Practical No. 6

Title : IP Security (IPSec) Configuration

Aim: To Configure IPSec on network devices to provide secure communication and protect against unauthorized access and attacks.

Theory: Some theoretical aspects of IPSec and the concept of an IPSec

VPN tunnel:

1. IPSec Overview: - IPSec (Internet Protocol Security) is a comprehensive suite of protocols and standards used for securing communication over IP networks, such as the Internet. - It ensures the confidentiality, integrity, and authenticity of data transmitted between devices or networks.

2. Security Goals of IPSec: - Confidentiality: IPSec achieves data privacy through encryption. - Integrity: It guarantees that data remains unaltered during transit. - Authentication: IPSec verifies the identity of communicating parties to prevent unauthorized access and impersonation.

3. Components of IPSec: - IPSec comprises multiple protocols and elements, including Authentication Header (AH), Encapsulating Security Payload (ESP), Security Associations (SAs), and key management protocols.

4. IPSec VPN Tunnel: - An IPSec VPN tunnel is a secure, encrypted connection established between two endpoints or networks over the Internet or untrusted networks. - It is created using the IPSec suite to provide a secure and private channel for data transmission.

5. Establishing a VPN Tunnel: - The process begins with the negotiation and establishment of Security Associations (SAs) between the endpoints. - These SAs define parameters like encryption methods, authentication, and shared keys.

6. Modes of Operation: - VPN tunnels can operate in either Transport Mode (securing data payload) or Tunnel Mode (securing entire IP packets, including headers). - Transport Mode is often used for host-to-host communication, while Tunnel Mode is suitable for network-to-network connections.

7. Data Encryption and Authentication: - Data transmitted through the VPN tunnel is encrypted using algorithms specified in the SAs, ensuring data privacy. - Authentication and data integrity checks prevent tampering or unauthorized access.

8. Routing and Secure Communication: - Once established, the VPN tunnel allows secure data routing between the endpoints or networks Applications and services on either side can communicate securely, even over untrusted networks like the Internet.

9. Use Cases: - IPSec VPN tunnels are used for various purposes, including remote access VPNs, site-to-site VPNs, secure data transfer, and protecting real-time communication like VoIP and video conferencing.

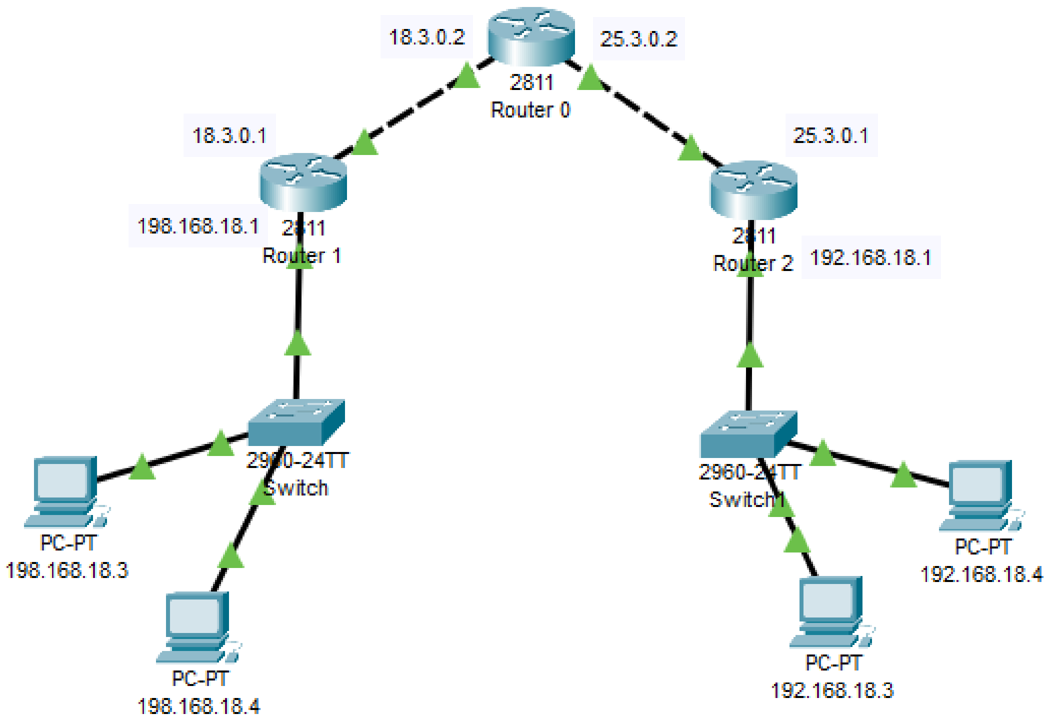
10. Key Management: - Secure key management is critical for the long-term security of IPSec VPN tunnels. - Keys can be generated manually or through automated key exchange protocols like Internet Key Exchange (IKE).

