password rollno

Output: Go to cmd of PC0



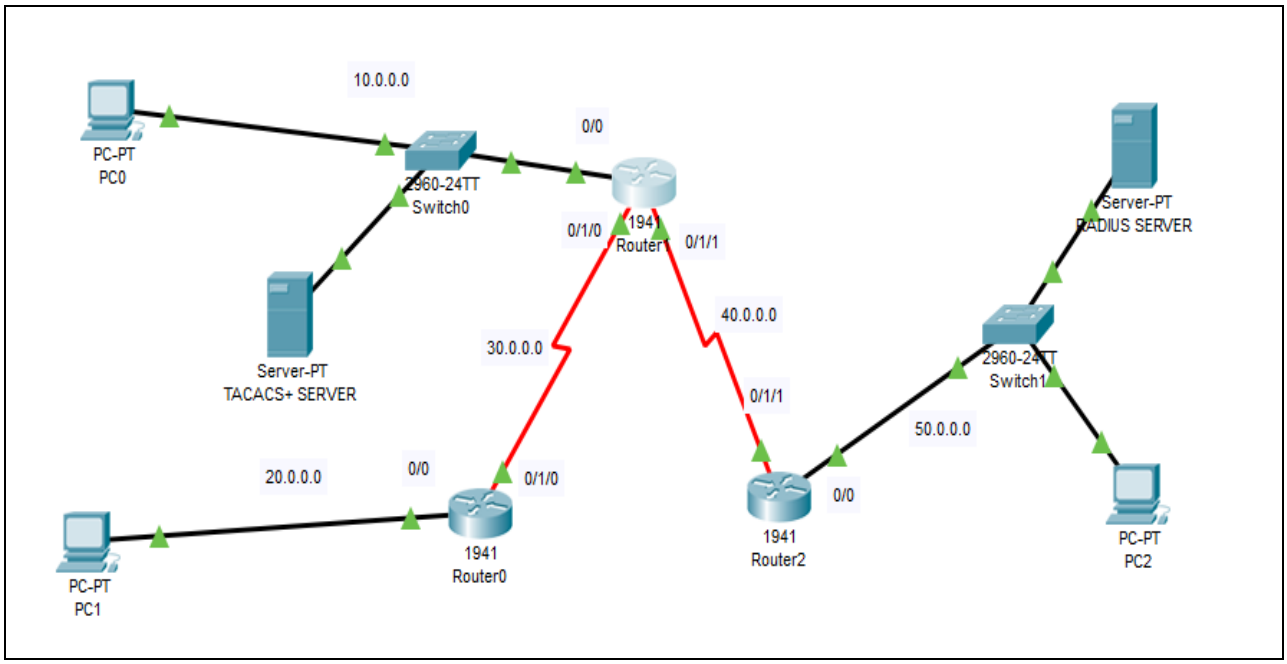
Practical No. 2:
Configure AAA Authentication

Access control is the way you control who is allowed access to the network server and what services the security services provide the primary framework through which you set up access control on your device or access server.
AAA is an architectural framework for configuring a set of three independent security functions in a consistent manner. AAA provides a modular way of performing the following services:
· Authentication−Provides the method of identifying users, including login and password dialog, challenge and response, messaging support, and, depending on the security protocol you select, encryption.
Authorization−Provides the method for remote access control, including one-time authorization or authorization for each service, per-user account list and profile, user group support, and support of IP and Telnet.
Accounting−Provides the method for collecting and sending security server information used for billing, auditing, and reporting, such as user identities, start and stop times.

AAA provides the following benefits:
· Increased flexibility and control of access configuration
· Scalability
· Standardized authentication methods, such as RADIUS and TACACS+
· Multiple backup systems

a) Configure a local user account on Router and configure authenticate on the console and vty lines using local AAA

We use the following topology for the present case.



Configure Router0

```
Router>enable
Router#
Router#configure terminal
Router(config)#interface GigabitEthernet0/0
Router(config-if)#ip address 20.0.0.1 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#interface Serial0/1/0
Router(config-if)#ip address 30.0.0.1 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit
```

```
Router(config)#router rip
Router(config-router)#network 20.0.0.0
Router(config-router)#network 30.0.0.0
Router(config-router)#
```

Configure Router1

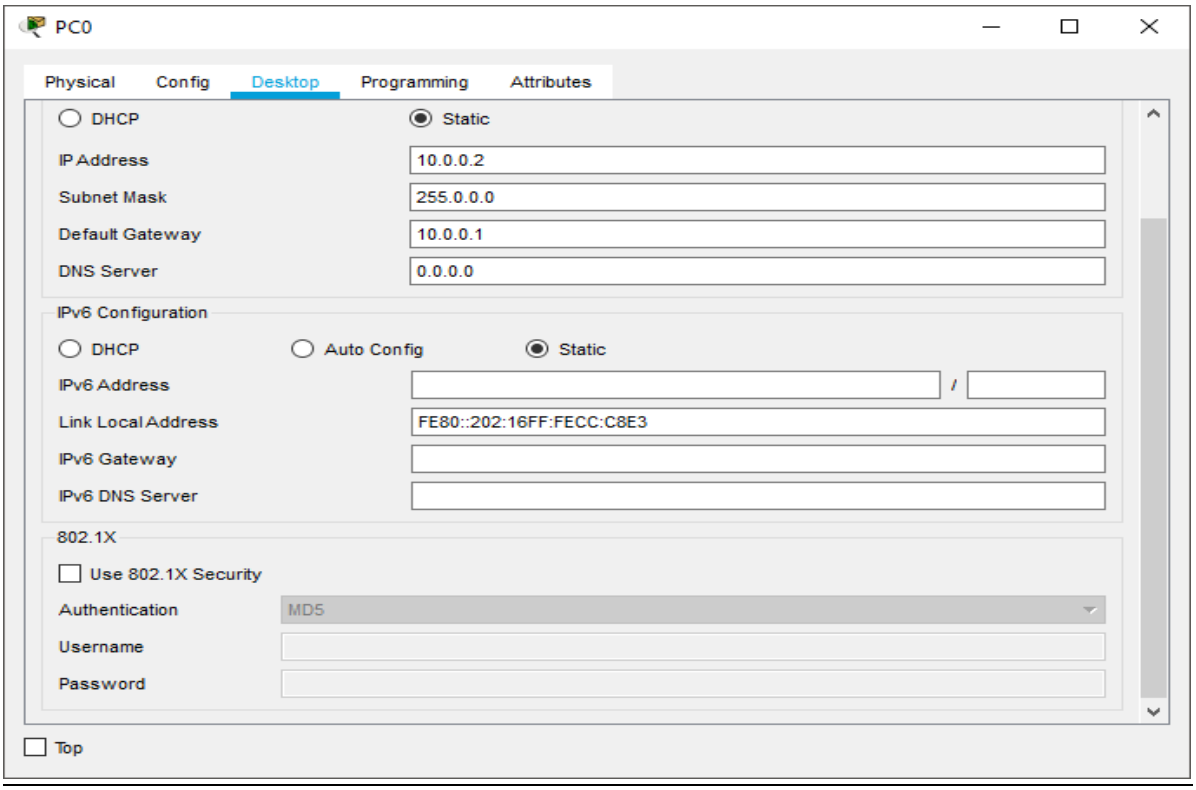
```
Router>enable
Router#
Router#configure terminal
Router(config)#interface GigabitEthernet0/0
```

```
Router(config-if)#ip address 10.0.0.1 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#interface Serial0/1/0
Router(config-if)#ip address 30.0.0.2 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#interface Serial0/1/1
Router(config-if)#ip address 40.0.0.1 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit


Router(config)#router rip
Router(config-router)#network 10.0.0.0
Router(config-router)#network 30.0.0.0
Router(config-router)#network 40.0.0.0
Router(config-router)#
```

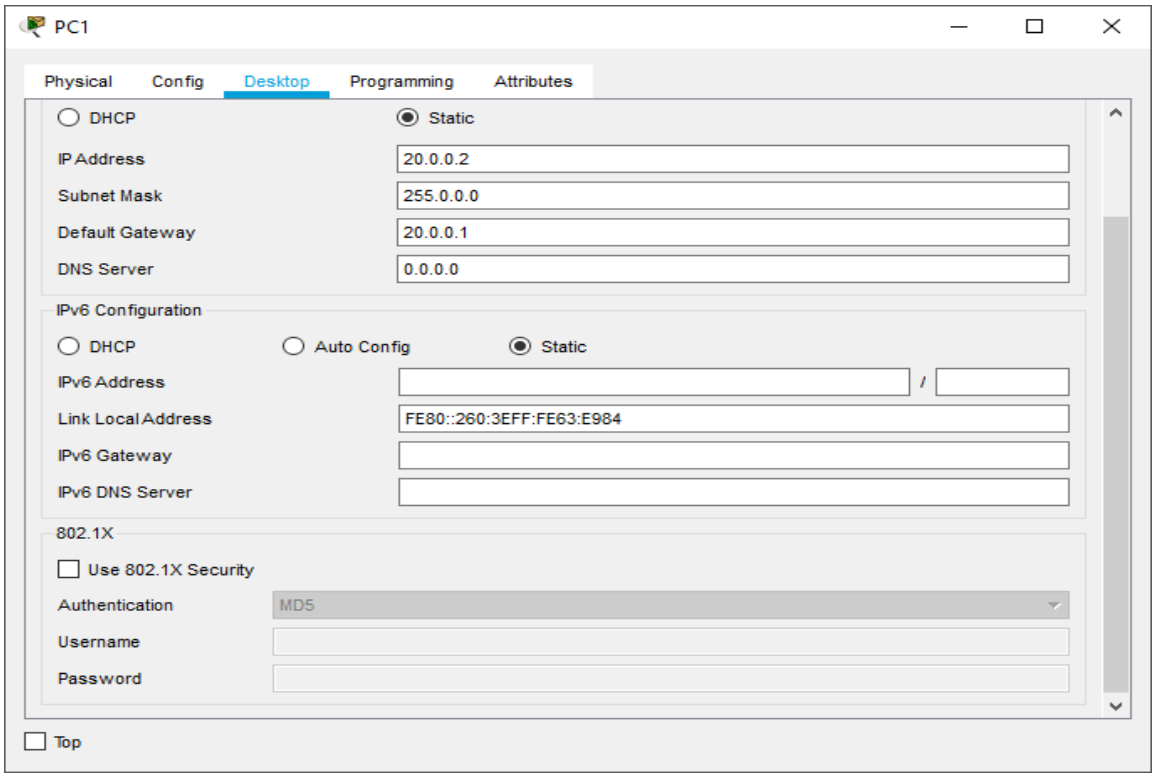
Configure Router2

```
Router>enable
Router#
Router#configure terminal
Router(config)#interface GigabitEthernet0/0
Router(config-if)#ip address 50.0.0.1 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#interface Serial0/1/0
Router(config-if)#ip address 40.0.0.2 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit


Router(config)#router rip
Router(config-router)#network 40.0.0.0
Router(config-router)#network 50.0.0.0
Router(config-router)#
```

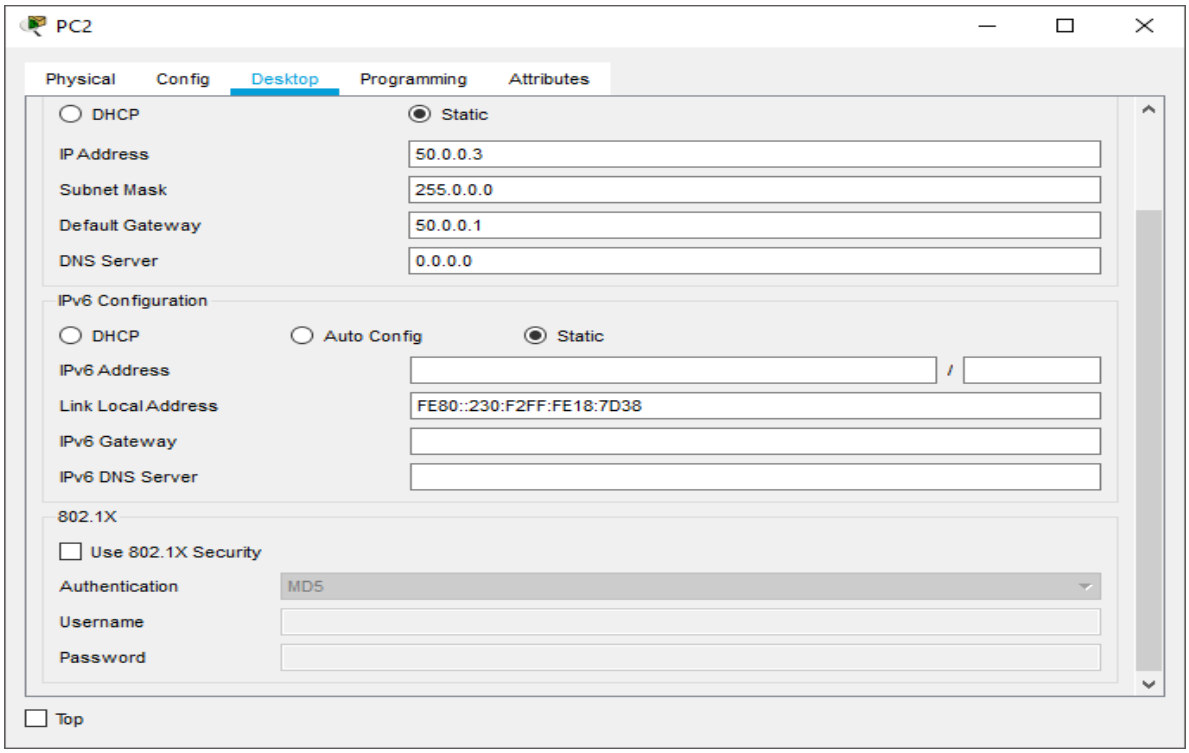
Configure PC0



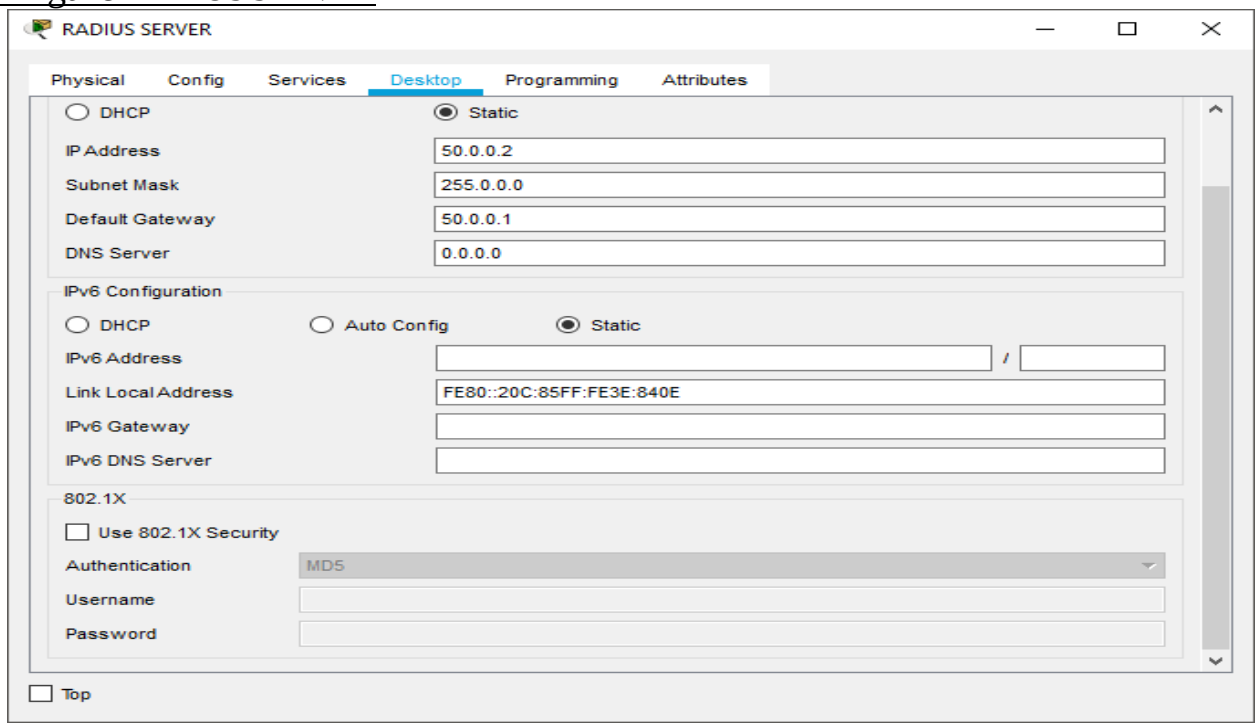
Configure PC1



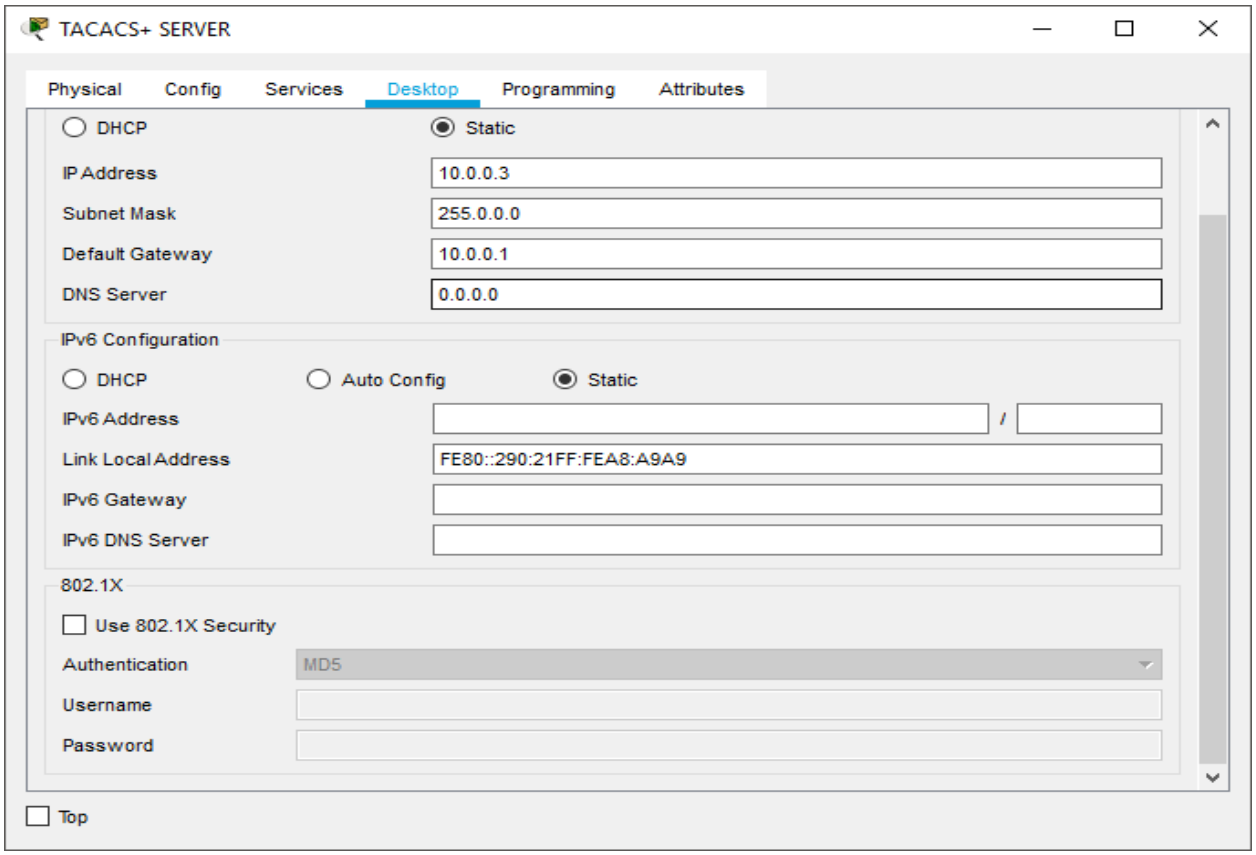
Configure PC2



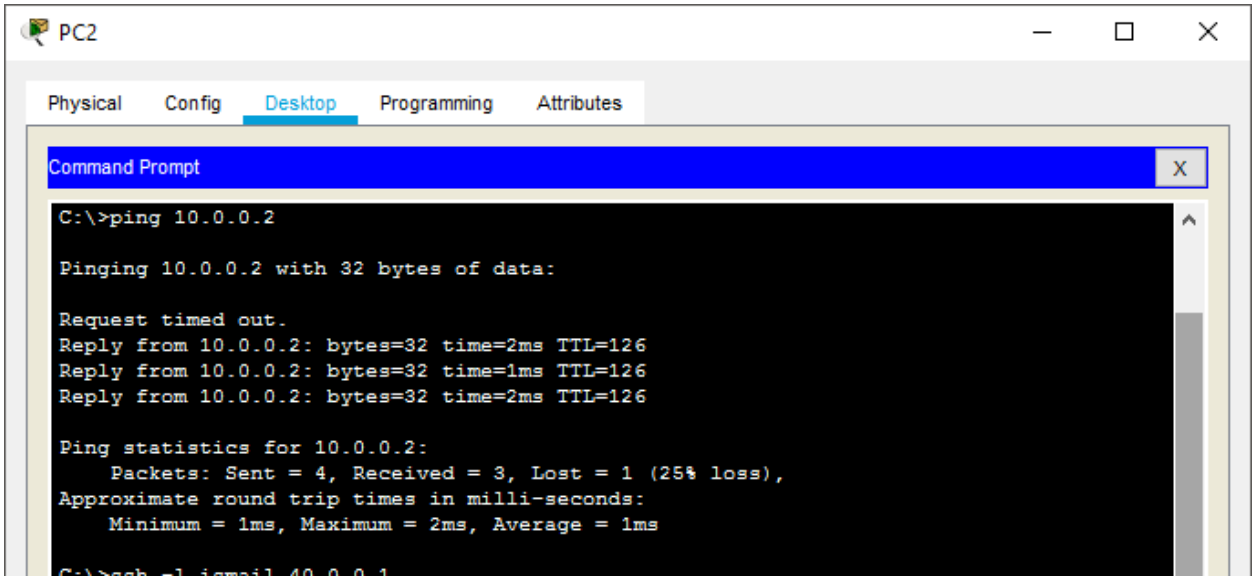
Configure RADIUS SERVER

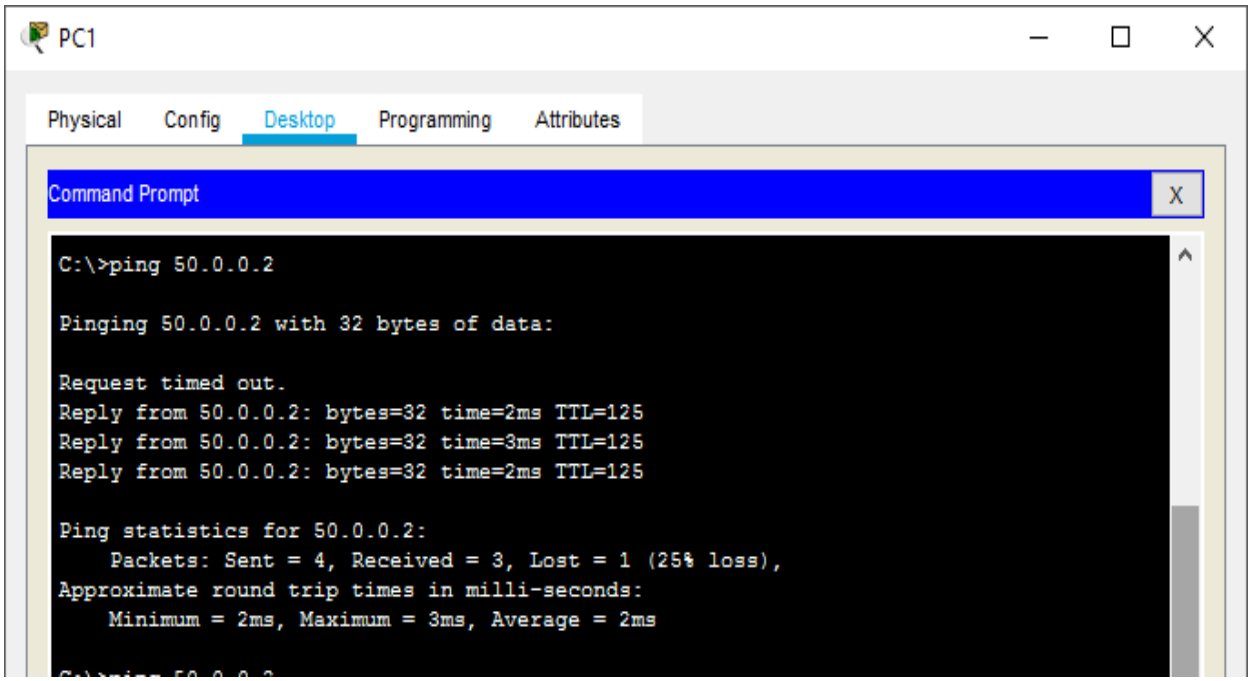


Configure TACACS+ SERVER



We verify the connectivity by using the following commands





Configure the Local AAA Authentication for Console Access on Router0 (type the following commands in the CLI mode of Router0)

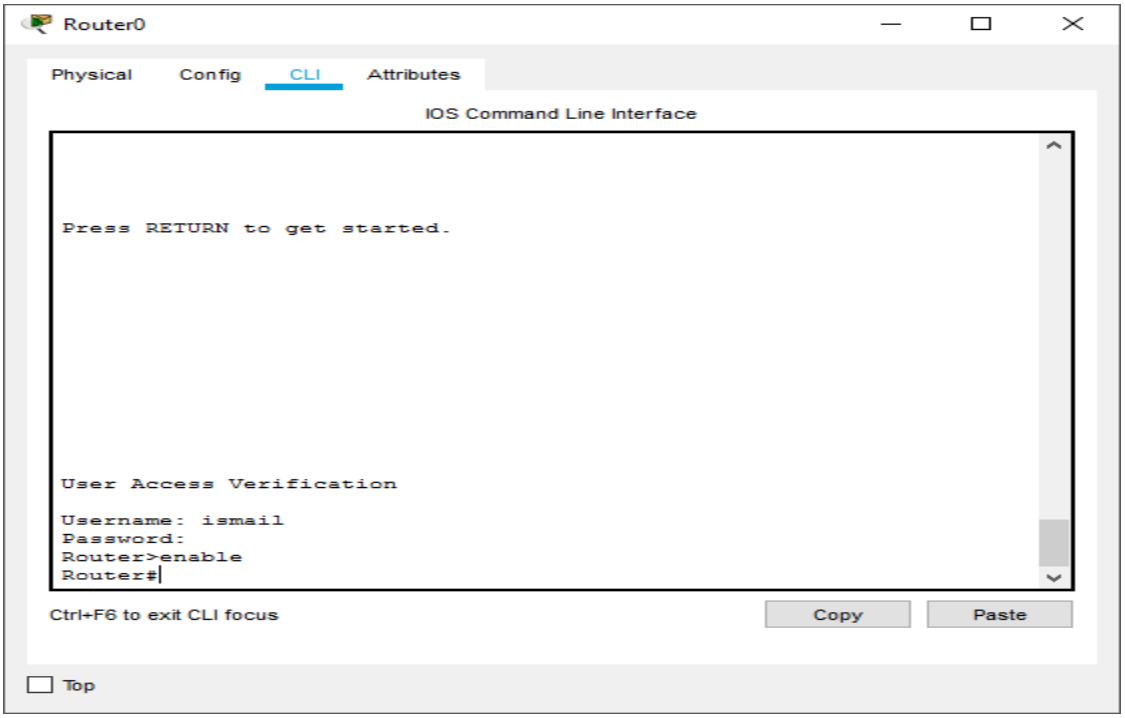
Router>
Router>en
Router#configure terminal
Router(config)#username admin secret abcd
Router(config)#aaa new-model
Router(config)#aaa authentication login default local
Router(config)#line console 0
Router(config-line)#login authentication default
Router(config-line)#end
Router#exit

Press ENTER to get started.

User Access Verification

Username: admin
Password:
Router>enable
Router#

Hence the Authentication is done



Configure the vty lines to use the defined AAA authentication method(type the following command in Router0)

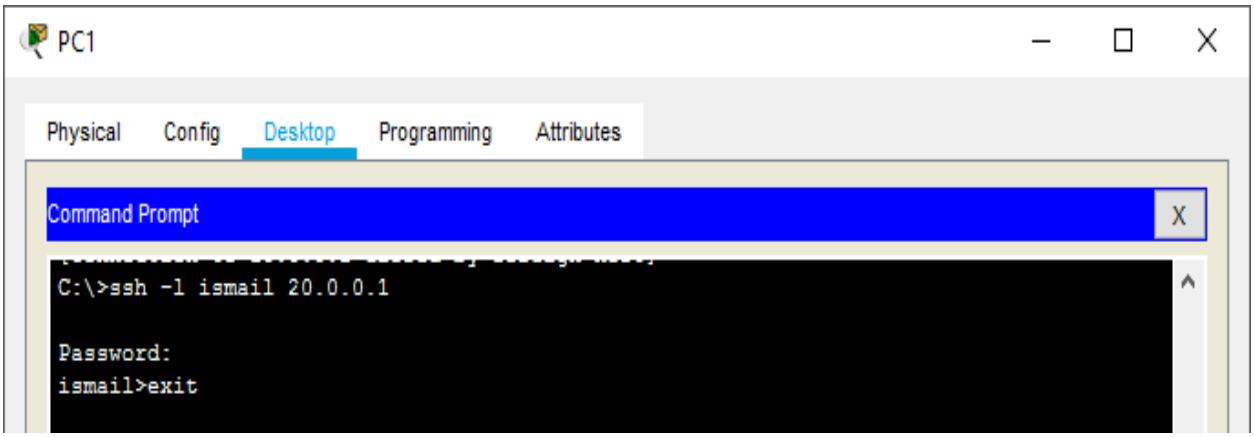
Router>enable
Router#configure terminal
Router(config)#ip domain-name admin.com
Router(config)#hostname admin
admin(config)#crypto key generate rsa
The name for the keys will be: admin.admin.com
Choose the size of the key modulus in the range of 360 to 2048 for your General Purpose Keys. Choosing a key 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]

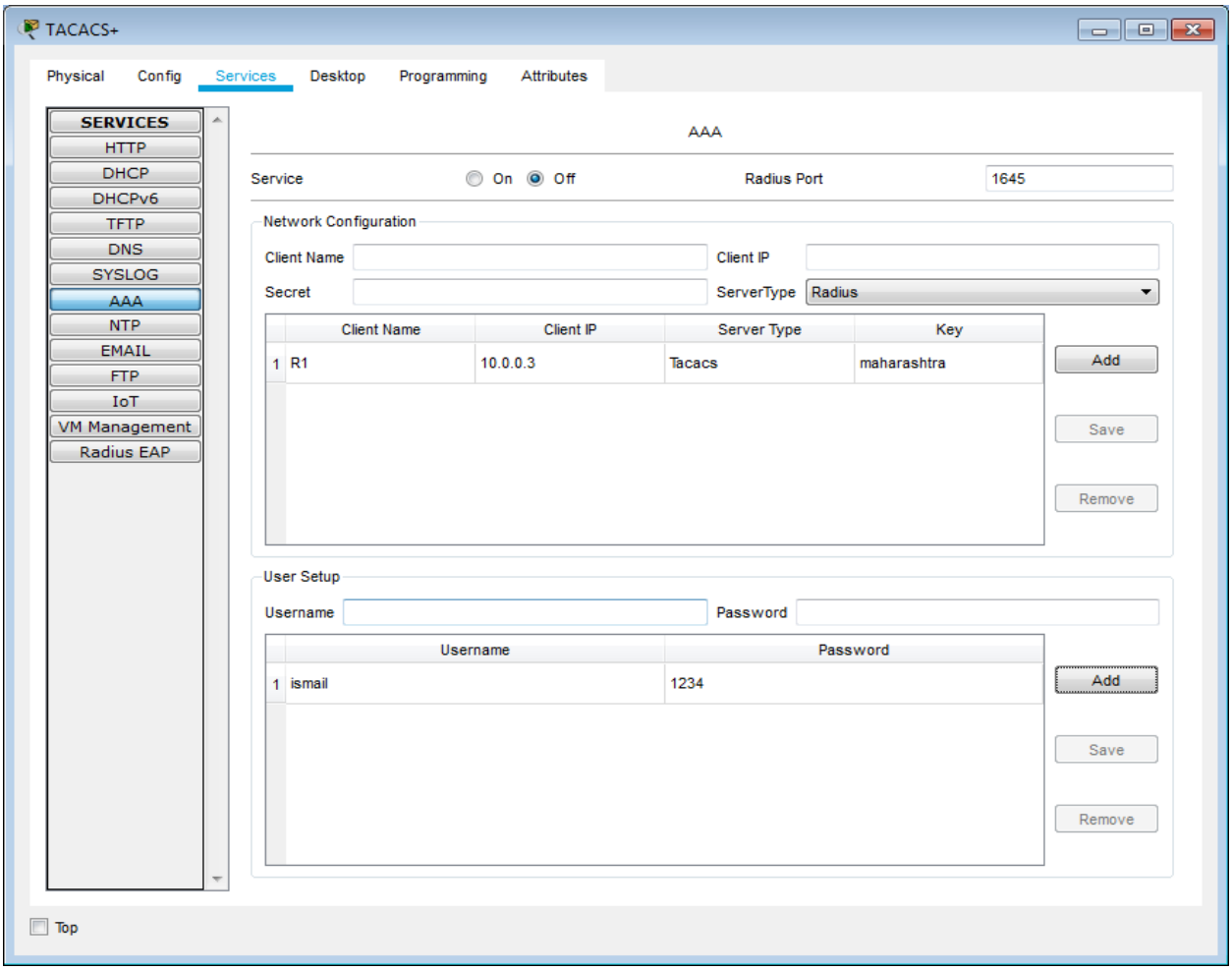
admin(config)#aaa authentication login ssh-admin local
admin(config)#line vty 0 4
admin(config-line)#login authentication ssh-admin

admin(config-line)#transport input ssh
admin(config-line)#end
admin#

Now verify the configuration using the following



TACACS+ Server configuration



Configure Server-Based AAA Authentication Using TACACS+ on Router1(type the following commands in the CLI mode of Router1)

Router#configure terminal
Router(config)#username admin secret 12345
Router(config)#tacacs-server host 10.0.0.3
Router(config)#tacacs-server key 1234
Router(config)#hostname R1
R1(config)#aaa new-model
R1(config)#aaa authentication login default group tacacs+ local
R1(config)#line console 0
R1(config-line)#login authentication default
R1(config-line)#end
R1#

R1#exit

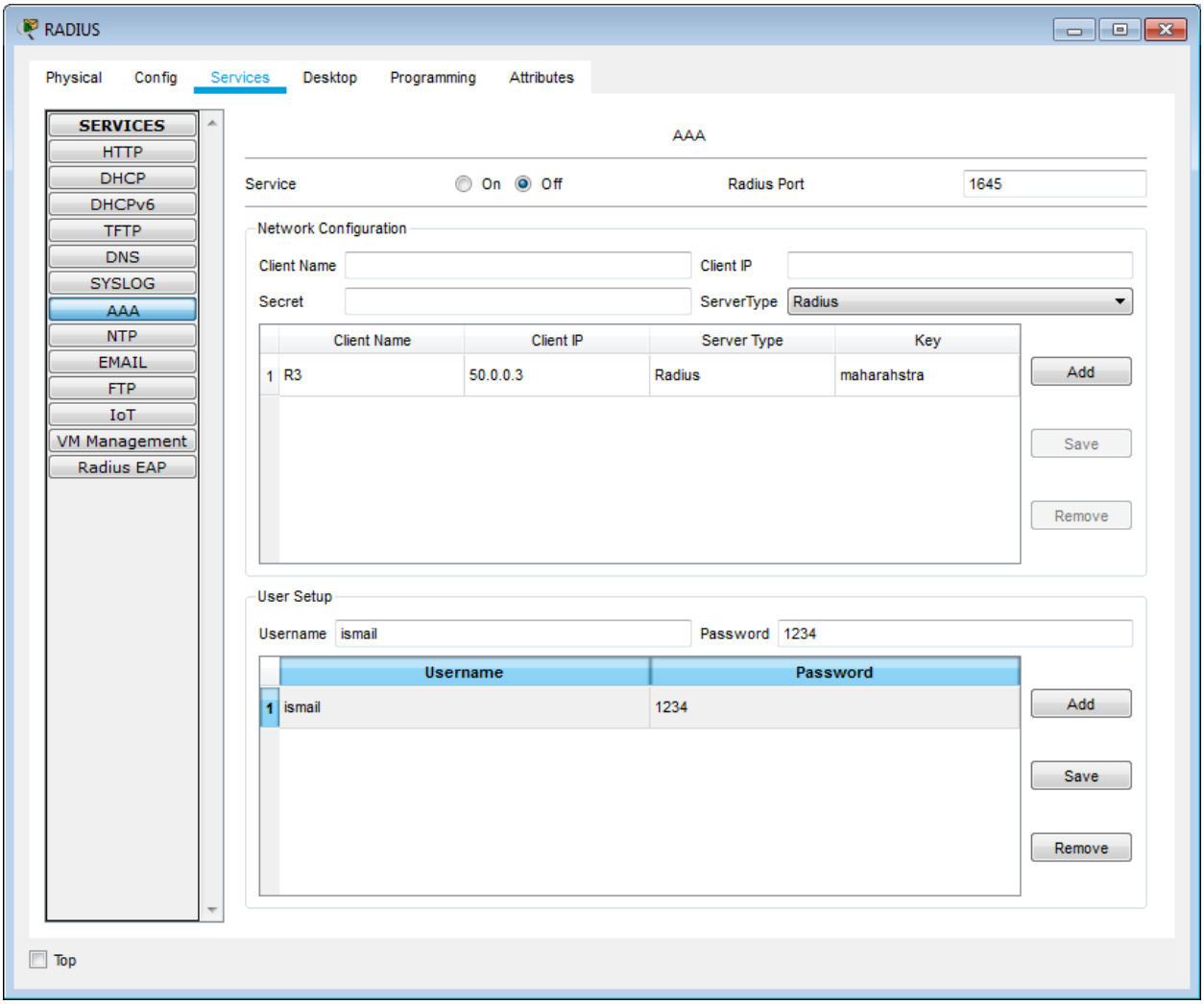
Press Enter to get started.

User Access Verification

Username: admin
Password:
R1>en
R1#exit

Configure Server-Based AAA Authentication Using RADIUS on R3

RADIUS Server configuration



Configure Server-Based AAA Authentication Using RADIUS Server on Router3(type the following commands in the CLI mode of Router1)

Router#configure terminal
Router(config)#username admin secret 12345
Router(config)#radius-server host 50.0.0.3
Router(config)#radius-server key 1234
Router(config)#hostname R3
R3(config)#aaa new-model
R3(config)#aaa authentication login default group tacacs+ local
R3(config)#line console 0
R3(config-line)#login authentication default
R3(config-line)#end
R3#

R3#exit

Press Enter to get started.

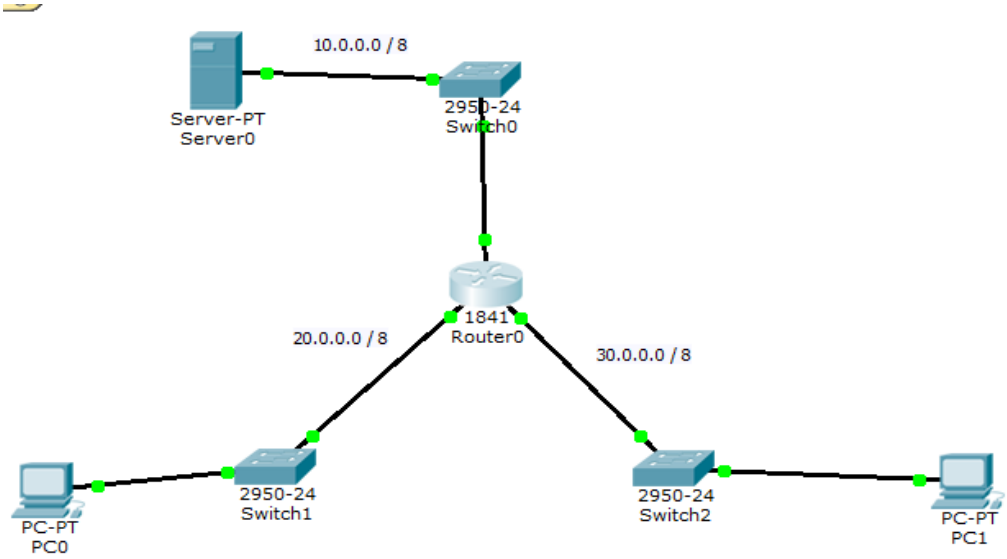
User Access Verification

Username: admin
Password:
R3>en
R3#exit

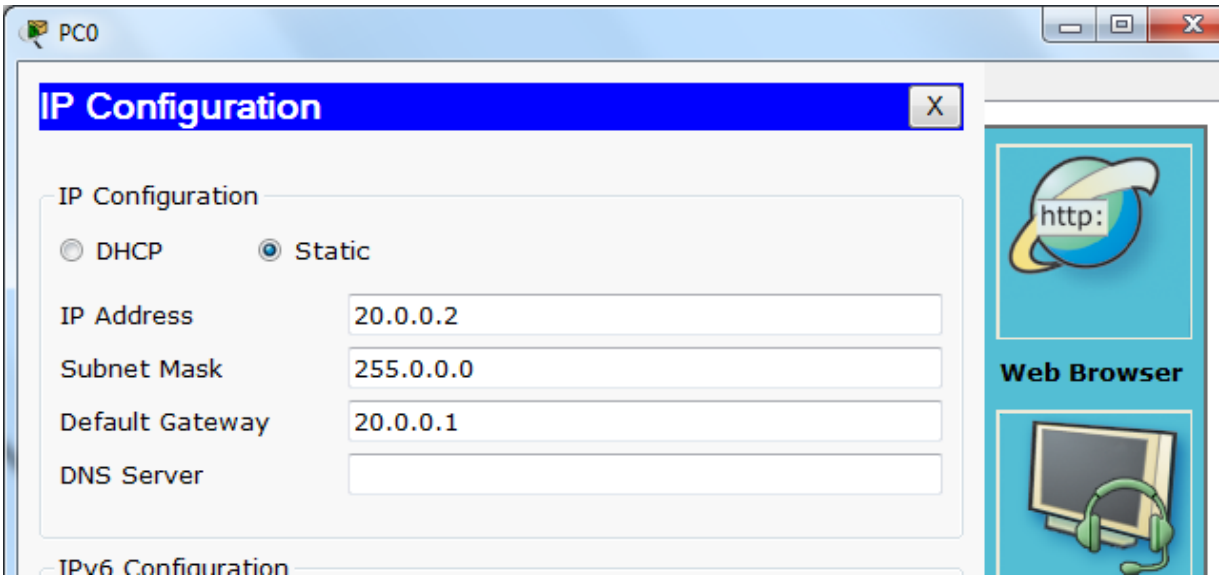
PRACTICAL NO 3: Configuring Extended ACLs

ACLs are used to control network access or to specify traffic for many features to act upon. An e xtended ACL is made up of one or more access control entries (ACEs). Each ACE specifies a source and destination for matching traffic. You can identify parameters within the access-list command, or you can create objects or object groups for use in the ACL

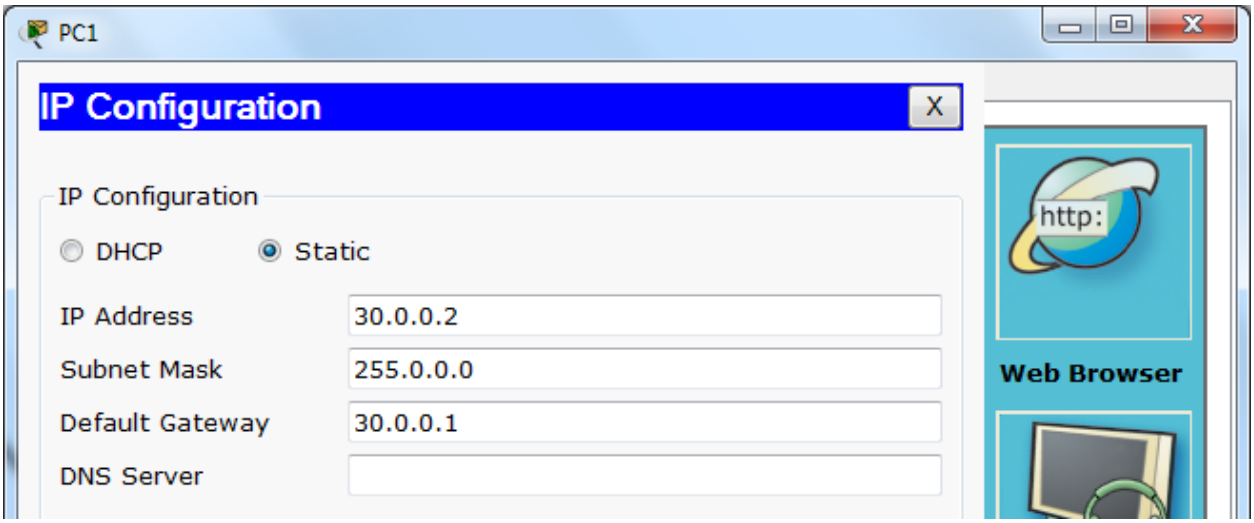
We use t he following topology to study ACL configuration