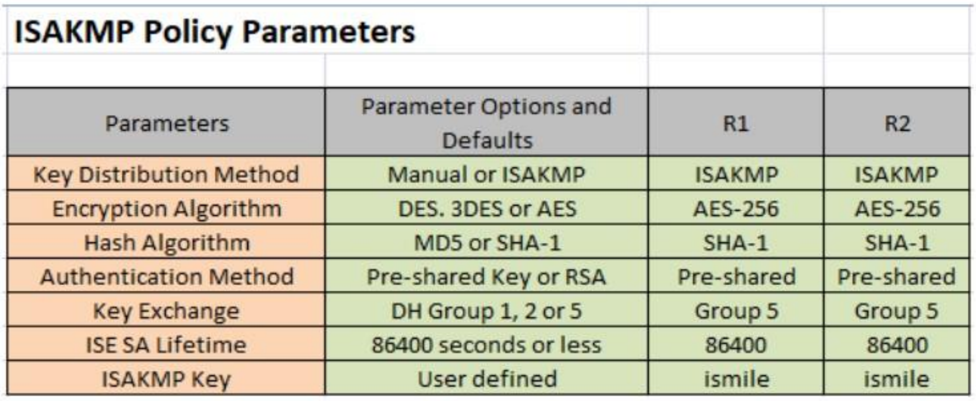
11. Security Policies: - Organizations define security policies that determine when and how IPSec should be applied to protect specific types of traffic or communication.

12. Interoperability: - IPSec is widely adopted, ensuring interoperability between different vendors' equipment and making it a versatile choice for securing networks and data. Understanding the principles of IPSec and IPSec VPN tunnels is essential for designing, deploying, and managing secure communication in various network environments, ensuring data remains confidential, unaltered, and protected from unauthorized access.

Topology: We use the following topology for the present case

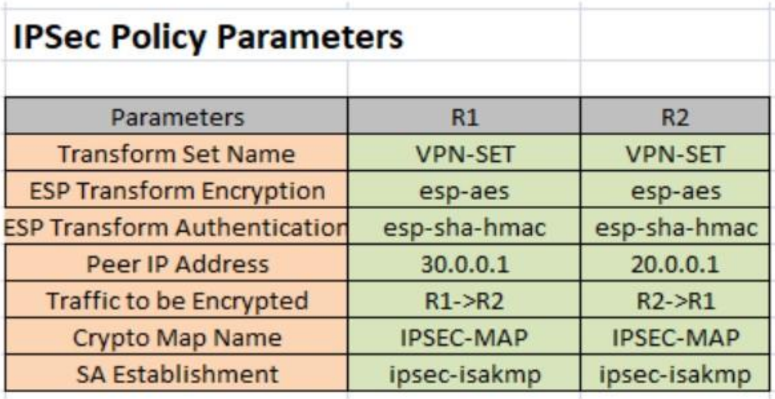
NetWork Diagram:





ISAKMP Policy Parameters

Parameters	Parameter Options and Defaults	R1	R2
Key Distribution Method	Manual or ISAKMP	ISAKMP	ISAKMP
Encryption Algorithm	DES. 3DES or AES	AES-256	AES-256
Hash Algorithm	MD5 or SHA-1	SHA-1	SHA-1
Authentication Method	Pre-shared Key or RSA	Pre-shared	Pre-shared
Key Exchange	DH Group 1, 2 or 5	Group 5	Group 5
ISE SA Lifetime	86400 seconds or less	86400	86400
ISAKMP Key	User defined	ismile	ismile

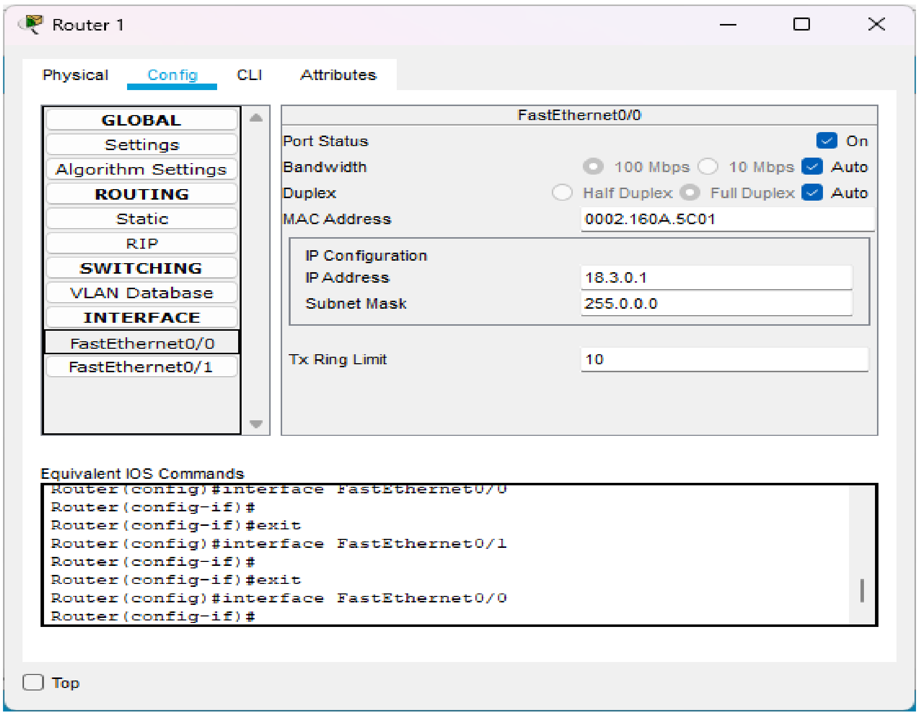


IPSec Policy Parameters

Parameters	R1	R2
Transform Set Name	VPN-SET	VPN-SET
ESP Transform Encryption	esp-aes	esp-aes
ESP Transform Authentication	esp-sha-hmac	esp-sha-hmac
Peer IP Address	30.0.0.1	20.0.0.1
Traffic to be Encrypted	R1->R2	R2->R1
Crypto Map Name	IPSEC-MAP	IPSEC-MAP
SA Establishment	ipsec-isakmp	ipsec-isakmp

Router 1 Configuration

Interface GigabitEthernet0/0:



FastEthernet0/0

Port Status ☑ On

Bandwidth ○ 100 Mbps ○ 10 Mbps ☑ Auto

Duplex ○ Half Duplex ○ Full Duplex ☑ Auto

MAC Address 0002.160A.5C01

IP Configuration

IP Address 18.3.0.1

Subnet Mask 255.0.0.0

Tx Ring Limit 10

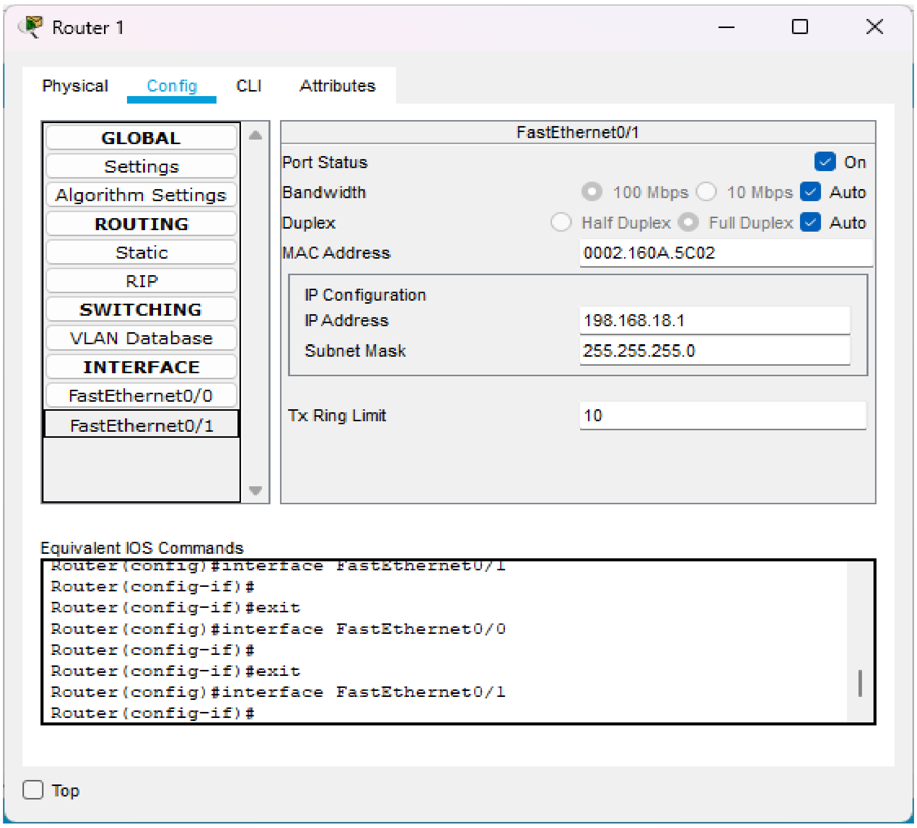
Equivalent IOS Commands

```
Router(config)#interface FastEthernet0/0
Router(config-if)#
Router(config-if)#exit
Router(config)#interface FastEthernet0/1
Router(config-if)#
Router(config-if)#exit
Router(config)#interface FastEthernet0/0
Router(config-if)#
```

☐ Top

Router 1 Configuration

Interface GigabitEthernet0/1:



FastEthernet0/1

Port Status ☑ On

Bandwidth ○ 100 Mbps ○ 10 Mbps ☑ Auto

Duplex ○ Half Duplex ○ Full Duplex ☑ Auto

MAC Address 0002.160A.5C02

IP Configuration

IP Address 198.168.18.1

Subnet Mask 255.255.255.0

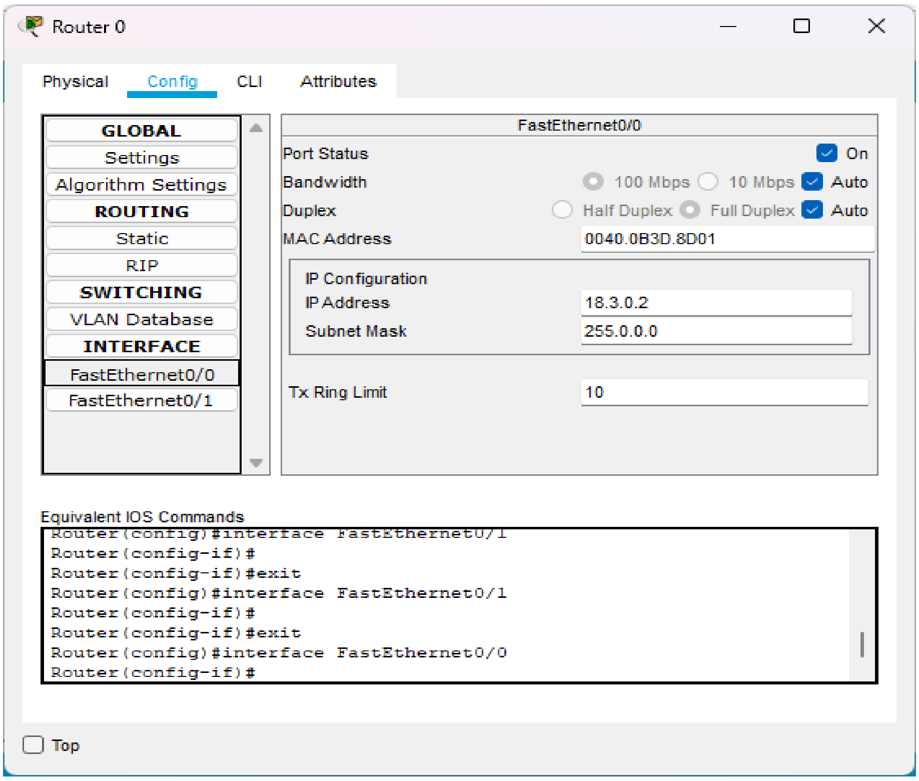
Tx Ring Limit 10

```
Router(config)#interface FastEthernet0/1
Router(config-if)#
Router(config-if)#exit
Router(config)#interface FastEthernet0/0
Router(config-if)#
Router(config-if)#exit
Router(config)#interface FastEthernet0/1
Router(config-if)#
```