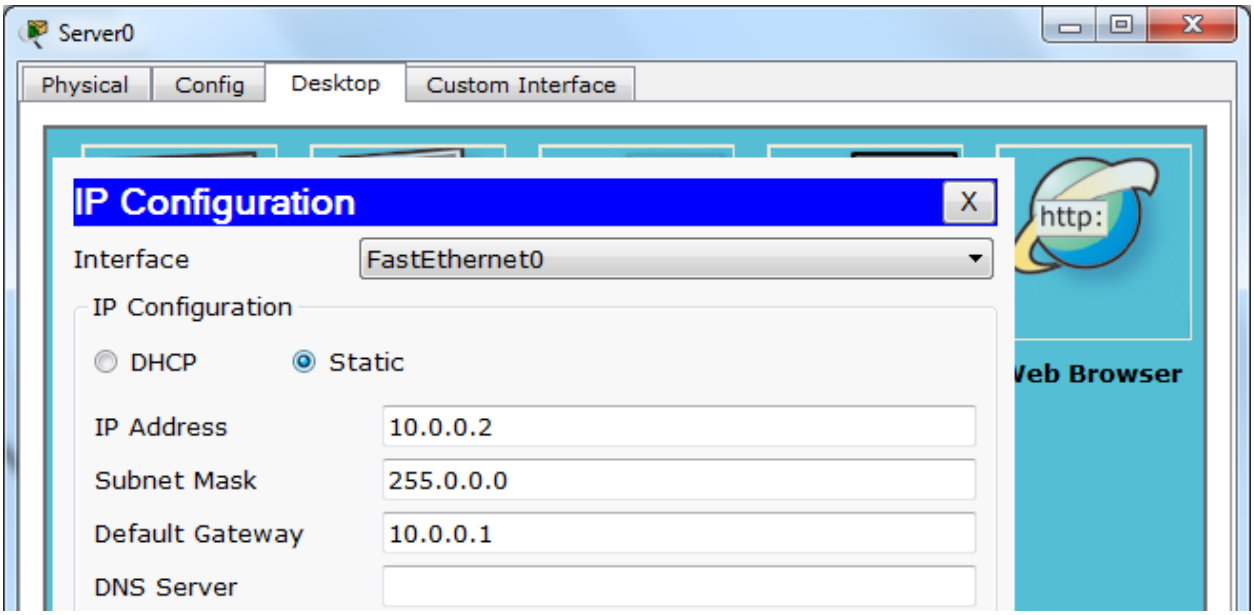
Configuring PC0



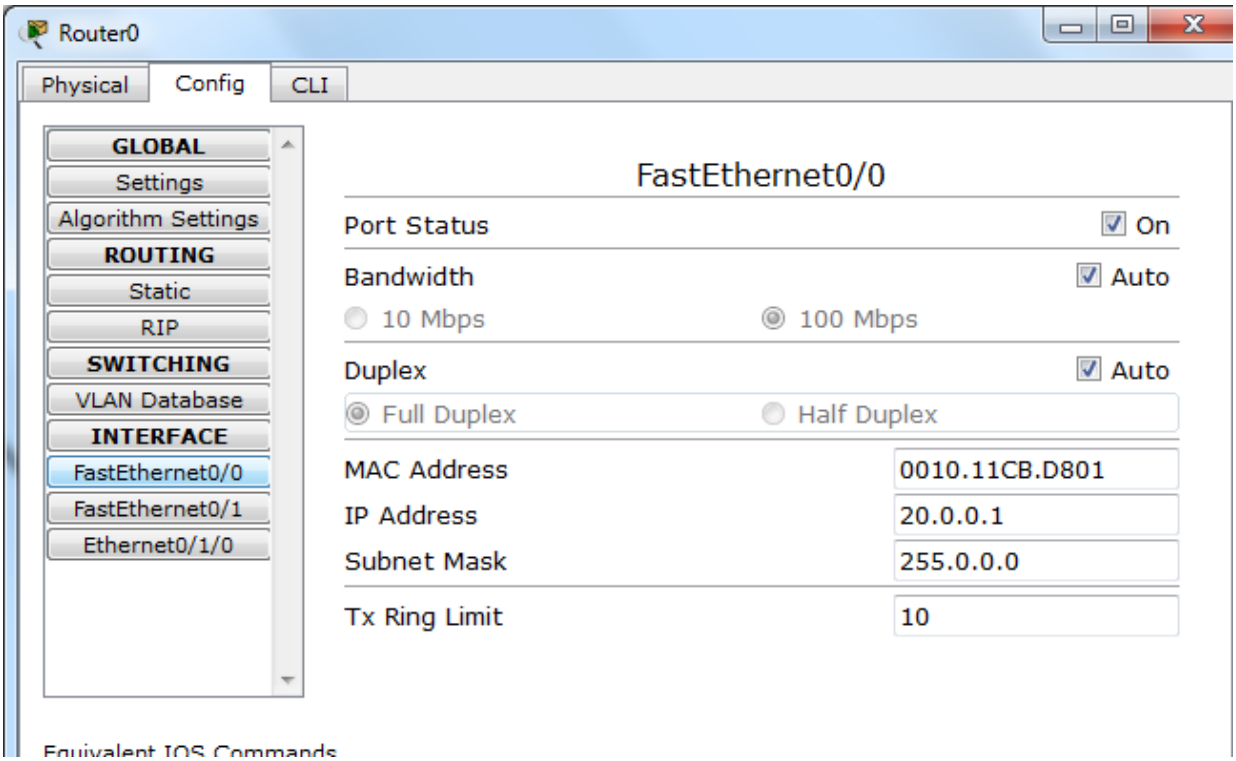
Configuring PC1

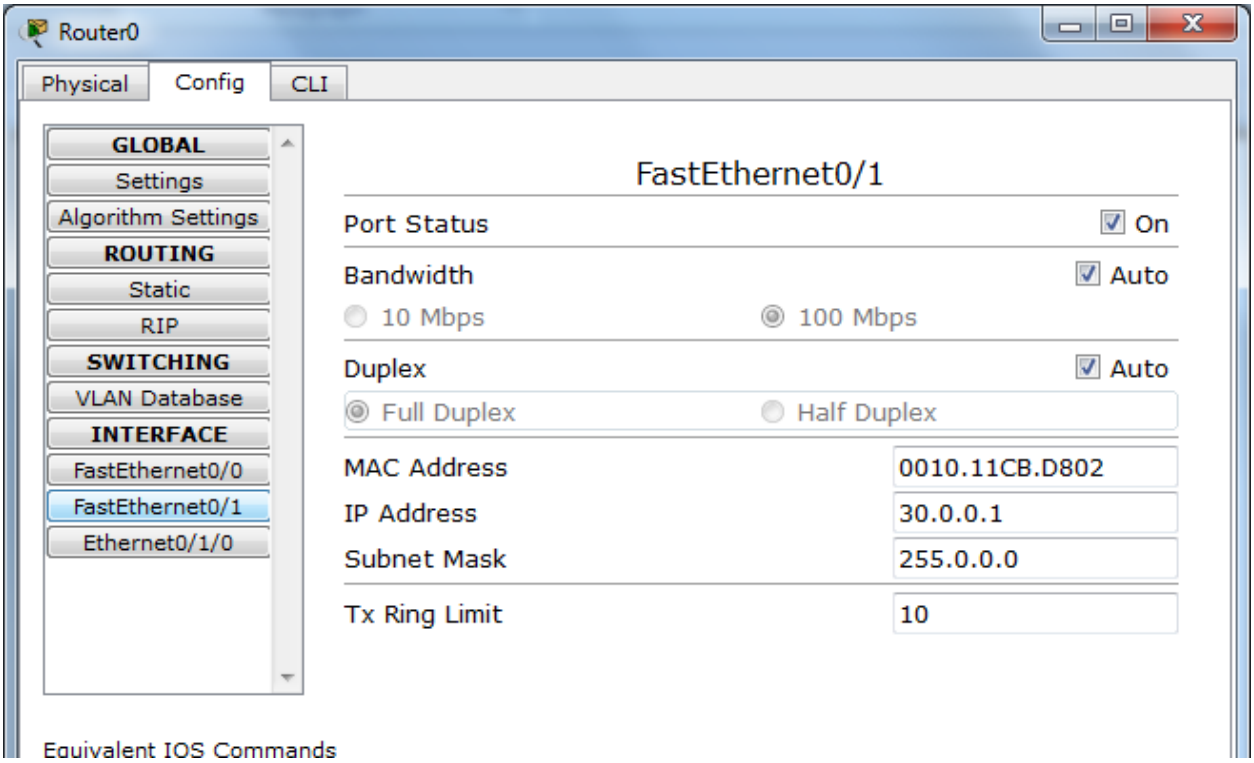


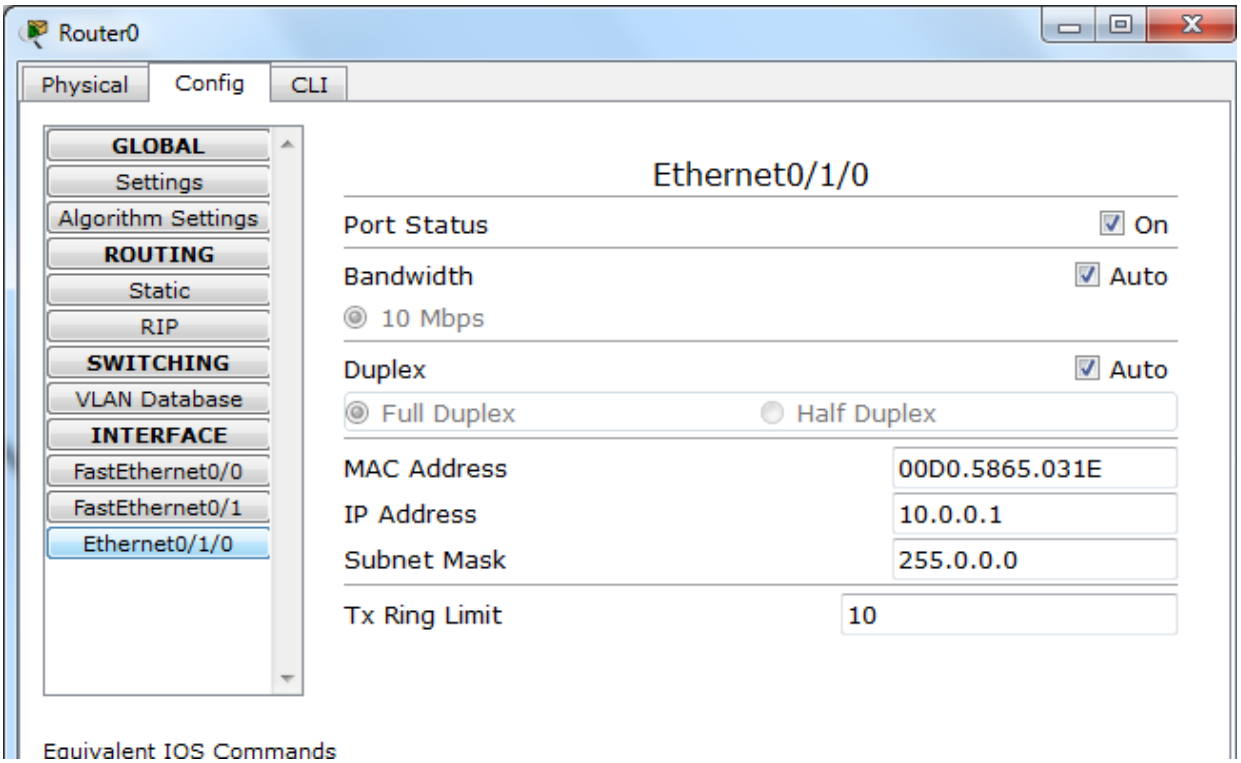
Configuring Server



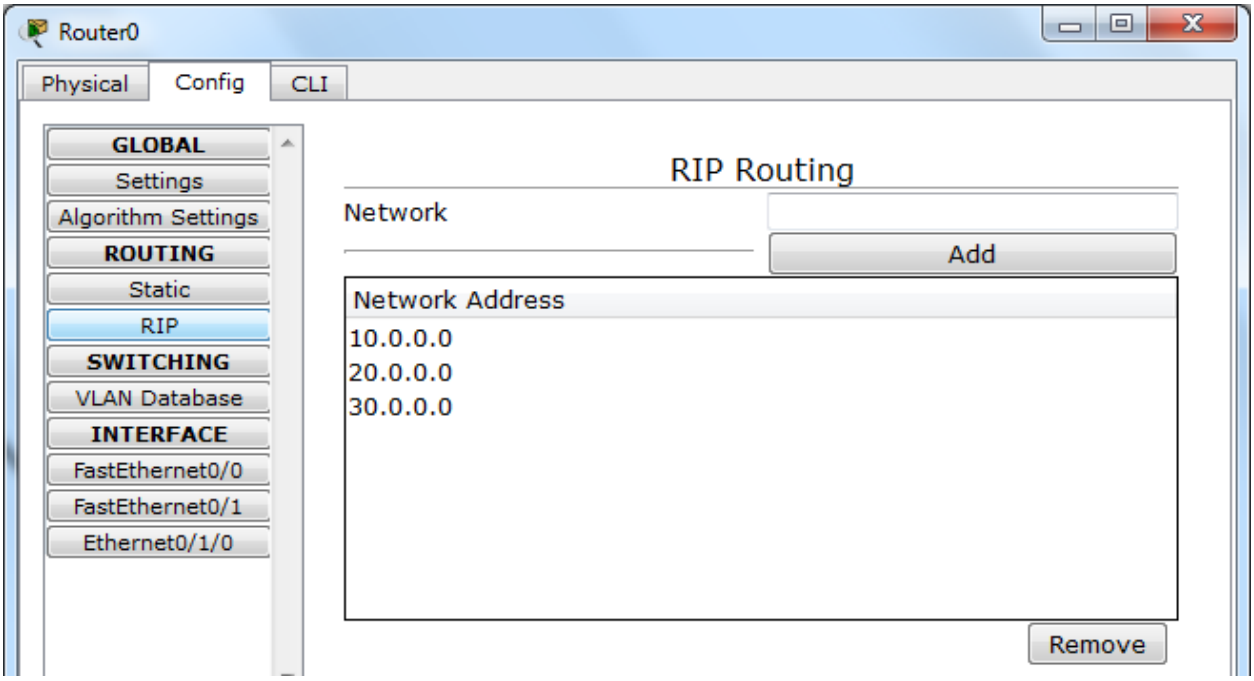
Configuring Router







RIP Configuration for the Router



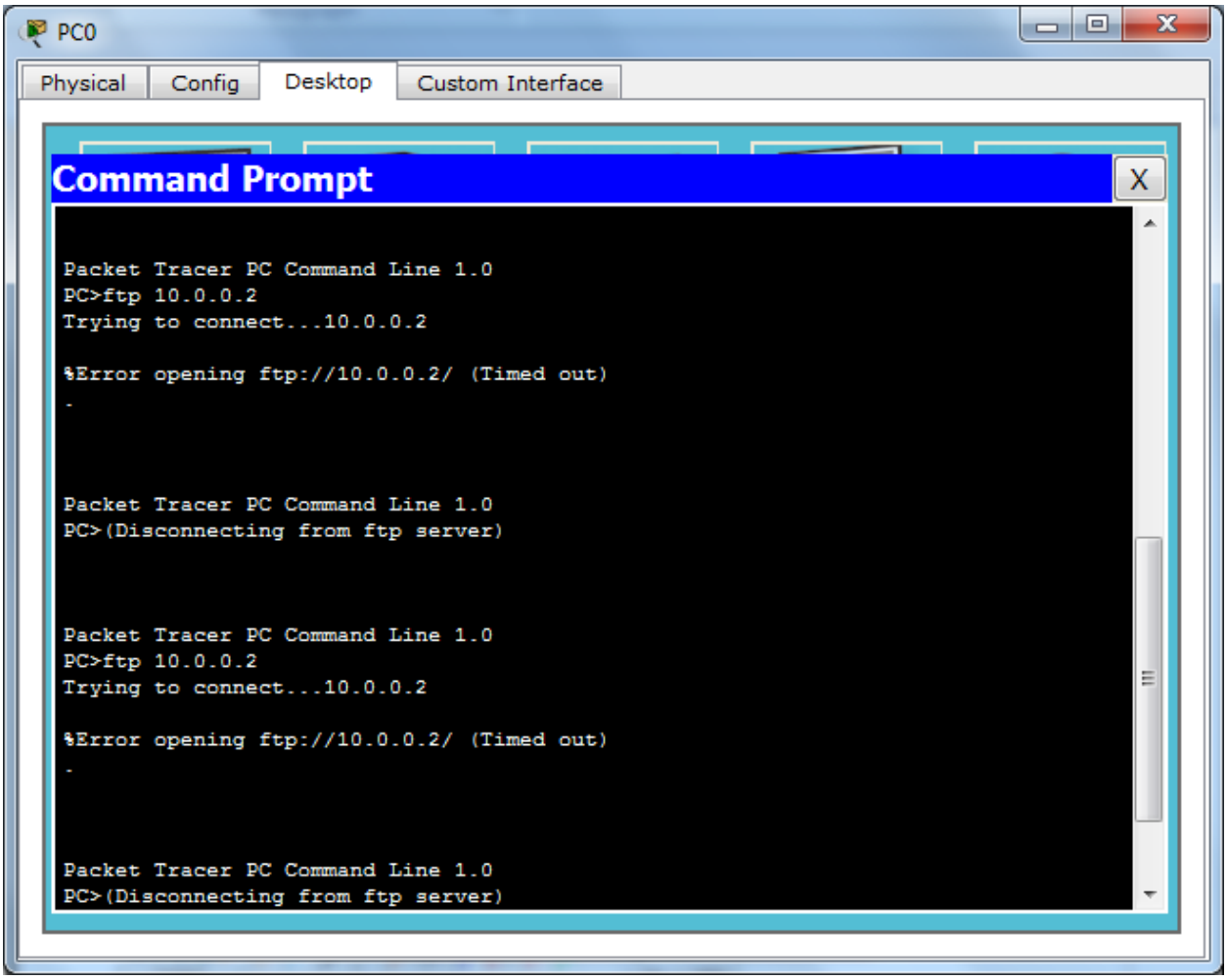
```
Router(config)#access-list ?
  <1-99>      IP standard access list
  <100-199>  IP extended access list
Router(config)#access-list 100 ?
  deny    Specify packets to reject
  permit  Specify packets to forward
  remark  Access list entry comment
Router(config)#access-list 100 permit ?
  ahp    Authentication Header Protocol
  eigrp  Cisco's EIGRP routing protocol
  esp    Encapsulation Security Payload
  gre    Cisco's GRE tunneling
  icmp   Internet Control Message Protocol
  ip     Any Internet Protocol
  ospf   OSPF routing protocol
  tcp    Transmission Control Protocol
  udp    User Datagram Protocol
Router(config)#access-list 100 permit tcp ?
  A.B.C.D  Source address
  any      Any source host
  host     A single source host
Router(config)#access-list 100 permit tcp 10.0.0.2 ?
  A.B.C.D  Source wildcard bits
Router(config)#access-list 100 permit tcp 10.0.0.2 0.255.255.255 ?
  A.B.C.D  Destination address
  any      Any destination host
  eq       Match only packets on a given port number
  gt       Match only packets with a greater port number
  host     A single destination host
  lt       Match only packets with a lower port number
  neq      Match only packets not on a given port number
  range    Match only packets in the range of port numbers
Router(config)#access-list 100 permit tcp 10.0.0.2 0.255.255.255 host ?
  A.B.C.D  Destination address
Router(config)#access-list 100 permit tcp 10.0.0.2 0.255.255.255 host 20.0.0.2 ?
  dscp         Match packets with given dscp value
  eq           Match only packets on a given port number
  established  established
  gt           Match only packets with a greater port number
  lt           Match only packets with a lower port number
  neq          Match only packets not on a given port number
  precedence   Match packets with given precedence value
  range        Match only packets in the range of port numbers
  <cr>
Router(config)#access-list 100 permit tcp 10.0.0.2 0.255.255.255 host 20.0.0.2 eq ?
  <0-65535>  Port number
```

```
  ftp       File Transfer Protocol (21)
  pop3      Post Office Protocol v3 (110)
  smtp      Simple Mail Transport Protocol (25)
  telnet    Telnet (23)
  www       World Wide Web (HTTP, 80)
Router(config)#access-list 100 permit tcp 10.0.0.2 0.255.255.255 host 20.0.0.2 eq ftp
Router(config)#interface FastEthernet0/0
Router(config-if)#ip access-group 100 in
```