□ Top

Router 0 Configuration

Interface GigabitEthernet0/0:



FastEthernet0/0

Port Status ☑ On

Bandwidth ○ 100 Mbps ○ 10 Mbps ☑ Auto

Duplex ○ Half Duplex ○ Full Duplex ☑ Auto

MAC Address 0040.0B3D.8D01

IP Configuration

IP Address 18.3.0.2

Subnet Mask 255.0.0.0

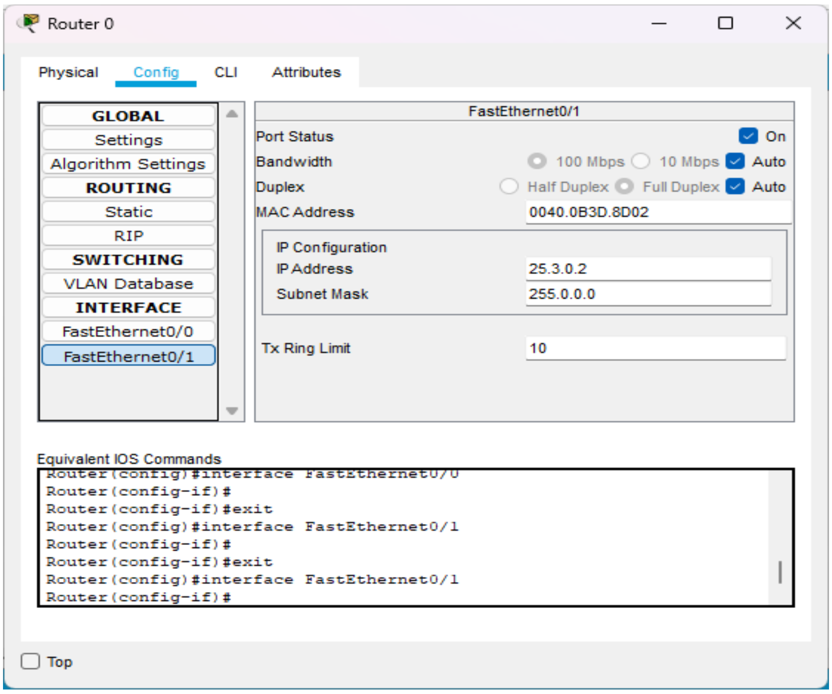
Tx Ring Limit 10

```
Router(config)#interface FastEthernet0/1
Router(config-if)#
Router(config-if)#exit
Router(config)#interface FastEthernet0/1
Router(config-if)#
Router(config-if)#exit
Router(config)#interface FastEthernet0/0
Router(config-if)#
```

□ Top

Router 0 Configuration

Interface GigabitEthernet0/1:



FastEthernet0/1

Port Status ☑ On

Bandwidth ○ 100 Mbps ○ 10 Mbps ☑ Auto

Duplex ○ Half Duplex ○ Full Duplex ☑ Auto

MAC Address 0040.0B3D.8D02

IP Configuration

IP Address 25.3.0.2

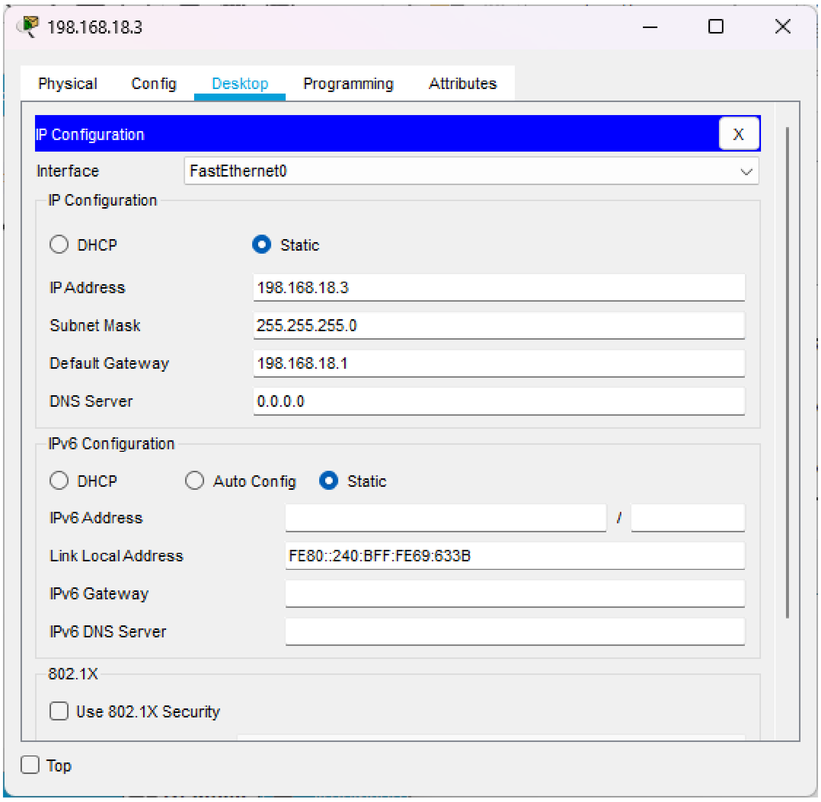
Subnet Mask 255.0.0.0

Tx Ring Limit 10

Equivalent IOS Commands

```
Router(config)#interface FastEthernet0/0
Router(config-if)#
Router(config-if)#exit
Router(config)#interface FastEthernet0/1
Router(config-if)#
Router(config-if)#exit
Router(config)#interface FastEthernet0/1
Router(config-if)#
```

PC 1 Configuration



IP Configuration

Interface FastEthernet0

IP Configuration

○ DHCP ● Static

IP Address 198.168.18.3

Subnet Mask 255.255.255.0

Default Gateway 198.168.18.1

DNS Server 0.0.0.0

IPv6 Configuration

○ DHCP ○ Auto Config ● Static

IPv6 Address /

Link Local Address FE80::240:BFF:FE69:633B

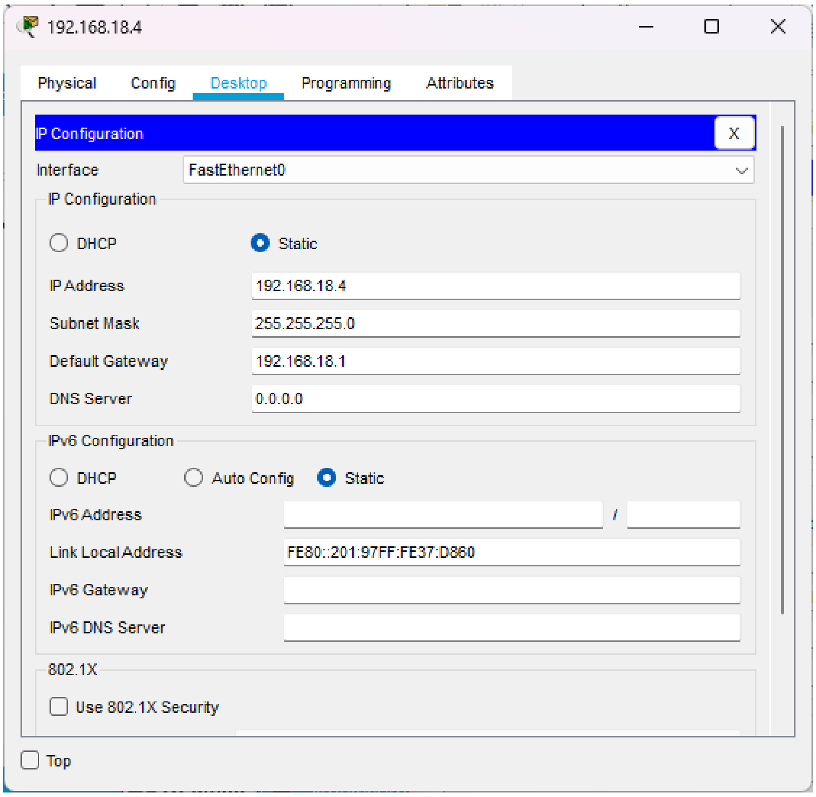
IPv6 Gateway

IPv6 DNS Server

802.1X

□ Use 802.1X Security

PC 2 Configuration



192.168.18.4

Physical | Config | Desktop | Programming | Attributes

IP Configuration

Interface: FastEthernet0

IP Configuration

○ DHCP ● Static

IP Address: 192.168.18.4

Subnet Mask: 255.255.255.0

Default Gateway: 192.168.18.1

DNS Server: 0.0.0.0

IPv6 Configuration

○ DHCP ○ Auto Config ● Static

IPv6 Address: /

Link Local Address: FE80::201:97FF:FE37:D860

IPv6 Gateway:

IPv6 DNS Server:

802.1X

□ Use 802.1X Security

□ Top

Checking and Enabling the Security features in Router R1 and R2:

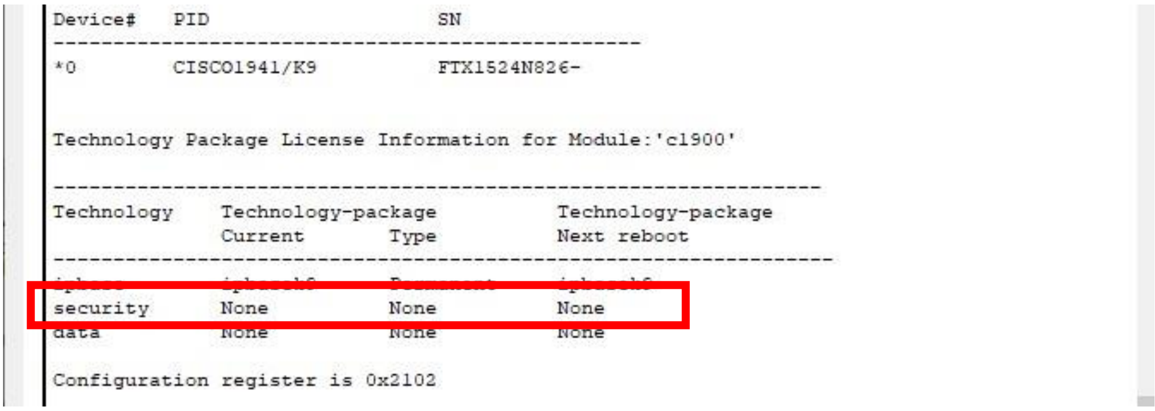
Enter the following command in the CLI mode of Router1

Router(config)#ip route 0.0.0.0 0.0.0.0 20.0.0.2

Router(config)#hostname R1

R1(config)#exit

R1#show version



```
Device#   PID                   SN
-------------------------------------------------
*0        CISCO1941/K9          FTX1524N826-


Technology Package License Information for Module:'c1900'

----------------------------------------------------------------
Technology    Technology-package           Technology-package
              Current       Type           Next reboot
-----------------------------------------------------------------
ipbase        ipbasek9      Permanent      ipbasek9
security      None          None           None
data          None          None           None

Configuration register is 0x2102
```

(We see that the security feature is not enabled, hence we need to enable the security package

R1#

R1#configure terminal

Enter configuration commands, one per line. End with CNTL/Z.

R1(config)#

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

R1(config)#exit

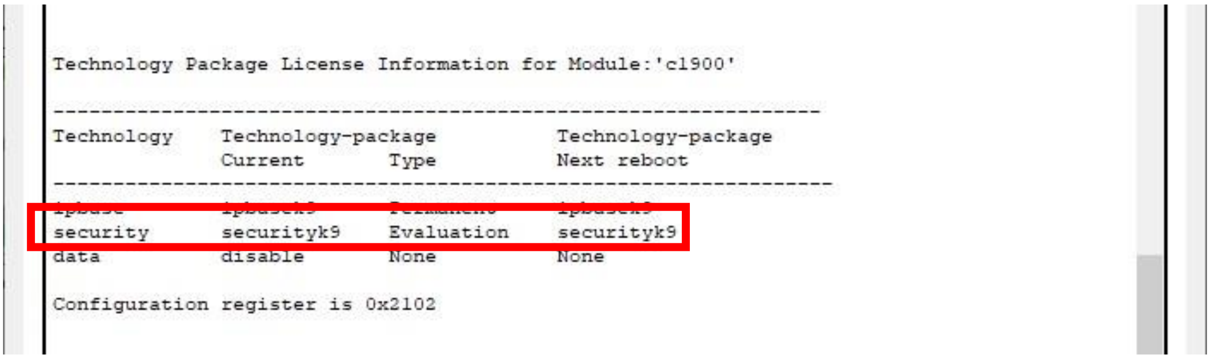
R1#

R1#copy run startup-config

R1#reload

R1>enable

R1#show version



```
Technology Package License Information for Module:'c1900'

-----------------------------------------------------------------
Technology    Technology-package           Technology-package
              Current       Type           Next reboot
------------------------------------------------------------------
ipbase        ipbasek9      Permanent      ipbasek9
security      securityk9    Evaluation     securityk9
data          disable       None           None

Configuration register is 0x2102
```

(The security package is enabled)

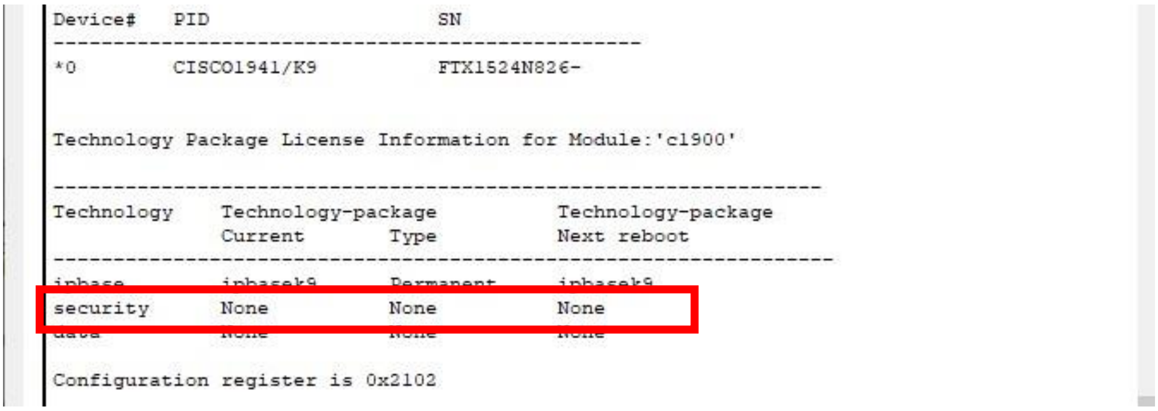
Enter the following command in the CLI mode of Router2

Router(config)#ip route 0.0.0.0 0.0.0.0 30.0.0.2

Router(config)#hostname R2

R2(config)#exit

R2#show version



```
Device#   PID                   SN
--------------------------------------------------
*0        CISCO1941/K9          FTX1524N826-


Technology Package License Information for Module:'c1900'

-----------------------------------------------------------------
Technology    Technology-package           Technology-package
              Current       Type           Next reboot
------------------------------------------------------------------
ipbase        ipbasek9      Permanent      ipbasek9
security      None          None           None
data          None          None           None

Configuration register is 0x2102
```

(We see that the security feature is not enabled, hence we need to enable the security package

R2#

R2#configure terminal

Enter configuration commands, one per line. End with CNTL/Z.