Verifying the output by typing the following command from PC0

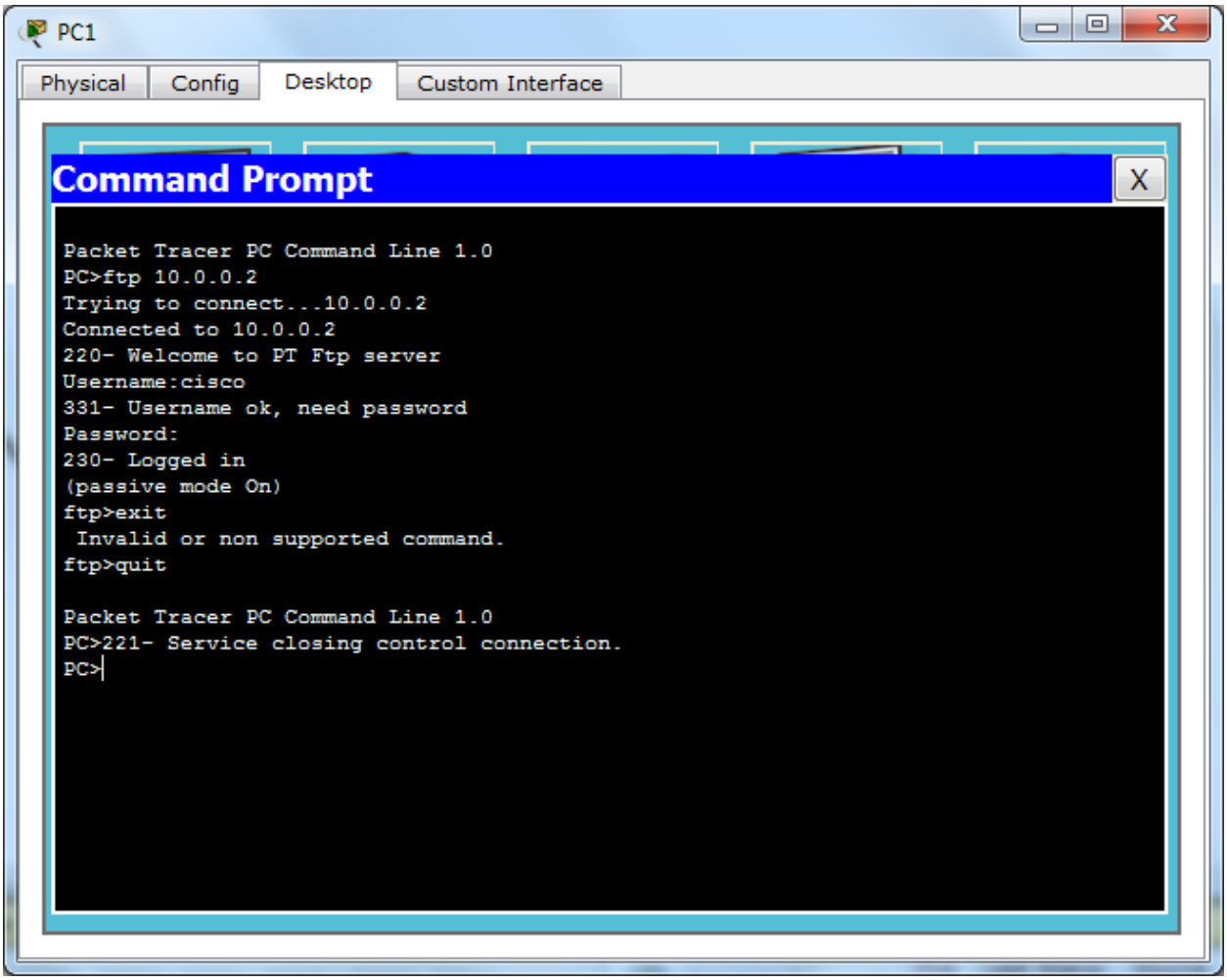
PC> ftp 10.0.0.2

We get the following output output

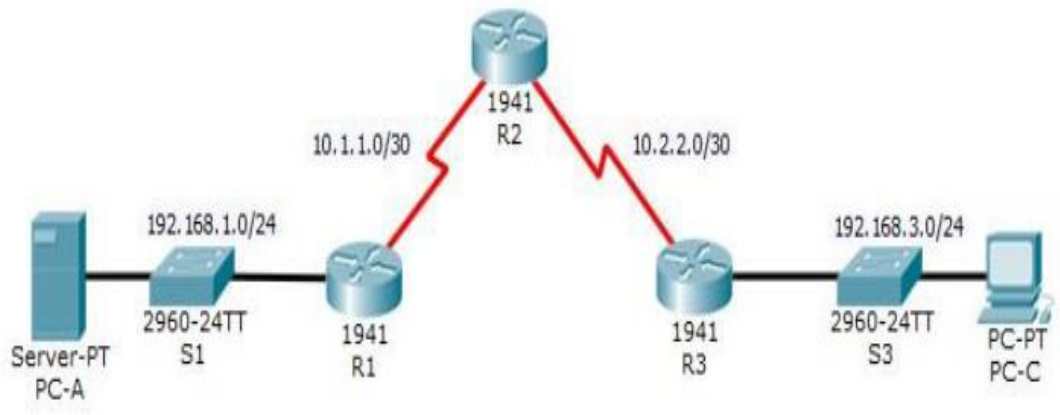


Now verifying the output by typing the following command from PC1

PC> ftp 10.0.0.2



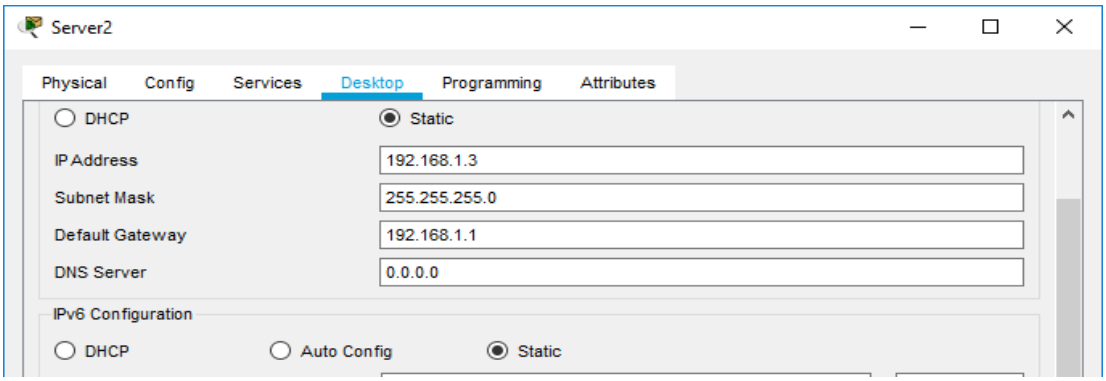
Practical 4: Configure IP ACLs to Mitigate Attacks.

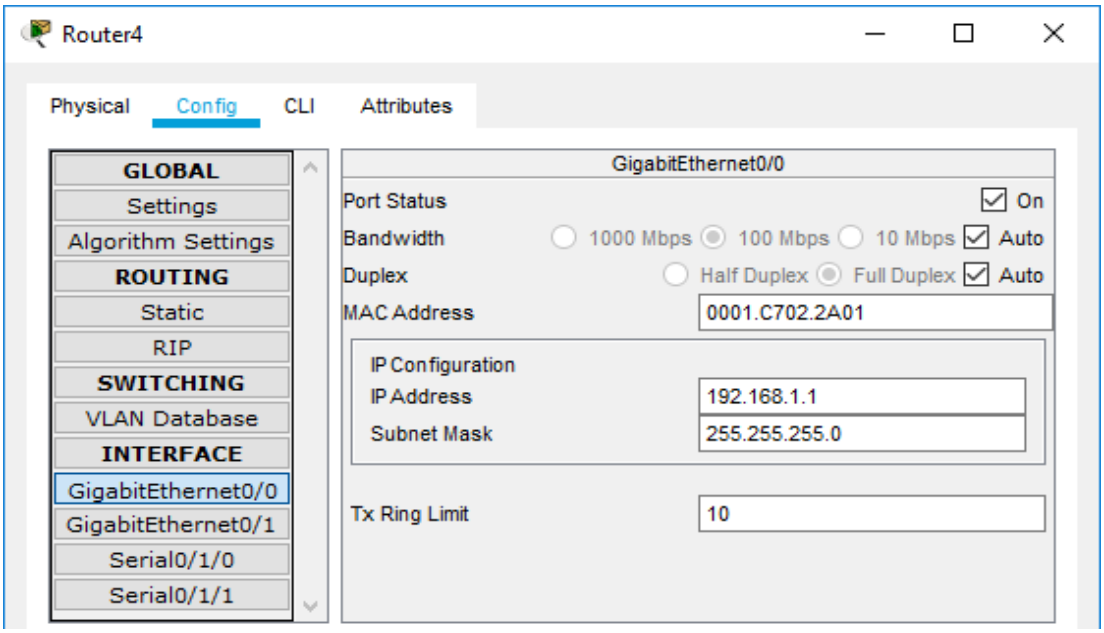


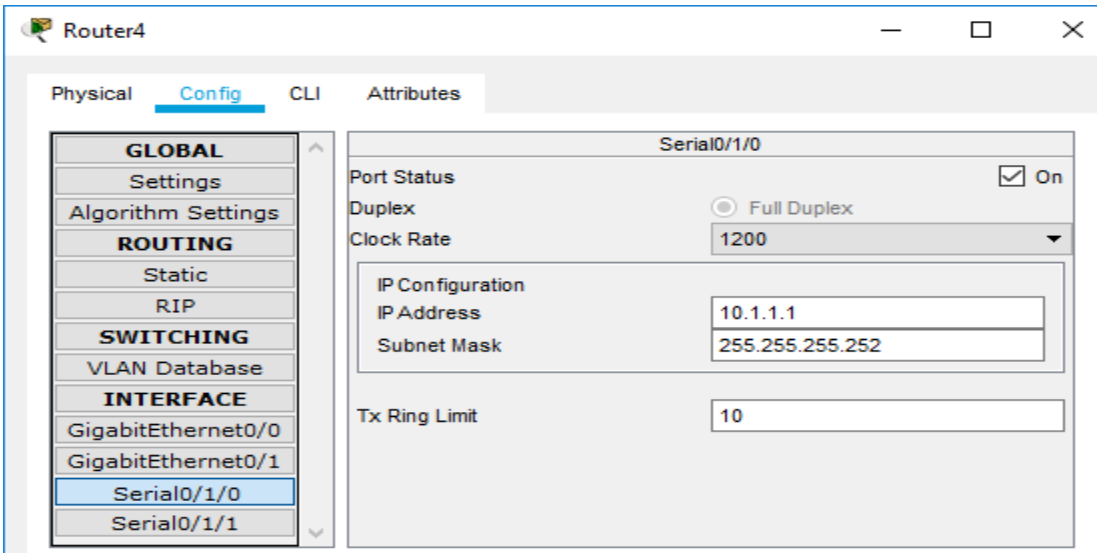
Addressing Table

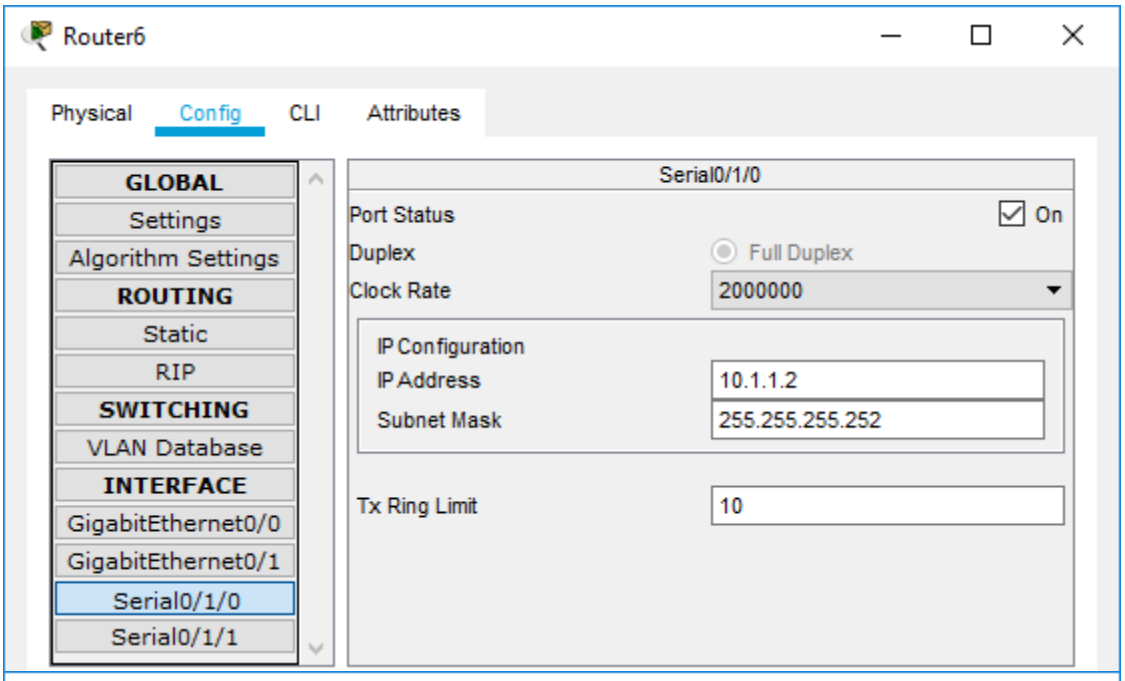
Device	Interface	IP Address	Subnet Mask	Default Gateway	Switch Port
R1	G0/1	192.168.1.1	255.255.255.0	N/A	S1 F0/5
	S0/0/0 (DCE)	10.1.1.1	255.255.255.252	N/A	N/A
R2	S0/0/0	10.1.1.2	255.255.255.252	N/A	N/A
	S0/0/1 (DCE)	10.2.2.2	255.255.255.252	N/A	N/A
	Lo0	192.168.2.1	255.255.255.0	N/A	N/A
R3	G0/1	192.168.3.1	255.255.255.0	N/A	S3 F0/5
	S0/0/1	10.2.2.1	255.255.255.252	N/A	N/A
PC-A	NIC	192.168.1.3	255.255.255.0	192.168.1.1	S1 F0/6
PC-C	NIC	192.168.3.3	255.255.255.0	192.168.3.1	S3 F0/18

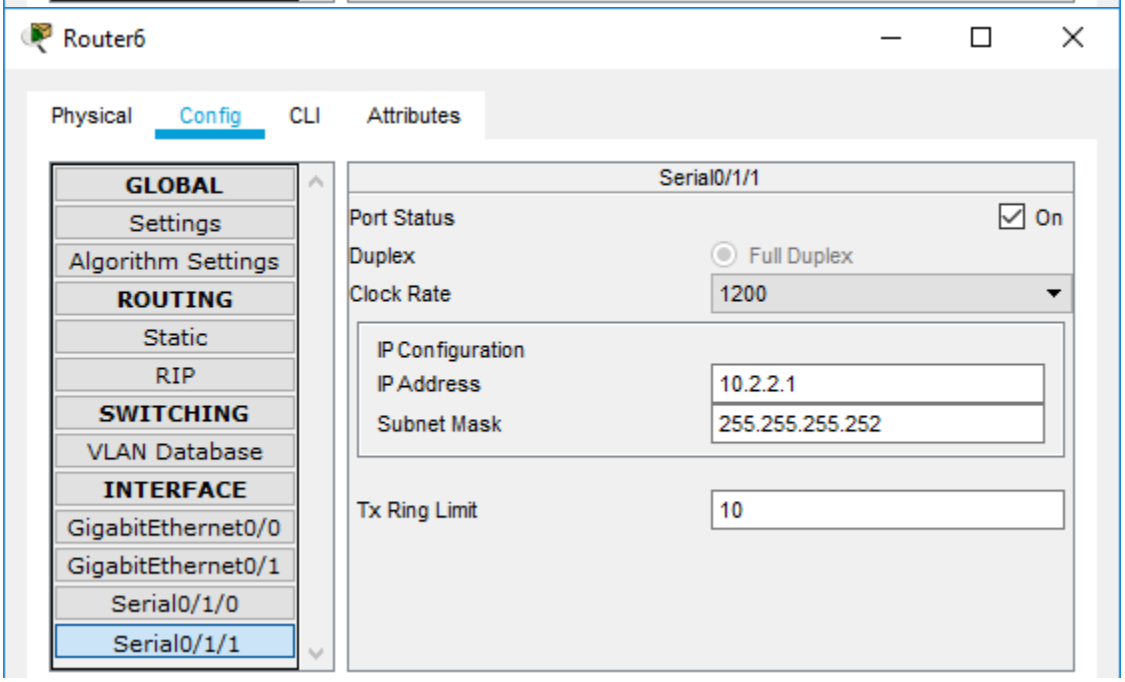
We configure the PCs, Server and Routers as follows

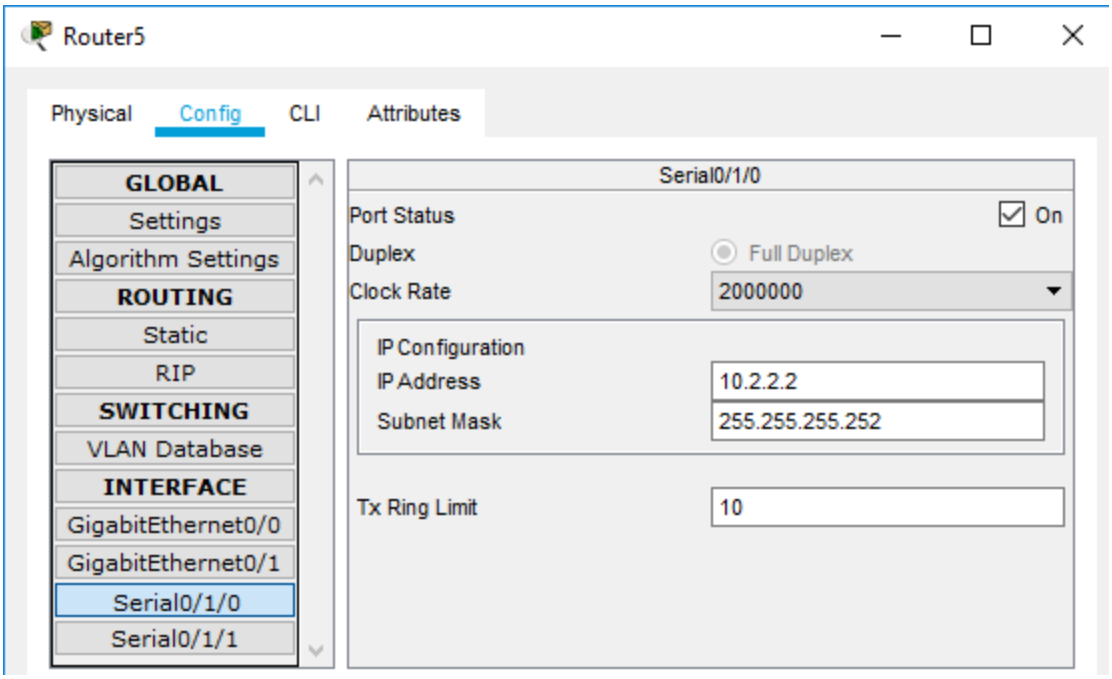

Server2
Physical
Config
Services
Desktop
Programming
Attributes
DHCP
Static
IP Address
192.168.1.3
Subnet Mask
255.255.255.0
Default Gateway
192.168.1.1
DNS Server
0.0.0.0
IPv6 Configuration
DHCP
Auto Config
Static

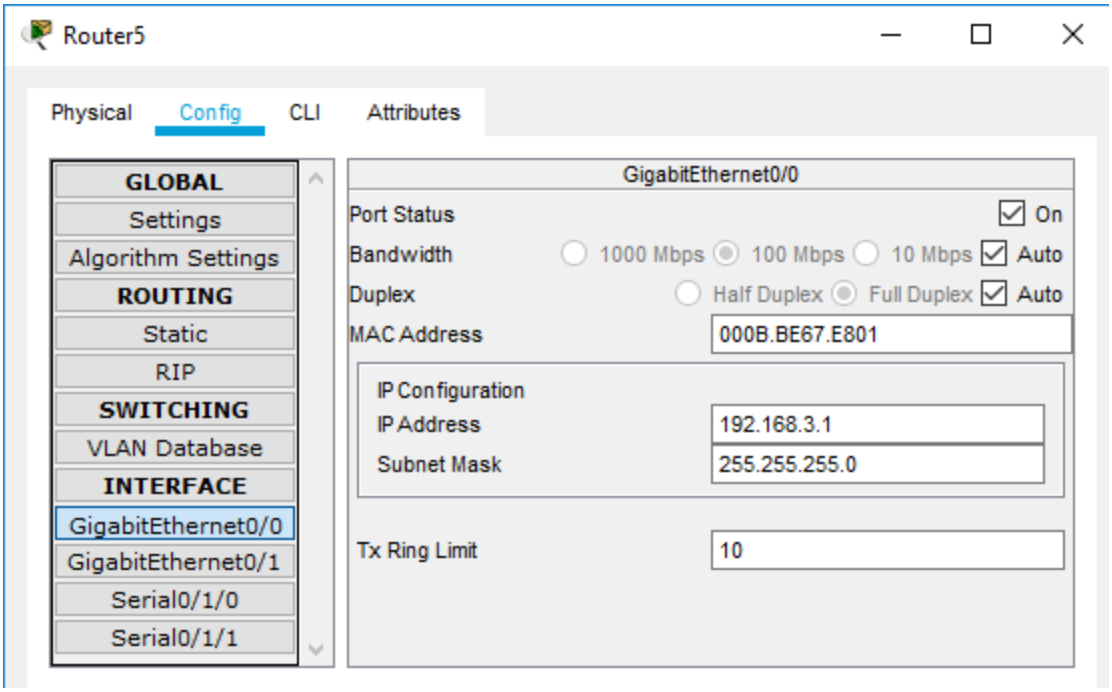

Router4
Physical
Config
CLI
Attributes
GLOBAL
Settings
Algorithm Settings
ROUTING
Static
RIP
SWITCHING
VLAN Database
INTERFACE
GigabitEthernet0/0
GigabitEthernet0/1
Serial0/1/0
Serial0/1/1
GigabitEthernet0/0
Port Status
On
Bandwidth
1000 Mbps
100 Mbps
10 Mbps
Auto
Duplex
Half Duplex
Full Duplex
Auto
MAC Address
0001.C702.2A01
IP Configuration
IP Address
192.168.1.1
Subnet Mask
255.255.255.0
Tx Ring Limit
10

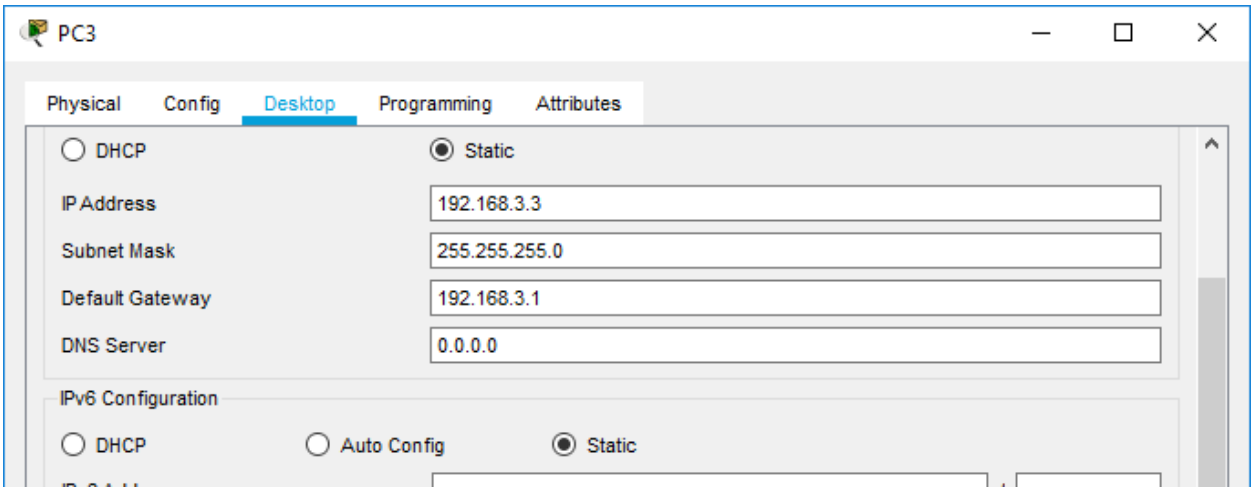

Router4
Physical
Config
CLI
Attributes
GLOBAL
Settings
Algorithm Settings
ROUTING
Static
RIP
SWITCHING
VLAN Database
INTERFACE
GigabitEthernet0/0
GigabitEthernet0/1
Serial0/1/0
Serial0/1/1
Serial0/1/0
Port Status
On
Duplex
Full Duplex
Clock Rate
1200
IP Configuration
IP Address
10.1.1.1
Subnet Mask
255.255.255.252
Tx Ring Limit
10


Router6
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
Serial0/1/0
Port Status
On
Duplex
Full Duplex
Clock Rate
2000000
IP Configuration
IP Address
10.1.1.2
Subnet Mask
255.255.255.252
Tx Ring Limit
10


Router6
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
1200
IP Configuration
IP Address
10.2.2.1
Subnet Mask
255.255.255.252
Tx Ring Limit
10