R2(config)#

R2(config)#license boot module c1900 technology-package securityk9

R2(config)#exit

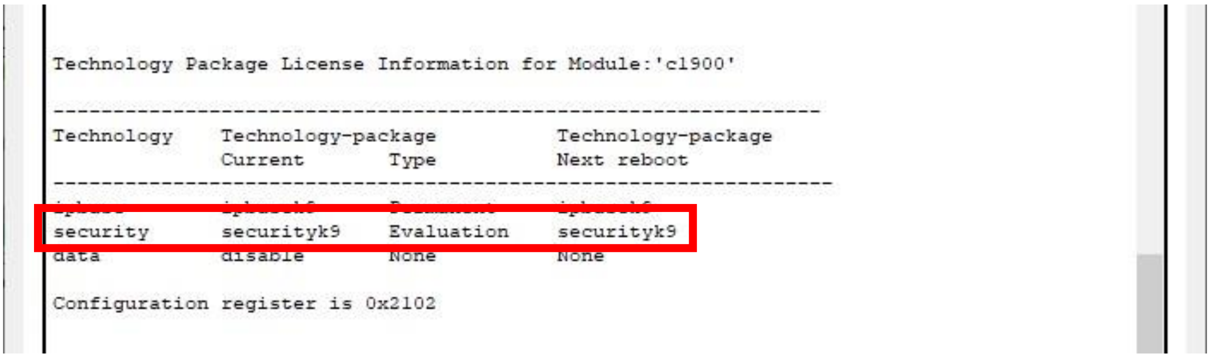
R2#

R2#copy run startup-config

R2#reload

R2>enable

R2#show version



```
Technology Package License Information for Module:'c1900'

-----------------------------------------------------------------
Technology    Technology-package           Technology-package
              Current       Type           Next reboot
------------------------------------------------------------------
ipbase        ipbasek9      Permanent      ipbasek9
security      securityk9    Evaluation     securityk9
data          disable       None           None

Configuration register is 0x2102
```

(The security package is enabled)

Enter the following command in the CLI mode of Router0

Router>enable

Router#configure terminal

Router(config)#hostname R0

R0(config)#

Defining the Hostname for all Routers and Configuring the Routers R1 and R2 for IPSec VPN tunnel R1#configure terminal

R1(config)#access-list 100 permit ip 192.168.1.0 0.0.0.255 192.168.2.0 0.0.0.255

R1(config)#crypto isakmp policy 10

R1(config-isakmp)#encryption aes 256

R1(config-isakmp)#authentication pre-share

R1(config-isakmp)#group 5

R1(config-isakmp)#exit

R1(config)#crypto isakmp key ismile address 30.0.0.1

R1(config)#crypto ipsec transform-set R1->R2 esp-aes 256 esp-sha-hmac
R1(config)#

```
R2#
R2#configure terminal
R2(config)#access-list 100 permit ip 192.168.2.0 0.0.0.255 192.168.1.0 0.0.0.255
R2(config)#crypto isakmp policy 10
R2(config-isakmp)#encryption aes 256
R2(config-isakmp)#authentication pre-share
R2(config-isakmp)#group 5
R2(config-isakmp)#exit
R2(config)#crypto isakmp key ismile address 20.0.0.1
R2(config)#crypto ipsec transform-set R2->R1 esp-aes 256 esp-sha-hmac
R2(config)#
```

```
R1>enable
R1#configure terminal
R1(config)#crypto map IPSEC-MAP 10 ipsec-isakmp
R1(config-crypto-map)#set peer 30.0.0.1
R1(config-crypto-map)#set pfs group5
R1(config-crypto-map)#set security-association lifetime seconds 86400
R1(config-crypto-map)#set transform-set R1->R2
R1(config-crypto-map)#match address 100
R1(config-crypto-map)#exit
R1(config)#interface g0/0
R1(config-if)#crypto map IPSEC-MAP
```

```
R2>enable
R2#configure terminal
R2(config)#crypto map IPSEC-MAP 10 ipsec-isakmp
R2(config-crypto-map)#set peer 20.0.0.1
R2(config-crypto-map)#set pfs group5
R2(config-crypto-map)#set security-association lifetime seconds 86400
R2(config-crypto-map)#set transform-set R2->R1
R2(config-crypto-map)#match address 100
```