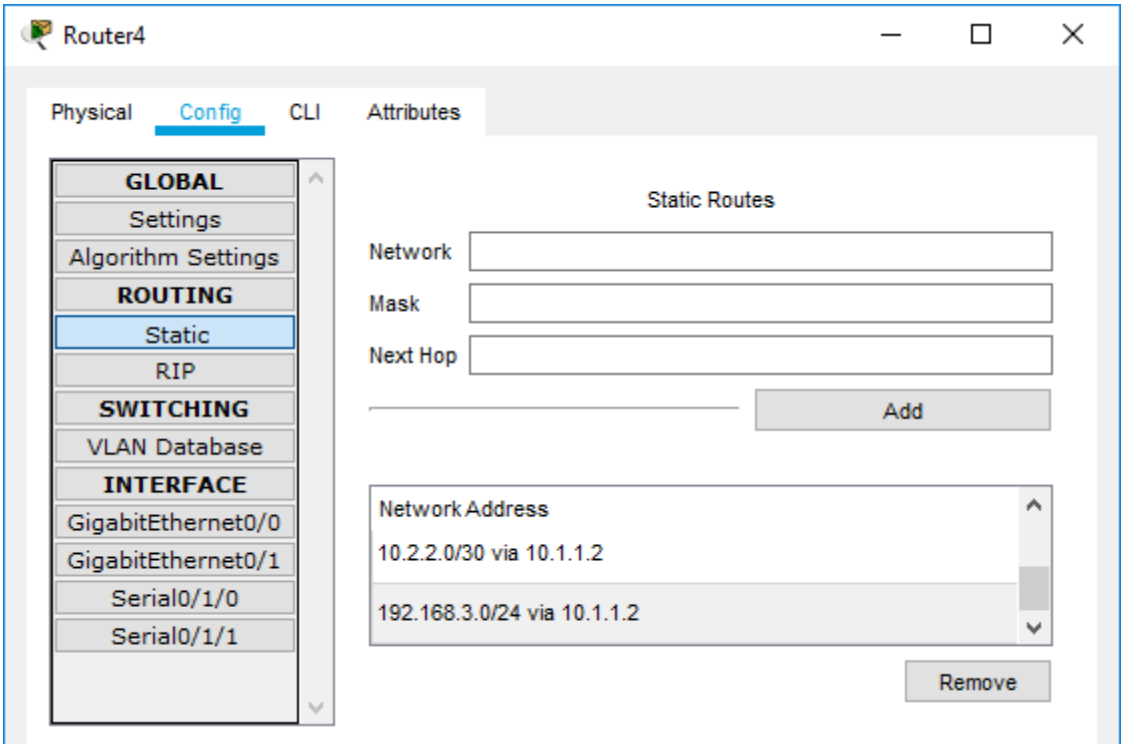

Router5
Physical
Config
CLI
Attributes
GLOBAL
Settings
Algorithm Settings
ROUTING
Static
RIP
SWITCHING
VLAN Database
INTERFACE
GigabitEthernet0/0
GigabitEthernet0/1
Serial0/1/0
Serial0/1/1
Serial0/1/0
Port Status
On
Duplex
Full Duplex
Clock Rate
2000000
IP Configuration
IP Address
10.2.2.2
Subnet Mask
255.255.255.252
Tx Ring Limit
10

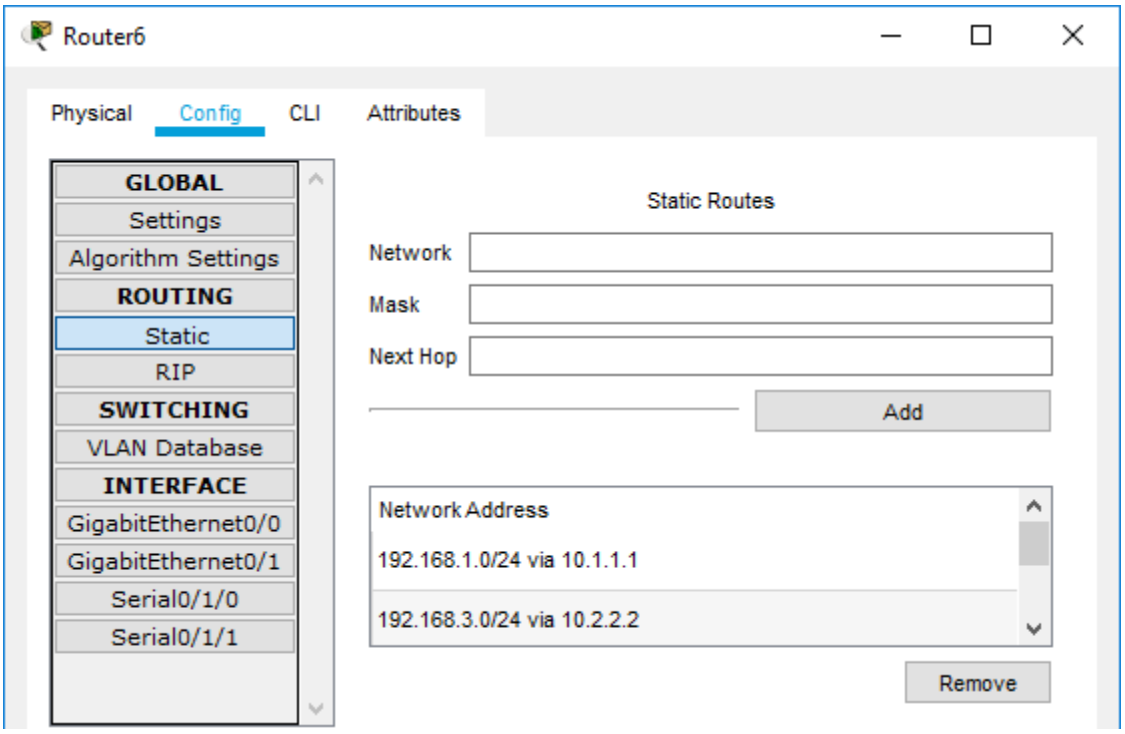

Router5
Physical
Config
CLI
Attributes
GLOBAL
Settings
Algorithm Settings
ROUTING
Static
RIP
SWITCHING
VLAN Database
INTERFACE
GigabitEthernet0/0
GigabitEthernet0/1
Serial0/1/0
Serial0/1/1
GigabitEthernet0/0
Port Status
On
Bandwidth
1000 Mbps
100 Mbps
10 Mbps
Auto
Duplex
Half Duplex
Full Duplex
Auto
MAC Address
000B.BE67.E801
IP Configuration
IP Address
192.168.3.1
Subnet Mask
255.255.255.0
Tx Ring Limit
10

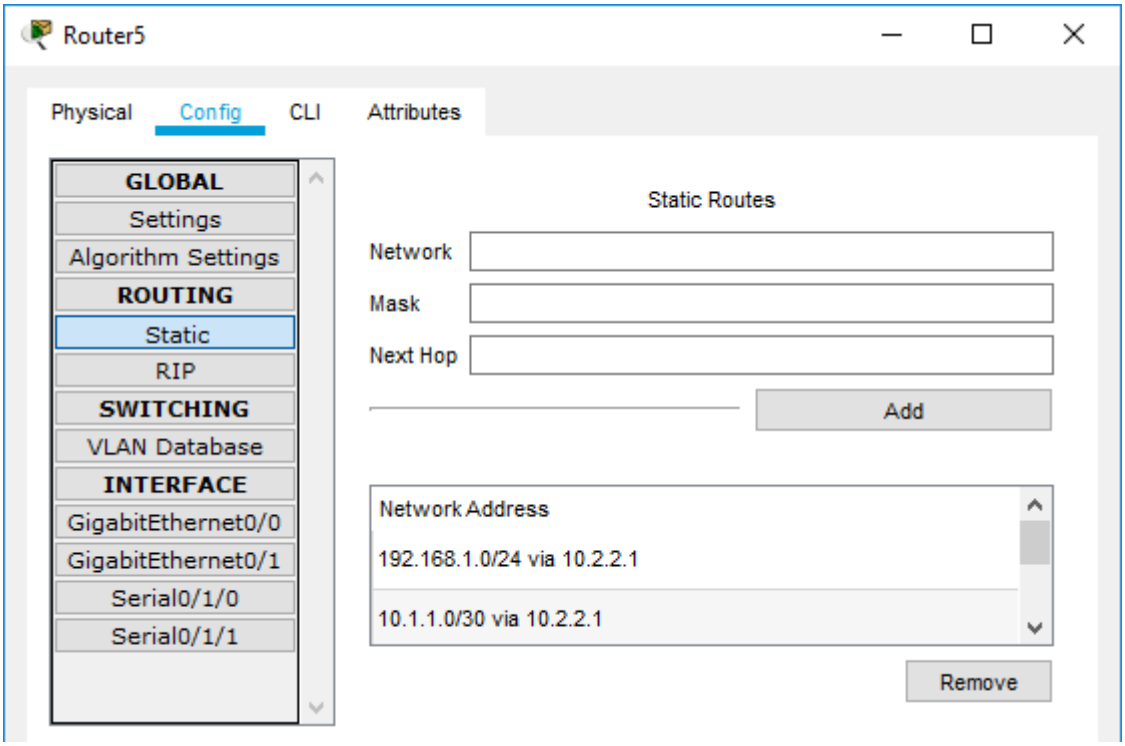


STATIC ROUTING :

Now we do the Static Routing on all the Routers as follows

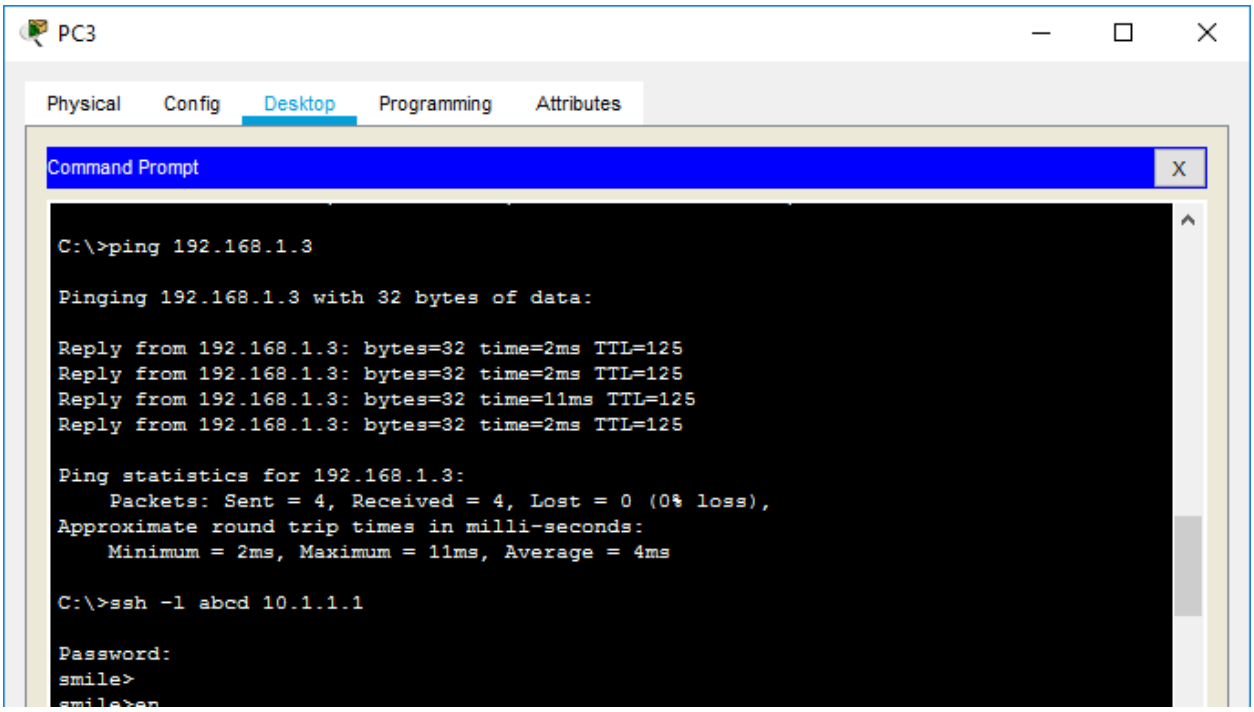



Router6
Physical
Config
CLI
Attributes
GLOBAL
Settings
Algorithm Settings
ROUTING
Static
RIP
SWITCHING
VLAN Database
INTERFACE
GigabitEthernet0/0
GigabitEthernet0/1
Serial0/1/0
Serial0/1/1
Static Routes
Network
Mask
Next Hop
Add
Network Address
192.168.1.0/24 via 10.1.1.1
192.168.3.0/24 via 10.2.2.2
Remove


Router5
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
Mask
Next Hop
Add
Network Address
192.168.1.0/24 via 10.2.2.1
10.1.1.0/30 via 10.2.2.1
Remove

PART 1 : Verify the basic network connectivity

Now we check the connectivity by pinging the server (192.168.1.3) from the PC (192.168.3.3)

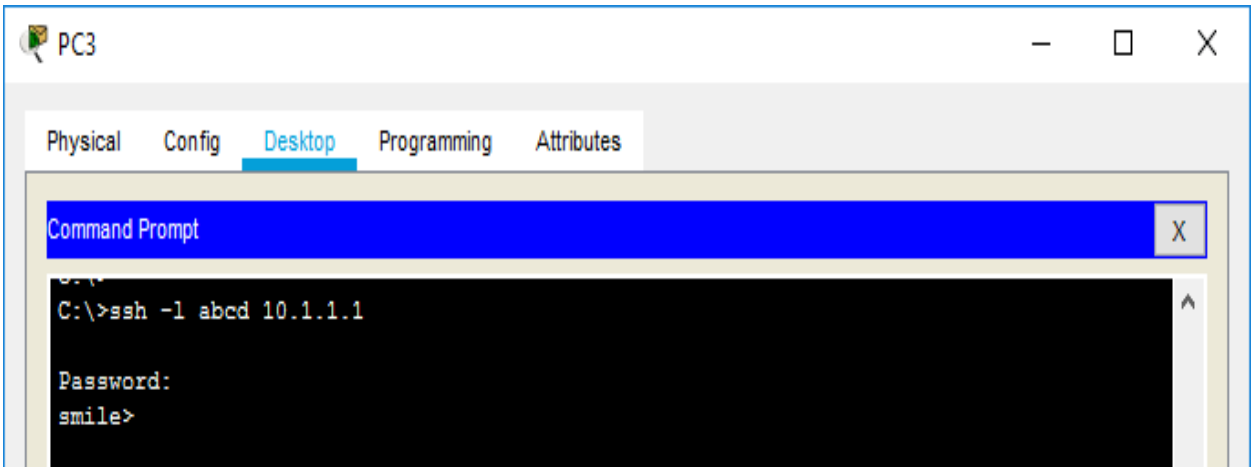


Setting the SSH on Router 4 using the following commands in the CLI mode

Router(config)#username abcd secret xyz
Router(config)#aaa new-model
Router(config)#aaa authentication login default local
Router(config)#ip domain-name smile.com
Router(config)#hostname smile
smile(config)#crypto
smile(config)#crypto key generate rsa
How many bits in the modulus [512]: 1024

smile(config)#aaa authentication login abcd local
smile(config)#line vty 0 4
smile(config-line)#login authentication abcd
smile(config-line)#transport input ssh
smile(config-line)#end

Now verifying the same using the following commands on the PC



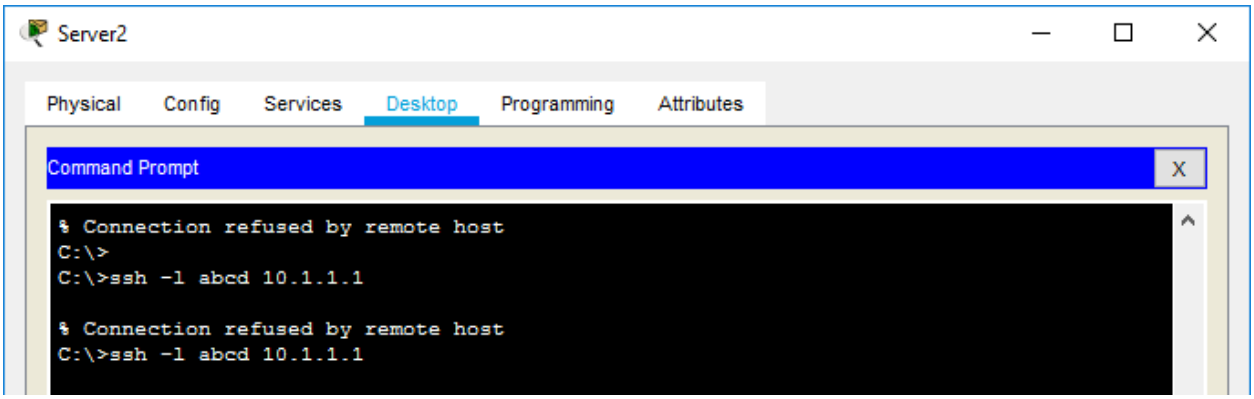
PART 2: Secure Access to Routers

Configure the Router 4 to block any access to the routers except the PC (192.168.3.3)

smile#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
smile(config)#access-list 10 permit host 192.168.3.3
smile(config)#line vty 0 4
smile(config-line)#access-class 10 in
smile(config-line)#exit

From the above commands we deny any host other than PC (192.168.3.3) to get access to the router 4

We check it by accessing the Router 4 through the Server (192.168.1.3) as follows

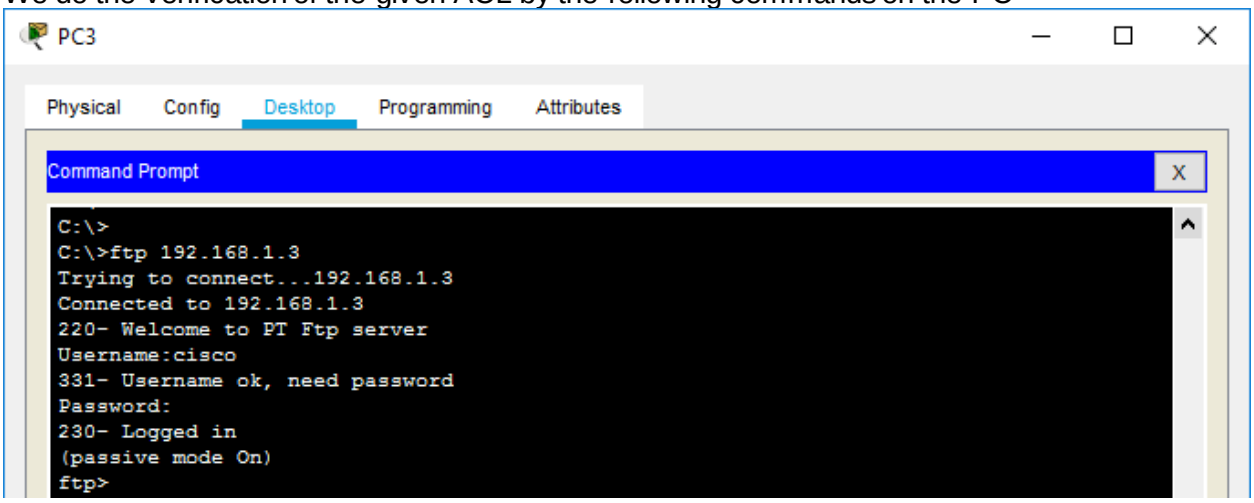


PART 3: Create a Numbered IP ACL 120 on Router 4

We type the following command in the CLI mode for the Router 4

```
smile#
smile#configure terminal
smile(config)#access-list 120 permit tcp any host 192.168.1.3 eq smtp
smile(config)#access-list 120 permit tcp any host 192.168.1.3 eq ftp
smile(config)#access-list 120 deny tcp any host 192.168.1.3 eq 443
smile(config)#access-list 120 permit tcp any host 192.168.1.3 eq 22
smile(config)#interface Serial0/1/0
smile(config-if)#ip access-group 120 in
smile(config-if)#exit
```

We do the verification of the given ACL by the following commands on the PC



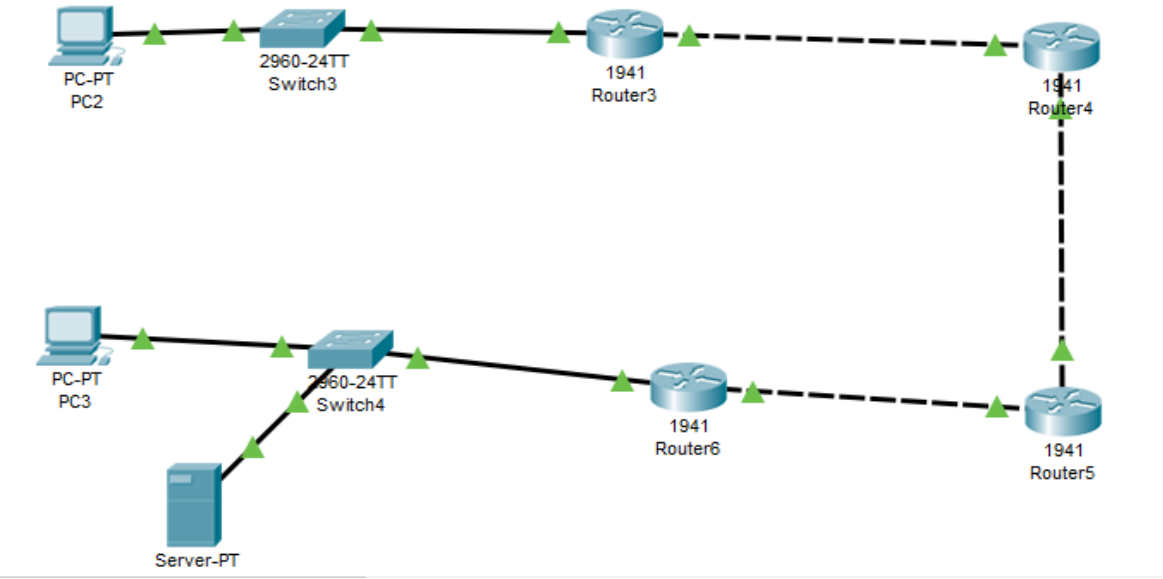
PART 4: Modify an Existing ACL on Router 4

```
Smile(config)# access-list 120 permit icmp any any echo-reply
Smile(config)# access-list 120 permit icmp any any unreachable
Smile(config)# access-list 120 deny icmp any any
Smile(config)# access-list 120 permit ip any any
```

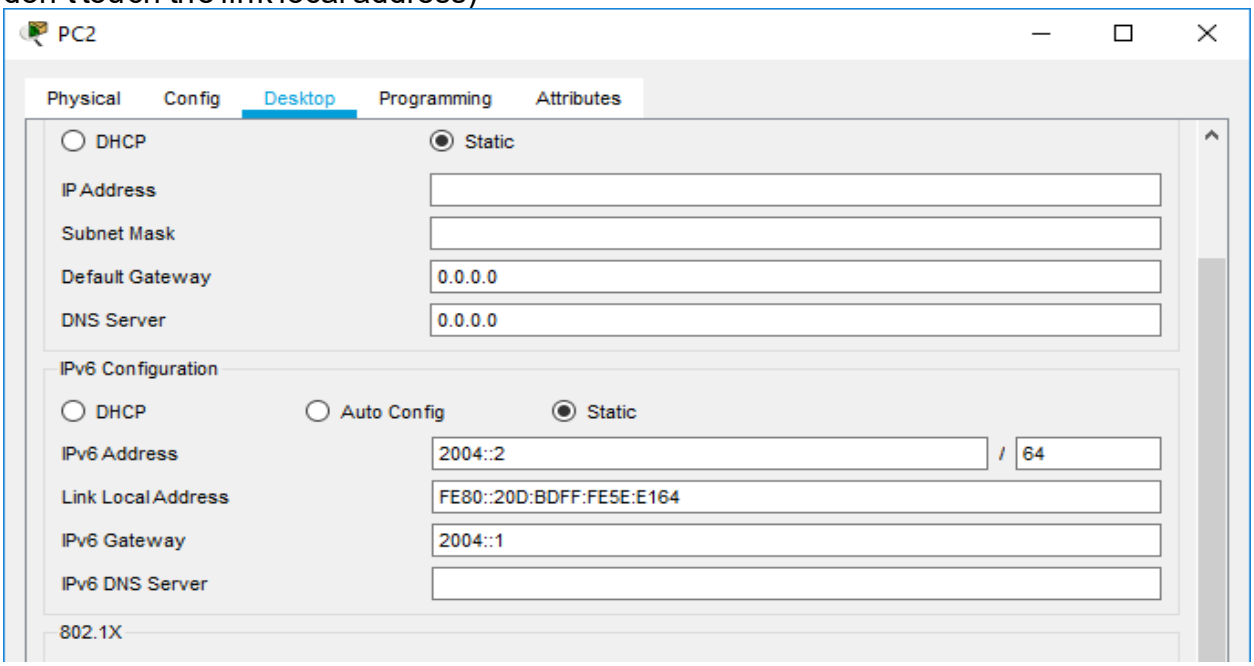
Similarly we can create and modify the ACLs for all the Routers

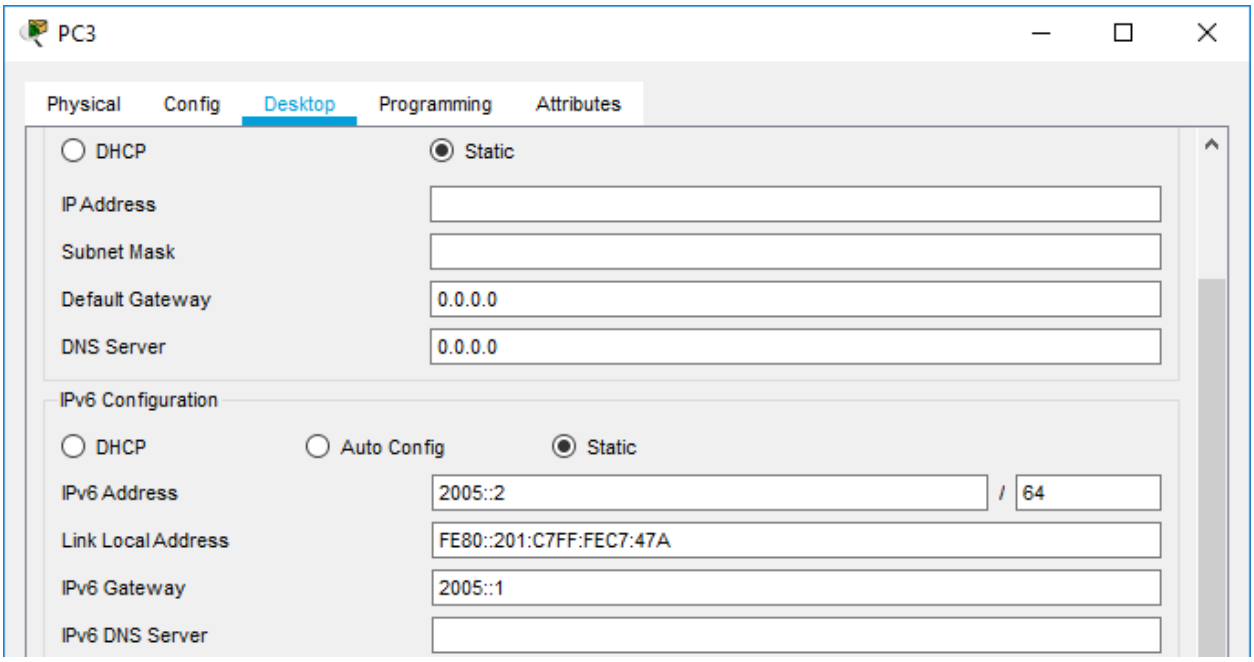
Practical 5: Configuring IPv6 ACLs

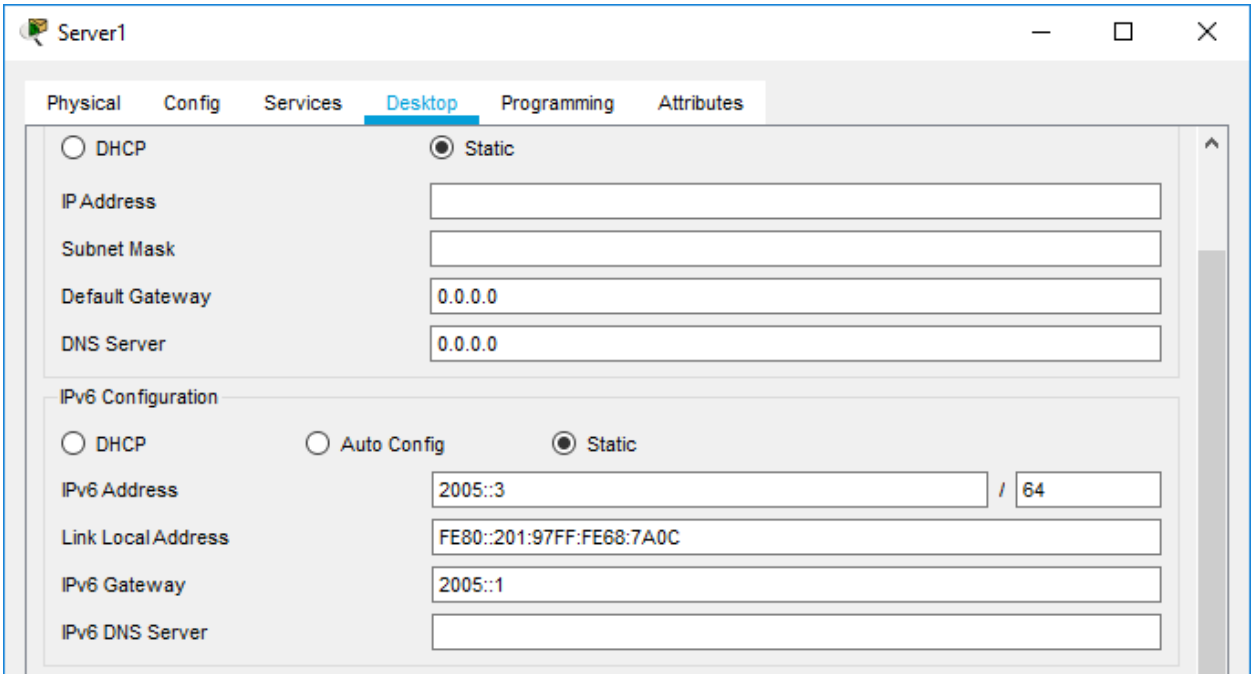
We use the following topology to configure the IPv6 ACLs



We configure the Hosts and Routers as follows (only add ipv6 address and gateway, don't touch the link local address)




PC3
Physical
Config
Desktop
Programming
Attributes
DHCP
Static
IP Address
Subnet Mask
Default Gateway
0.0.0.0
DNS Server
0.0.0.0
IPv6 Configuration
DHCP
Auto Config
Static
IPv6 Address
2005::2
/
64
Link Local Address
FE80::201:C7FF:FEC7:47A
IPv6 Gateway
2005::1
IPv6 DNS Server


Server1
Physical
Config
Services
Desktop
Programming
Attributes
DHCP
Static
IP Address
Subnet Mask
Default Gateway
0.0.0.0
DNS Server
0.0.0.0
IPv6 Configuration
DHCP
Auto Config
Static
IPv6 Address
2005::3
/
64
Link Local Address
FE80::201:97FF:FE68:7A0C
IPv6 Gateway
2005::1
IPv6 DNS Server

For router 3 type the following commands

```
Router>enable
Router#
Router#configure terminal
Router(config)#ipv6 unicast-routing
Router(config)#interface GigabitEthernet0/0
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)#interface GigabitEthernet0/1
Router(config-if)#ipv6 address 2002::1/64
Router(config-if)#ipv6 rip a enable
Router(config-if)#no shutdown
```

For router 4 type the following commands

```
Router>en
Router#configure terminal
Router(config)#ipv6 unicast-routing
Router(config)#interface GigabitEthernet0/0
Router(config-if)#ipv6 address 2002::2/64
Router(config-if)#ipv6 rip a enable
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#interface GigabitEthernet0/1
Router(config-if)#ipv6 address 2003::1/64
Router(config-if)#ipv6 rip a enable
```

For router 5 type the following commands

```
Router>
Router>enable
Router#configure terminal
Router(config)#ipv6 unicast-routing
Router(config)#interface GigabitEthernet0/1
Router(config-if)#ipv6 address 2003::2/64
Router(config-if)#ipv6 rip a enable
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#interface GigabitEthernet0/1
Router(config-if)#ipv6 address 2004::1/64
Router(config-if)#ipv6 rip a enable
Router(config-if)#exit
Router(config)#
```

For router 6 type the following commands

```
Router>
Router>enable
Router#configure terminal
Router(config)#ipv6 unicast-routing
Router(config)#interface GigabitEthernet0/1
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 GigabitEthernet0/1
Router(config-if)#ipv6 address 2005::1/64
Router(config-if)#ipv6 rip a enable
Router(config-if)#exit
Router(config)#
```

Now we configure, apply and verify the IPv6 ACL on Router 6

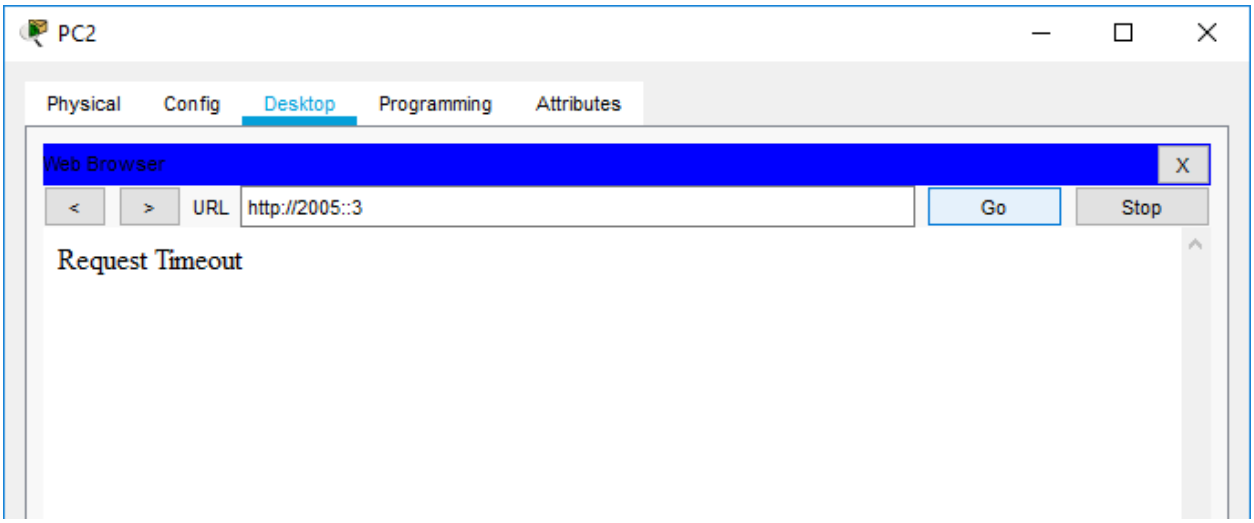
Type the following command in the CLI mode of Router 6

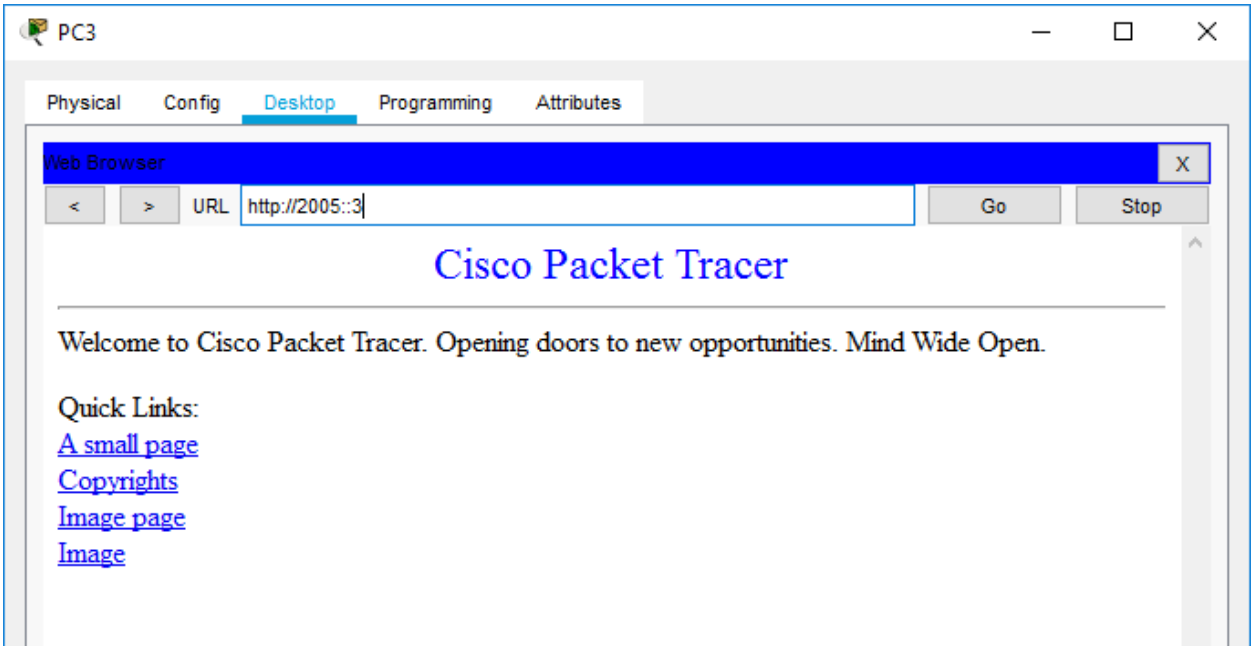
```
Router(config)#ipv6 acc
Router(config)#ipv6 access-list smile
Router(config-ipv6-acl)#
Router(config-ipv6-acl)#deny tcp any host 2005::3 eq www
Router(config-ipv6-acl)#deny tcp any host 2005::3 eq 443
Router(config-ipv6-acl)#exit
```

WE apply the ACL list to the proper interface as follows

```
Router(config)#
Router(config)#interface GigabitEthernet0/1
Router(config-if)#ipv6 traffic-filter smile in
Router(config-if)#
```

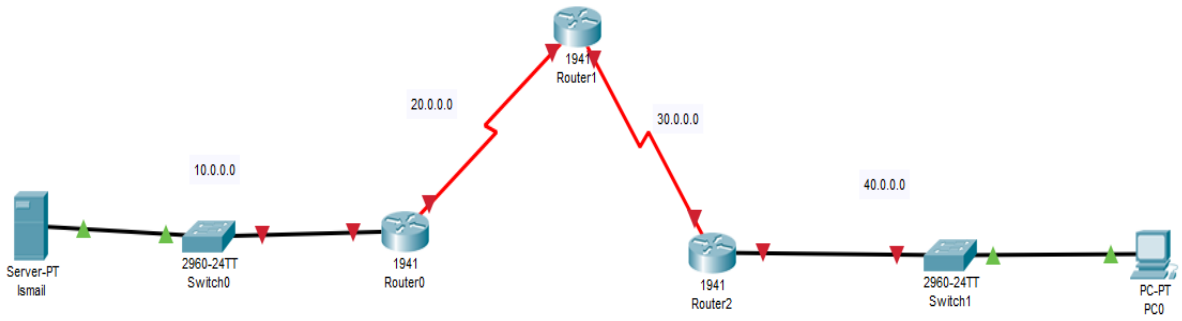
We verify the services www on PC2 and PC3 and get the following output



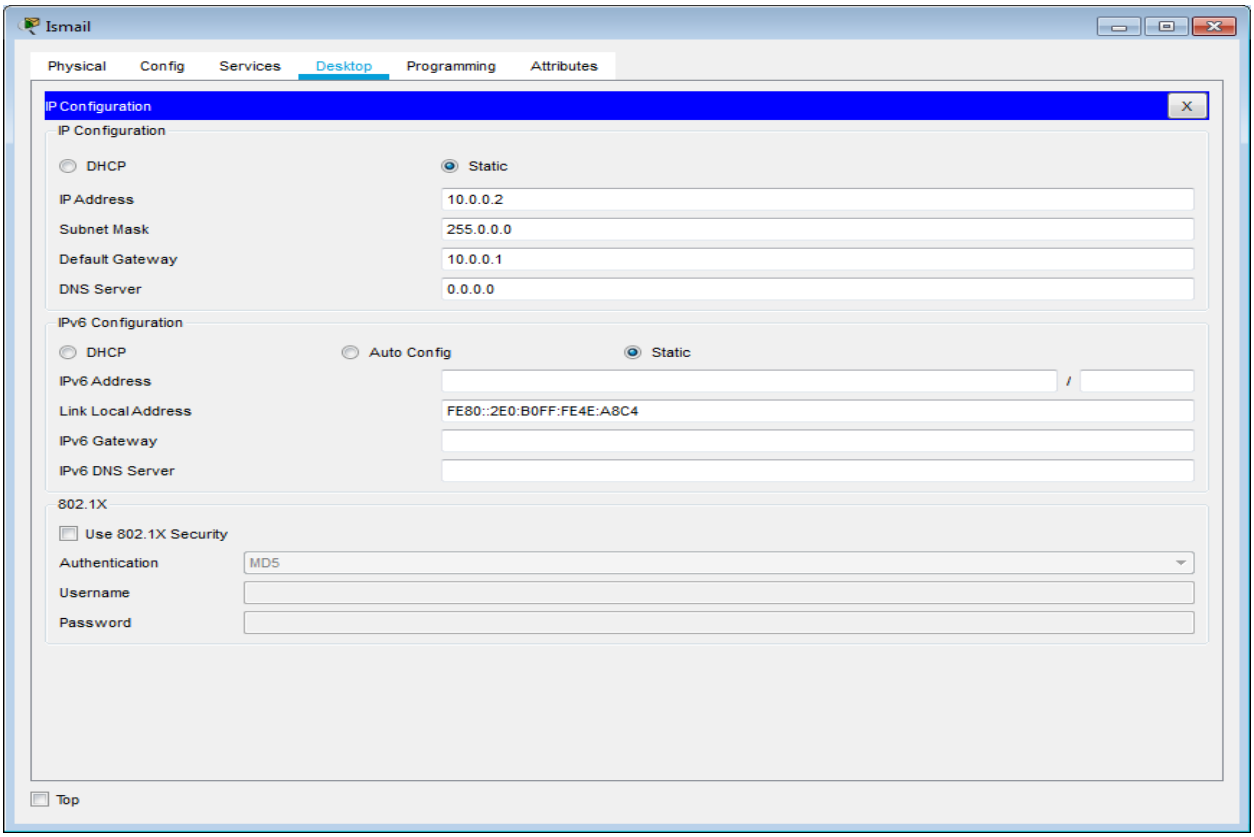


Practical 6: Configuring a Zone-Based Policy Firewall (ZPF)

Consider the following topology



Configuring Server



(Note: The SERIAL interface must be added on each Router before configuring them)

Configuring the Router0:

```
Router>enable
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#interface GigabitEthernet0/0
Router(config-if)#ip address 10.0.0.1 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#interface Serial0/1/0
Router(config-if)#ip address 20.0.0.1 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#
Router(config-if)#exit

Router(config)#router rip
Router(config-router)#network 10.0.0.0
Router(config-router)#network 20.0.0.0
Router(config-router)#
```

Configuring the Router1:

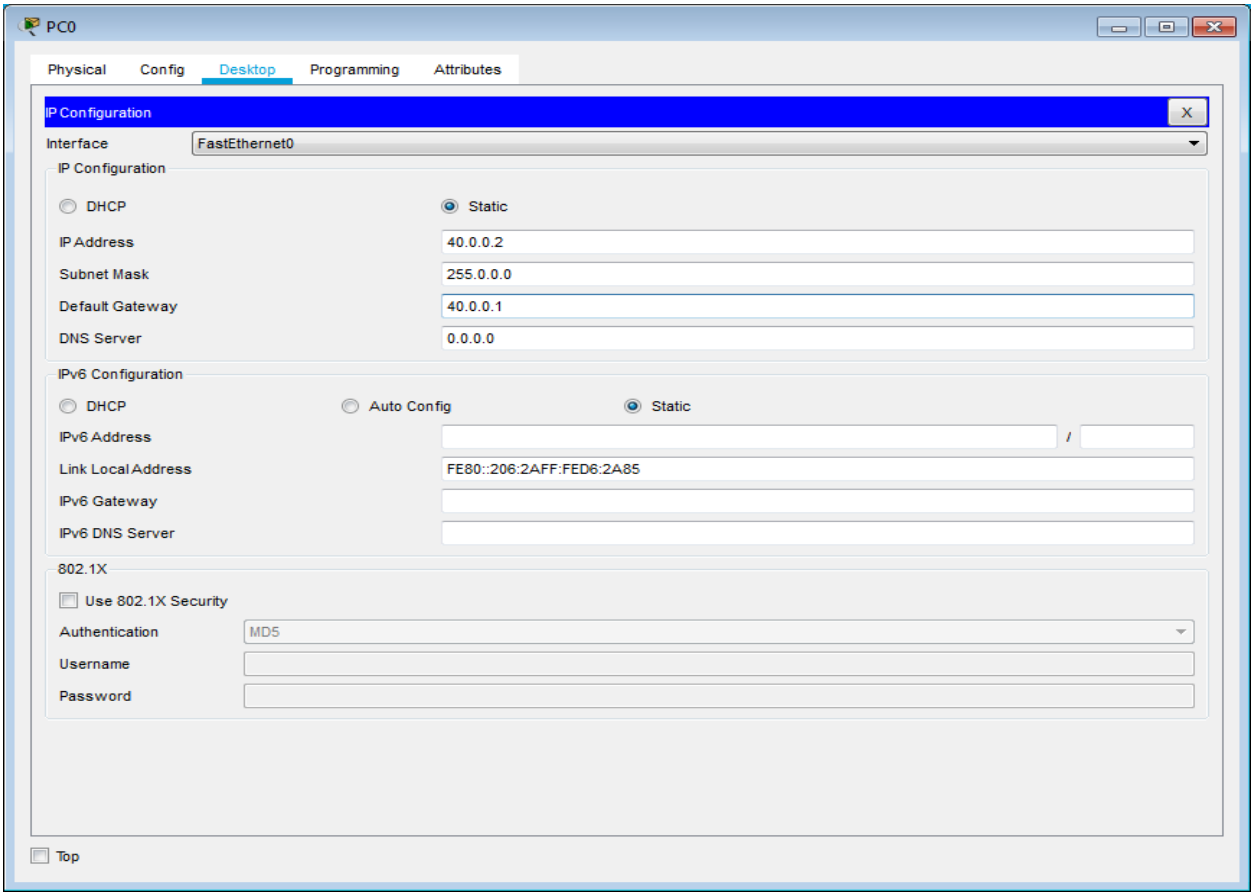
```
Router>enable
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#interface Serial0/1/0
Router(config-if)#ip address 20.0.0.2 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#interface Serial0/1/1
Router(config-if)#ip address 30.0.0.1 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#

Router(config)#router rip
Router(config-router)#network 30.0.0.0
Router(config-router)#network 20.0.0.0
Router(config-router)#
```