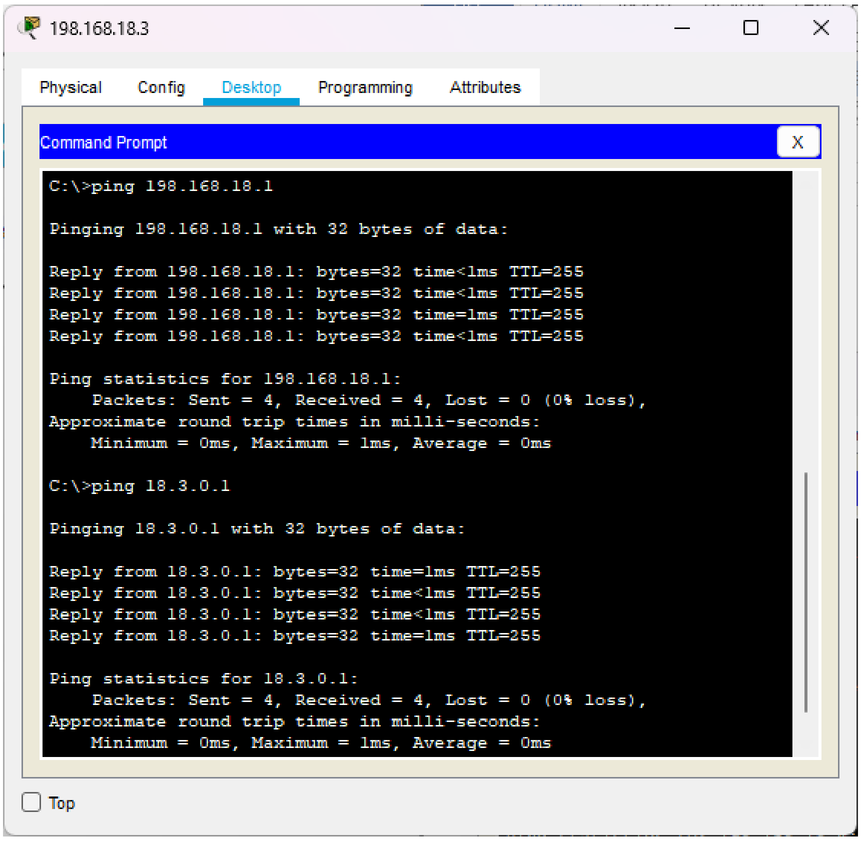
R2(config-crypto-map)#exit

R2(config)#interface g0/0

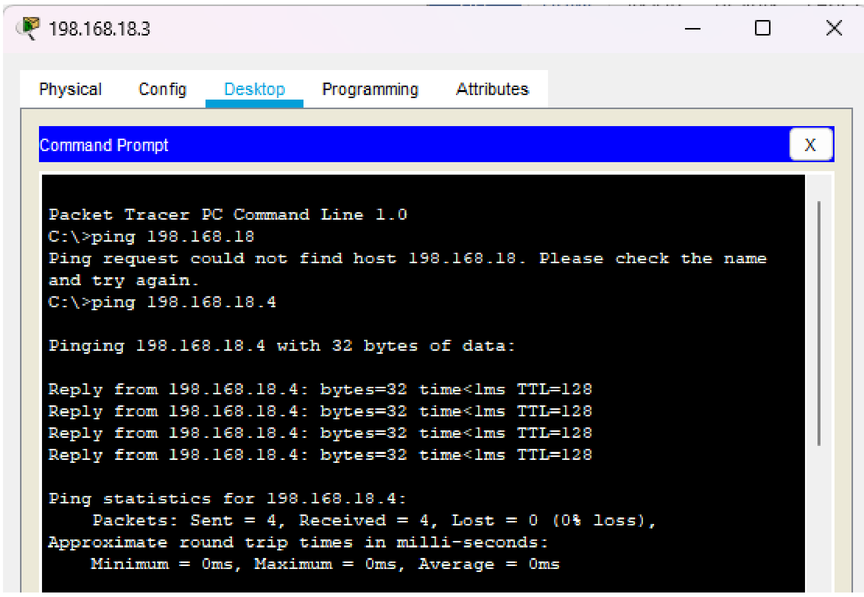
R2(config-if)#crypto map IPSEC-MAP

We verify the working of the IPSec VPN tunnel using the ping command as follows

Pinging PC2(198.168.18.3) from PC1 and then PC1(18.3.0.1) from PC2



```
C:\>ping 198.168.18.1

Pinging 198.168.18.1 with 32 bytes of data:

Reply from 198.168.18.1: bytes=32 time<1ms TTL=255
Reply from 198.168.18.1: bytes=32 time<1ms TTL=255
Reply from 198.168.18.1: bytes=32 time=1ms TTL=255
Reply from 198.168.18.1: bytes=32 time<1ms TTL=255

Ping statistics for 198.168.18.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\>ping 18.3.0.1

Pinging 18.3.0.1 with 32 bytes of data:

Reply from 18.3.0.1: bytes=32 time=1ms TTL=255
Reply from 18.3.0.1: bytes=32 time<1ms TTL=255
Reply from 18.3.0.1: bytes=32 time<1ms TTL=255
Reply from 18.3.0.1: bytes=32 time=1ms TTL=255

Ping statistics for 18.3.0.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms
```



```
Packet Tracer PC Command Line 1.0
C:\>ping 198.168.18
Ping request could not find host 198.168.18. Please check the name
and try again.
C:\>ping 198.168.18.4

Pinging 198.168.18.4 with 32 bytes of data:

Reply from 198.168.18.4: bytes=32 time<1ms TTL=128
Reply from 198.168.18.4: bytes=32 time<1ms TTL=128
Reply from 198.168.18.4: bytes=32 time<1ms TTL=128
Reply from 198.168.18.4: bytes=32 time<1ms TTL=128

Ping statistics for 198.168.18.4:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
```