Configuring the Router2:

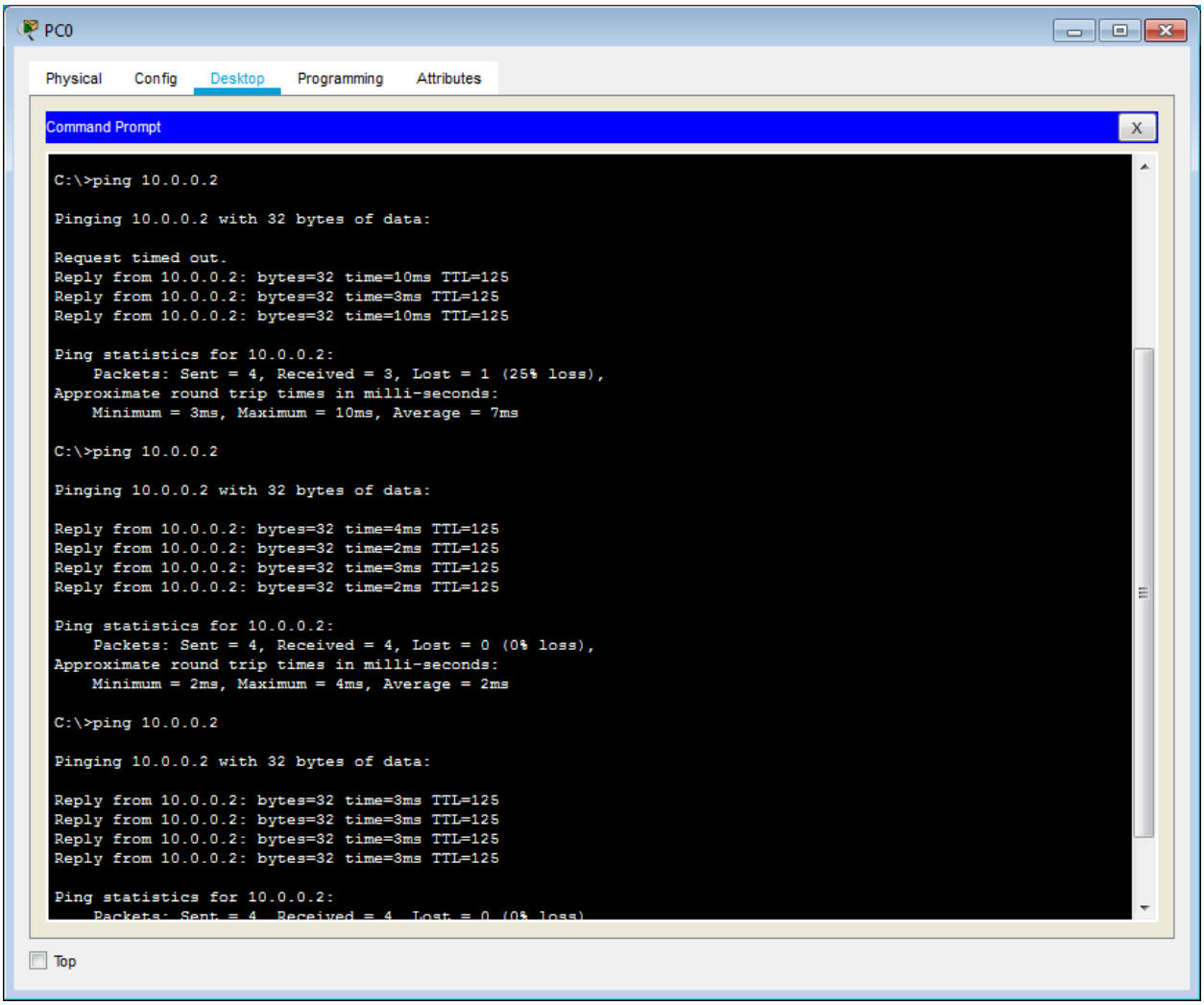
```
Router>enable
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#interface Serial0/1/1
```

```
Router(config-if)#ip address 30.0.0.2 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#interface GigabitEthernet0/0
Router(config-if)#ip address 40.0.0.1 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit

Router(config)#router rip
Router(config-router)#network 30.0.0.0
Router(config-router)#network 40.0.0.0
Router(config-router)#
```

Configure the PC



The Basic connectivity must be verified by using the ping command:



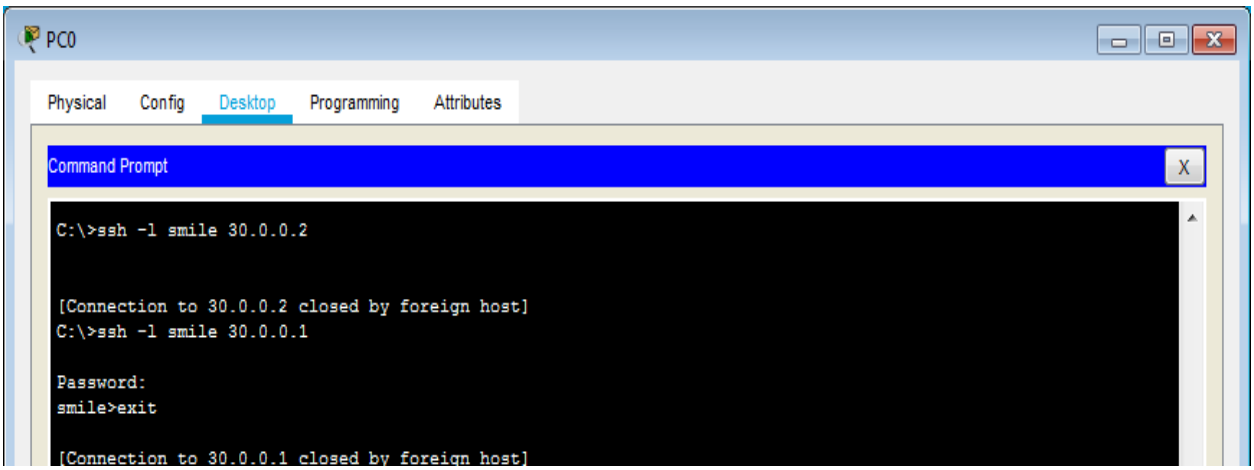
Setting the SSH on Router 1 using the following commands in the CLI mode

Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#username smile secret 1234
Router(config)#aaa new-model
Router(config)#aaa authentication login default local
Router(config)#ip domain-name smile.com
Router(config)#hostname smile
smile(config)#crypto key generate rsa
The name for the keys will be: smile.smile.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]

*Mar 1 0:30:13.877: %SSH-5-ENABLED: SSH 1.99 has been enabled
smile(config)#aaa authentication login smile local
smile(config)#line vty 0 4
smile(config-line)#login authentication smile
smile(config-line)#transport input ssh
smile(config-line)#end
smile#

Now verifying the same using the following commands on the PC



Checking the connectivity from Pc to Server by opening the Web Browser

Creating the FIREWALL ZONES ON Router2

Enabling the Security technology package on the Router2 using the following command

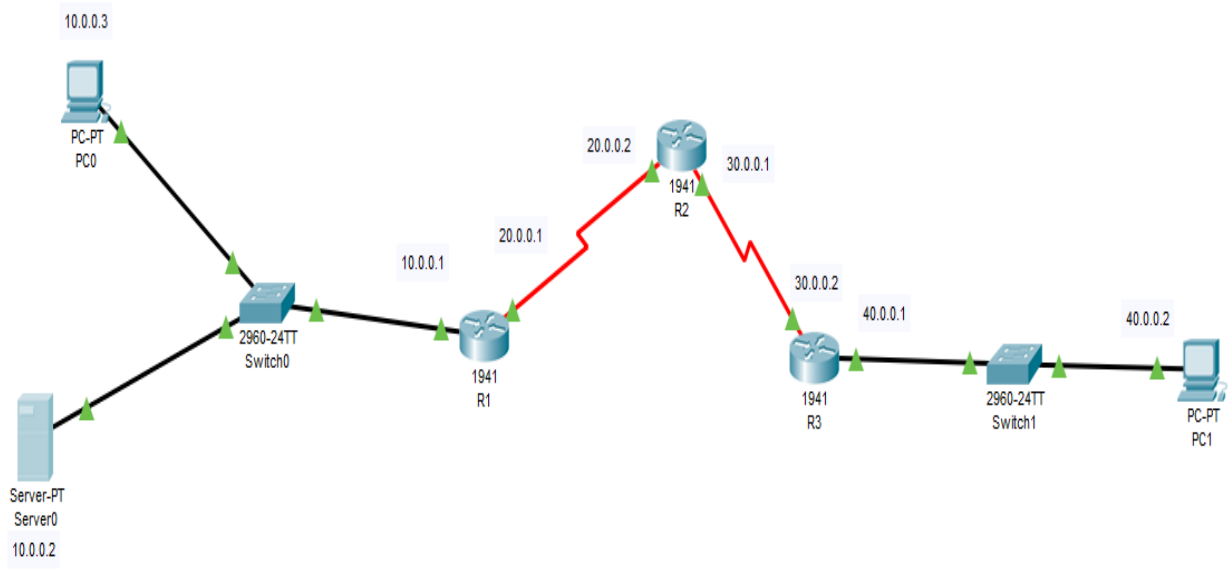
```
Router#
Router#conf
Router#configure ter
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#zone sec
Router(config)#zone security SMILE-ZONE
Router(config-sec-zone)#EXIT
Router(config)#
Router(config)#zone
Router(config)#zone se
Router(config)#zone security OUT-ZONE
Router(config-sec-zone)#EXIT
Router(config-sec-zone)#exit
Router(config)#
Router(config)#ac
Router(config)#access-list 101 permit 40.0.0.2 0.255.255.255 any
^
% Invalid input detected at '^' marker.
Router(config)#access-list 101 permit ip 40.0.0.2 0.255.255.255 any
Router(config)#class
Router(config)#class-map type
Router(config)#class-map type inspect match
Router(config)#class-map type inspect match-all IN-
Router(config)#class-map type inspect match-all IN-NET-
Router(config)#class-map type inspect match-all IN-NET-CLASS-MAP
Router(config-cmap)#
Router(config-cmap)#mat
Router(config-cmap)#match ac
Router(config-cmap)#match access-group 101
Router(config-cmap)#exit
Router(config)#pol
Router(config)#policy-map type in
Router(config)#policy-map type inspect IN-2
Router(config)#policy-map type inspect IN-2-OUT-PMAP
Router(config-pmap)#cl
Router(config-pmap)#class t
Router(config-pmap)#class type in
```

```
Router(config-pmap)#class type inspect IN-NET-CLASS-MAP
Router(config-pmap-c)#in
Router(config-pmap-c)#inspect
%No specific protocol configured in class IN-NET-CLASS-MAP for inspection. All protocols
will be inspected
Router(config-pmap-c)#exit
Router(config-pmap)#exit
Router(config)#
Router(config)#zone-pair security IN-2-OUT-ZPAIR
Router(config)#zone-pair security IN-2-OUT-ZPAIR ?
source Source zone
Router(config)#zone-pair security IN-2-OUT-ZPAIR SMILE-ZONE OUT-ZONE
^
% Invalid input detected at '^' marker.
Router(config)#zone-pair security IN-2-OUT-ZPAIR 40.0.0.1 30.0.0.2
^
% Invalid input detected at '^' marker.
Router(config)#zone-pair security IN-2-OUT-ZPAIR 40.0.0.1 SMILE-ZONE 30.0.0.2 OUT-
ZONE
^
% Invalid input detected at '^' marker.
Router(config)#zone-pair security IN-2-OUT-ZPAIR ?
source Source zone
Router(config)#zone-pair security IN-2-OUT-ZPAIR so
Router(config)#zone-pair security IN-2-OUT-ZPAIR source SMILE-ZONE de
Router(config)#zone-pair security IN-2-OUT-ZPAIR source SMILE-ZONE destination OUT-
ZONE
Router(config-sec-zone-pair)#ser
Router(config-sec-zone-pair)#service-policy  type in
Router(config-sec-zone-pair)#service-policy  type inspect IN
Router(config-sec-zone-pair)#service-policy  type inspect IN-2-OUT-PMAP
Router(config-sec-zone-pair)#exit
Router(config)#
Router(config)#interface Serial0/1/1
Router(config-if)#zone
Router(config-if)#zone-member sec
Router(config-if)#zone-member security
Router(config-if)#zone-member security SMILE-ZONE
Router(config-if)#EXIT
Router(config)#
Router(config)#interface Serial0/1/1
Router(config-if)#
Router(config-if)#exit
Router(config)#interface GigabitEthernet0/0
Router(config-if)#ZONE
Router(config-if)#
```

```
Router(config-if)#zone
Router(config-if)#zone-member se
Router(config-if)#zone-member security OUT-ZONE
Router(config-if)#
Router(config-if)#exit
Router(config)#
Router(config)#exitt
^
% Invalid input detected at '^' marker.
Router(config)#exit
Router#
%SYS-5-CONFIG_I: Configured from console by console

Router#copy
Router#copy ru
Router#copy running-config star
Router#copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
Router#
```

Practical 7: Configure IOS Intrusion Prevention System (IPS) Using the CLI

Consider the following topology



Configure the PCs, Routers and the Server with the following addresses

PC0	10.0.0.3
SERVER	10.0.0.2
R1 G0/0	10.0.0.1
S0/1/0	20.0.0.1
R2 S0/1/0	20.0.0.2
S0/1/1	30.0.0.1
R3 S0/1/1	30.0.0.2
G0/0	40.0.0.1
PC1	40.0.0.2

Use RIP routing protocol and add the networks in the Routers as follows

R1	10.0.0.0	20.0.0.0
R2	20.0.0.0	30.0.0.0
R3	30.0.0.0.	40.0.0.0

Configure Server as the SYSLLOG server

Ping the PC0 to PC1 and PC1 to PC0 and verify the connectivity

Type the following commands in R1

R1(config)# license boot module c1900 technology-package securityk9

Enable the security package and reload the router
R1(config)#exit
R1#write
R1#reload

R1# mkdir ipsdir
R1(config)# ip ips config location flash:ipsdir
R1(config)# ip ips name iosips
R1(config)# ip ips notify log
R1#set clock 11:12:23 5 APR 2019

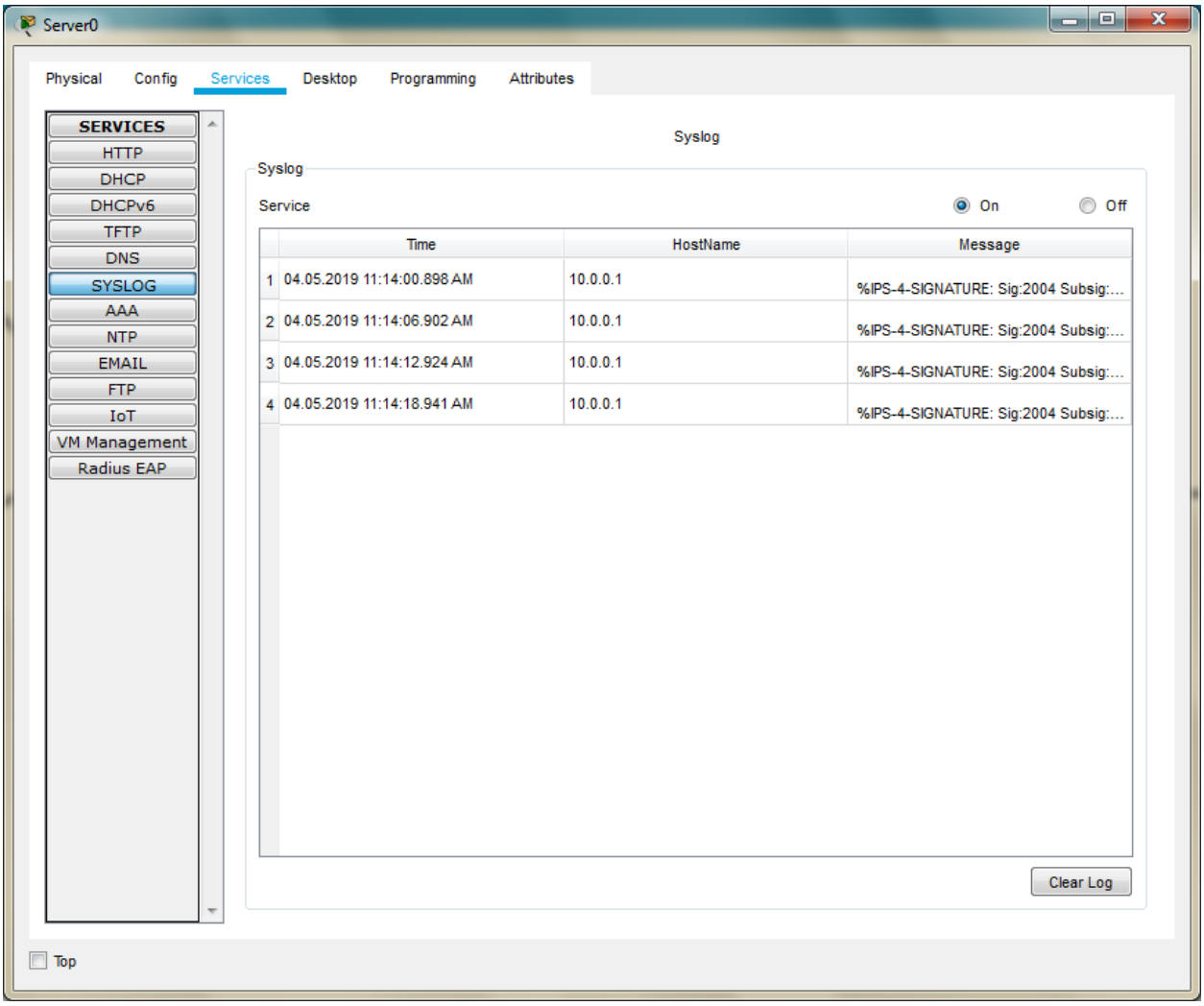
R1#Show clock
R1(config)# service timestamps log datetime msec
R1(config)#logging host 10.0.0.2

R1(config)# ip ips signaturecategory
R1(config-ips-category)# category all
R1(config-ips-category-action)# retired true
R1(config-ips-category-action)# exit
R1(config-ips-category)# category ios_ips basic
R1(config-ips-category-action)# retired false
R1(config-ips-category-action)# exit
R1(config-ips-cateogry)# exit
Do you want to accept these changes? [confirm] <Enter>

R1(config)# interface g0/0
R1(config-if)# ip ips iosips out

R1(config)# ip ips signature-definition
R1(config-sigdef)# signature 2004 0
R1(config-sigdef-sig)# status
R1(config-sigdef-sig-status)# retired false
R1(config-sigdef-sig-status)# enabled true
R1(config-sigdef-sig-status)# exit
R1(config-sigdef-sig)# engine
R1(config-sigdef-sig-engine)# event-action produce-alert
R1(config-sigdefsig-engine)# event-action deny-packet-inline
R1(config-sigdef-sig-engine)# exit
R1(config-sigdef-sig)# exit
R1(config-sigdef)# exit
Do you want to accept these changes? [confirm] <Enter>

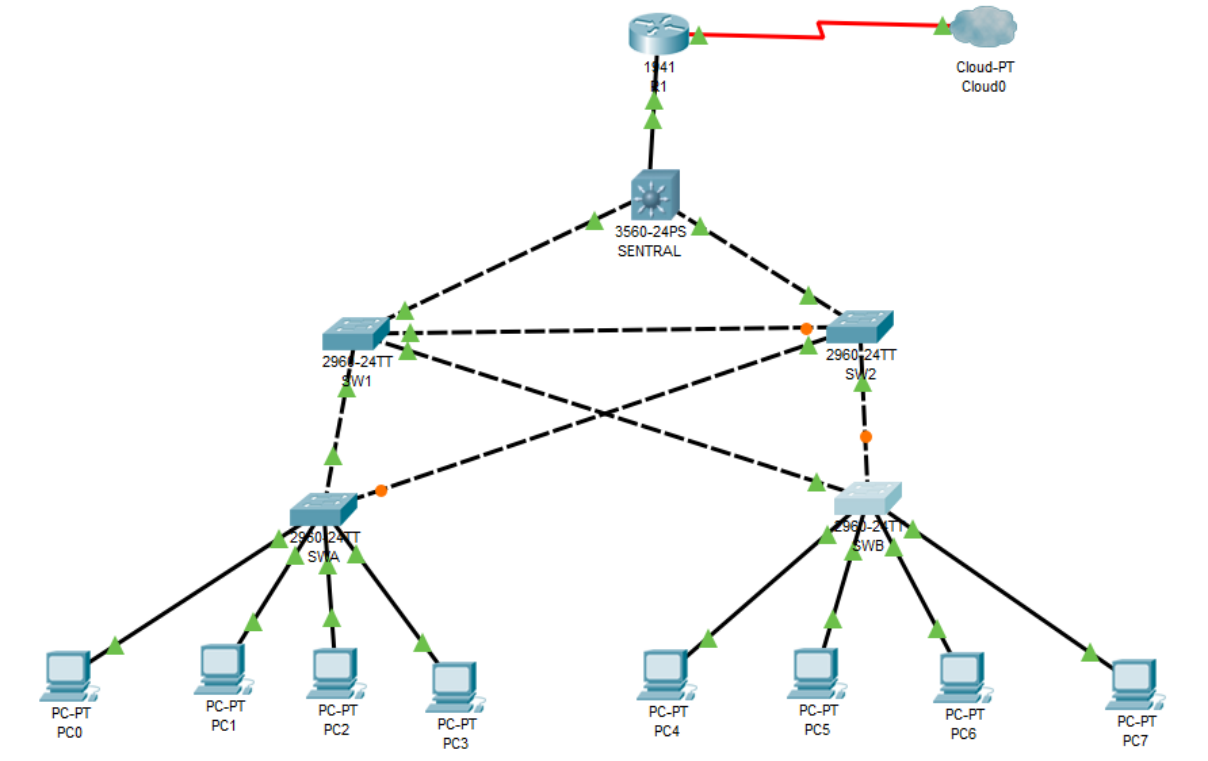
Now ping PC1 from PC0 and PC0 from PC1 and observe the output at the SYSLOG services of the Server



Only one ping is successful while the other fails

Practical 8: Packet Tracer – Layer 2 Security

Consider the following topology



Configure the Root Bridge

Type the following command in the CLI mode of CENTRAL switch

CENTRAL(config)#SPAnning-tree vlan 1 root primary
CENTRAL(config)#exit

Type the following command in the CLI mode of SW1 switch

Switch>enable
Switch#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#hostname SW1
SW1(config)#spanning-tree vlan 1 root secondary

Verify the spanning-tree configuration by using the following commands in the CENTRAL switch

CENTRAL#show spanning-tree

The following output is obtained
VLAN0001
Spanning tree enabled protocol ieee
Root ID Priority 24577
Address 00E0.8F81.9573
This bridge is the root
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 24577 (priority 24576 sys-id-ext 1)
Address 00E0.8F81.9573
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 20

Interface Role Sts Cost Prio.Nbr Type
---------- ---- --- --------- -------- --------------------------------
Fa0/1 Desg FWD 19 128.1 P2p
Gi0/1 Desg FWD 4 128.25 P2p
Gi0/2 Desg FWD 4 128.26 P2p

Protect against STP attacks

Type the following commands in the CLI modes of the Switches SWA and SWB
Enable portfast on all access ports

Switch>enable
Switch#configure terminal
Switch(config)#hostname SWA
SWA(config)#interface range f0/1-4
SWA(config-if-range)#spanning-tree portfast

Switch>enable
Switch#configure terminal
Switch(config)#hostname SWB
SWB(config)#interface range f0/1-4
SWB(config-if-range)#spanning-tree portfast

Enable BPDU guard on all access points
SWA(config-if-range)#spanning-tree bpduguard enable
SWA(config-if-range)#exit

SWB(config-if-range)#spanning-tree bpduguard enable
SWB(config-if-range)#exit

Enable root guard
SW1(config)#interface range f0/23-24
SW1(config-if-range)#spanning-tree guard root

SW2(config)#interface range f0/23-24
SW2(config-if-range)#spanning-tree guard root

Configure Port Security and Disable Unused Ports

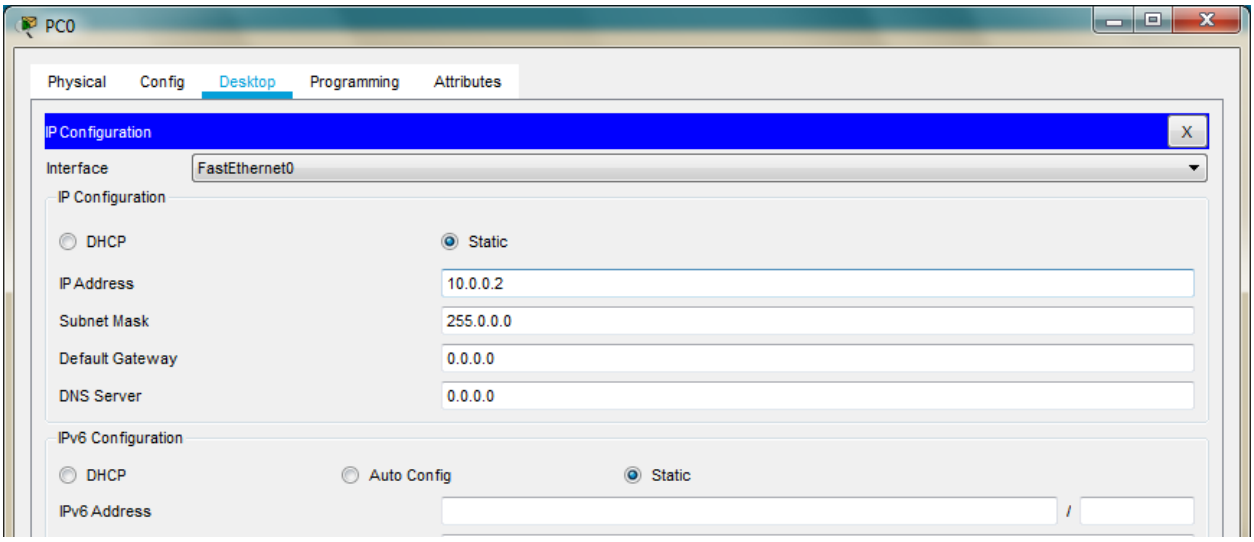
SWA(config-if-range)#exit
SWA(config)#interface range f0/1-22
SWA(config-if-range)#switchport port-security maximum 2
SWA(config-if-range)#switchport port-security violation shutdown
SWA(config-if-range)#switchport port-security mac-address sticky

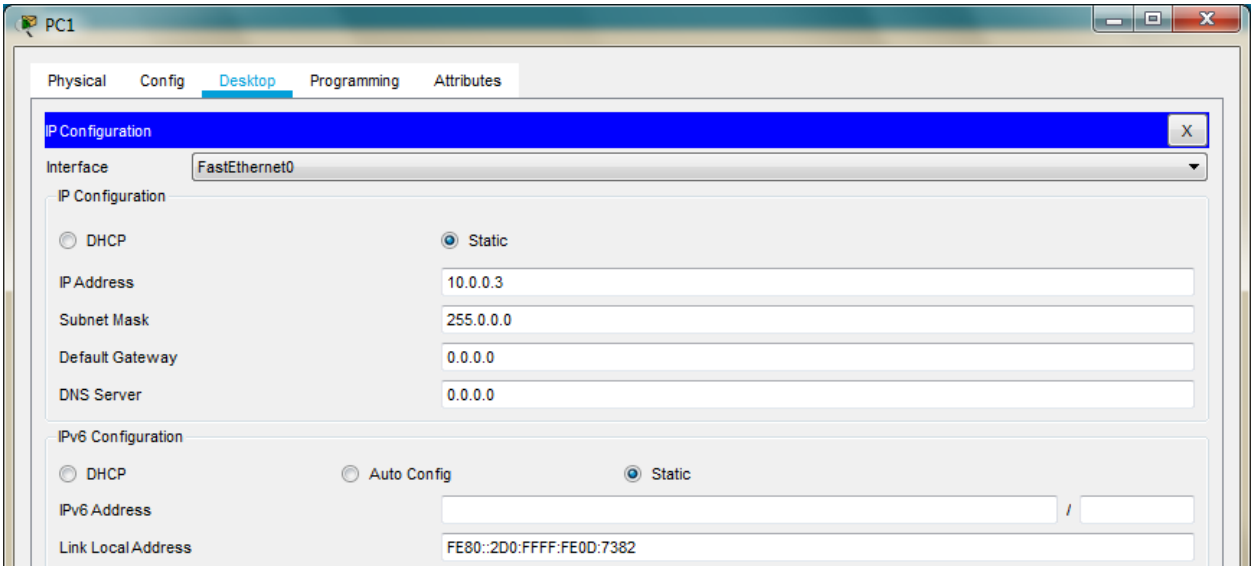
SWB(config-if-range)#exit
SWB(config)#interface range f0/1-22
SWB(config-if-range)#switchport port-security maximum 2
SWB(config-if-range)#switchport port-security violation shutdown
SWB(config-if-range)#switchport port-security mac-address sticky

Verify Port Security (type the commands in SWA) and observe the output
SWA#show port-security interface f0/1

We get the following output
Port Security : Enabled
Port Status : Secure-up
Violation Mode : Shutdown
Aging Time : 0 mins
Aging Type : Absolute
SecureStatic Address Aging : Disabled
Maximum MAC Addresses : 2
Total MAC Addresses : 0
Configured MAC Addresses : 0
Sticky MAC Addresses : 0
Last Source Address:Vlan : 0000.0000.0000:0
Security Violation Count : 0

Now we configure the PCs and Give assign IP address to any two PCs





Now we ping one of the PC from the other and then type the following command in SWA

SWA#show port-security interface f0/1

We get the following output

SWA#show port-security interface f0/1
Port Security : Enabled
Port Status : Secure-up
Violation Mode : Shutdown
Aging Time : 0 mins
Aging Type : Absolute
SecureStatic Address Aging : Disabled
Maximum MAC Addresses : 2

Total MAC Addresses : 1
Configured MAC Addresses : 0
Sticky MAC Addresses : 1
Last Source Address:Vlan : 0001.6406.2AAE:1
Security Violation Count : 0

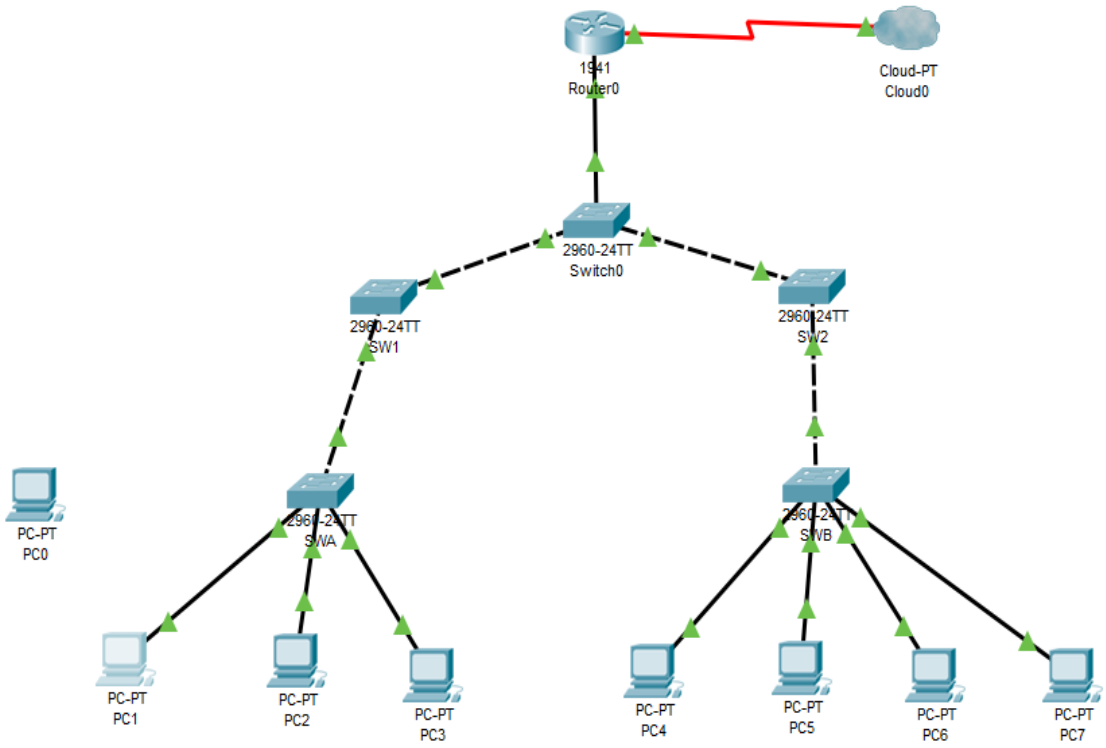
Finally we disable the unused ports

SWA#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
SWA(config)#interface range f0/5-22
SWA(config-if-range)#shutdown

SWB#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
SWB(config)#interface range f0/5-22
SWB(config-if-range)#shutdown

Practical 9: Layer 2 VLAN Security

We use the following topology

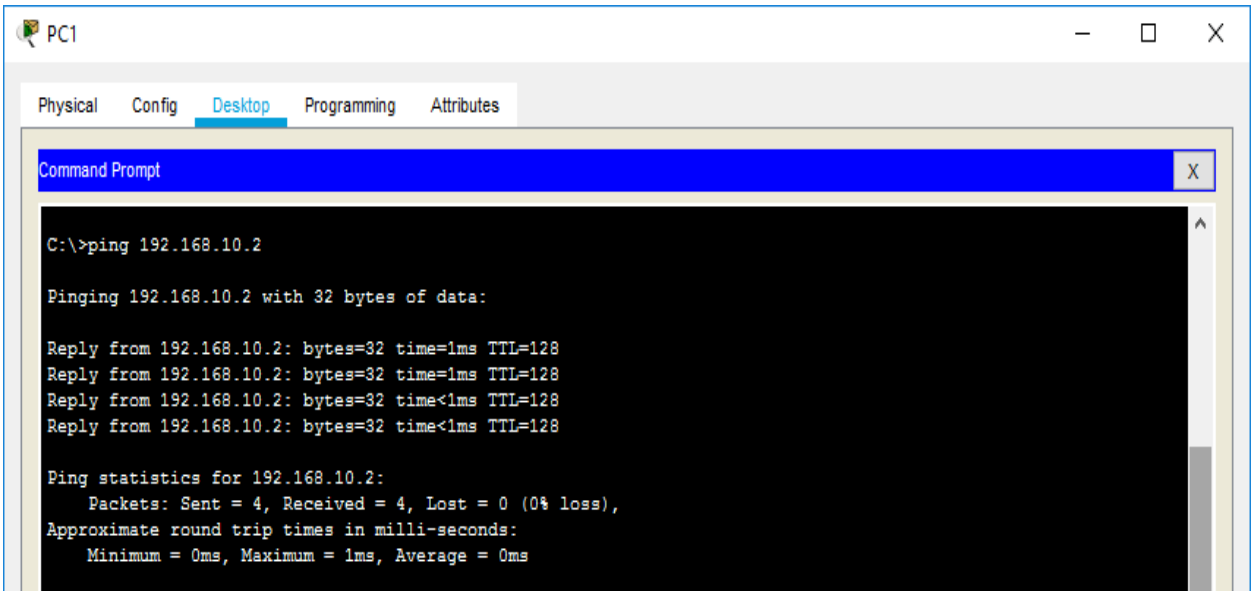


Assign IP addresses to the PCs

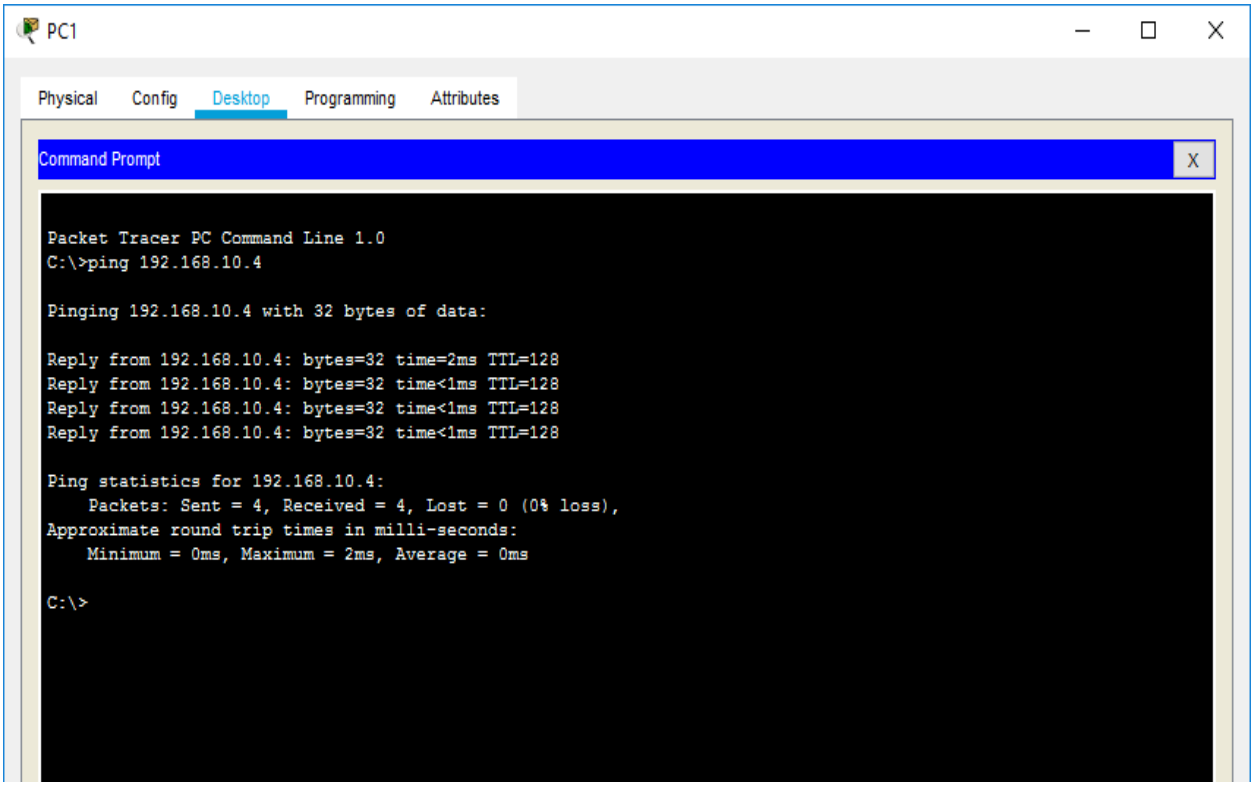
PC1	192.168.10.1
PC2	192.168.10.2
PC3	192.168.10.3
PC4	192.168.10.4
PC5	192.168.10.5
PC6	192.168.10.6
PC7	192.168.10.7
PC8	192.168.10.10

VERIFY CONNECTIVITY

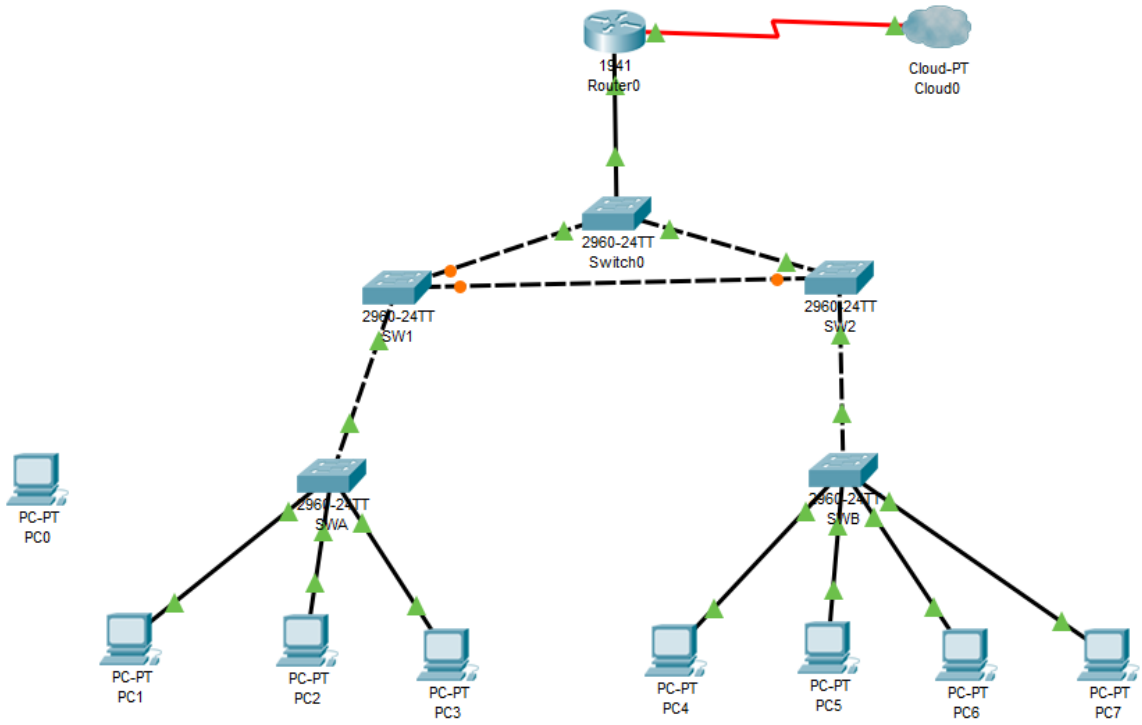
We Ping the PC2 from PC1



We Ping the PC4 from PC1



CREATE A REDUNDANT LINK BETWEEN SW1 and SW2 (f0/23 and f0/23)



Enable trunking, including all trunk security mechanisms on the link between SW-1 and SW-2.

Type the following commands in the CLI mode of SW1 and SW2

```
SW1(config)#interface f0/23
SW1(config-if)#switchport mode trunk
SW1(config-if)#switchport trunk native vlan 15
SW1(config-if)#switchport nonegotiate
SW1(config-if)#no shutdown
```

```
SW2(config)#interface f0/23
SW2(config-if)#switchport mode trunk
SW2(config-if)#switchport trunk native vlan 15
SW2(config-if)#switchport nonegotiate
SW2(config-if)#no shutdown
```

Enable VLAN 20 as a Management VLAN

```
SWA>
SWA>enable
SWA#conf
SWA#configure ter
SWA#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
SWA(config)#vlan 20
SWA(config-vlan)#exit
SWA(config-if)#ip address 192.168.20.1 255.255.255.0
SWA(config-if)#

SWB>enable
SWB#configure terminal
SWB(config)#vlan 20
SWB(config-vlan)#exit
SWB(config)#interface vlan 20
SWB(config-if)#ip address 192.168.20.2 255.255.255.0

SW1(config)#vlan 20
SW1(config-vlan)#exit
SW1(config)#interface vlan 20
SW1(config-if)#ip address 192.168.20.3 255.255.255.0


SW2(config)#vlan 20
SW2(config-vlan)#exit
SW2(config)#interface vlan 20
SW2(config-if)#ip address 192.168.20.4 255.255.255.0


Switch>
Switch>enable
Switch#configure terminal
Switch(config)#interface vlan 20
Switch(config-if)#ip address 192.168.20.5 255.255.255.0
```

Connect and configure the management PC.

Connect the management PC to **SW-A** port F0/5 and ensure that it is assigned an available IP address within the 192.168.10.10

Type the following commands in the Router
Router>

```
Router>en
Router>enable
Router#confi
Router#configure ter
Router#configure terminal
Router(config)#interface g0/0.3
Router(config-subif)#
Router(config-subif)#encapsulation dot1Q 20
Router(config-subif)#exit
Router(config)#interface g0/0.3
Router(config-subif)#ip address 192.168.20.100 255.255.255.0
Router(config-subif)#exit
Router(config)#
```

Enable security

R1(config)# **access-list 101 deny ip any 192.168.20.0 0.0.0.255** R1(config)# **access-list 101 permit ip any any**
R1(config)# **access-list 102 permit ip host 192.168.20.50 any**

R1(config)# **interface g0/0.1**
R1(config-subif)# **ip access-group 101 in**
R1(config-subif)# **interface g0/0.2**
R1(config-subif)# **ip access-group 101 in**
R1(config-subif)# **line vty 0 4**
R1(config-line)# **access-class 102 in**

R1(config-line)# **exit**

```
R1(config)#ip domain-name smile.com
R1(config)#crypto key generate rsa
The name for the keys will be:R1.smile.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]

R1(config)#aaa authentication login ssh-admin local
R1(config)#line vty 0 4
R1(config-line)#login authentication ssh-admin
R1(config-line)#transport input ssh
R1(config-line)#end
```

Verify security.

Verify only the Management PC can access the router. Use SSH to access R1 with username SSHadmin

No password set

.

PC> ssh -l SSHadmin 192.168.20.100