Configuring Dynamic Multipoint VPN Using GRE Over IPsec With OSPF, NAT, and Cisco IOS Firewall

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Introduction

This document provides a sample configuration for Dynamic Multipoint VPN (DMVPN) using generic routing encapsulation (GRE) over IPsec with Open Shortest Path First (OSPF), Network Address Translation (NAT), and Cisco IOS® Firewall.

Prerequisites

Requirements

Before a multipoint GRE (mGRE) and IPsec tunnel can be established, you must define an Internet Key Exchange (IKE) policy by using the **crypto isakmp policy** command.

Note: Use the Command Lookup Tool (registered customers only) to obtain more information on the commands used in this section.

Components Used

The information in this document is based on these software and hardware versions:

- Cisco IOS® Software Release 12.2(15)T1 on the hub router and Cisco IOS Software Release 12.3(1.6) on the spoke routers
- Cisco 3620 as hub router, two Cisco 1720 routers and one Cisco 3620 router as spoke routers

The information in this document was created from the devices in a specific lab environment. All of the devices used in this document started with a cleared (default) configuration. If your network is live, make sure that you understand the potential impact of any command.

Conventions

Refer to the Cisco Technical Tips Conventions for more information on document conventions.

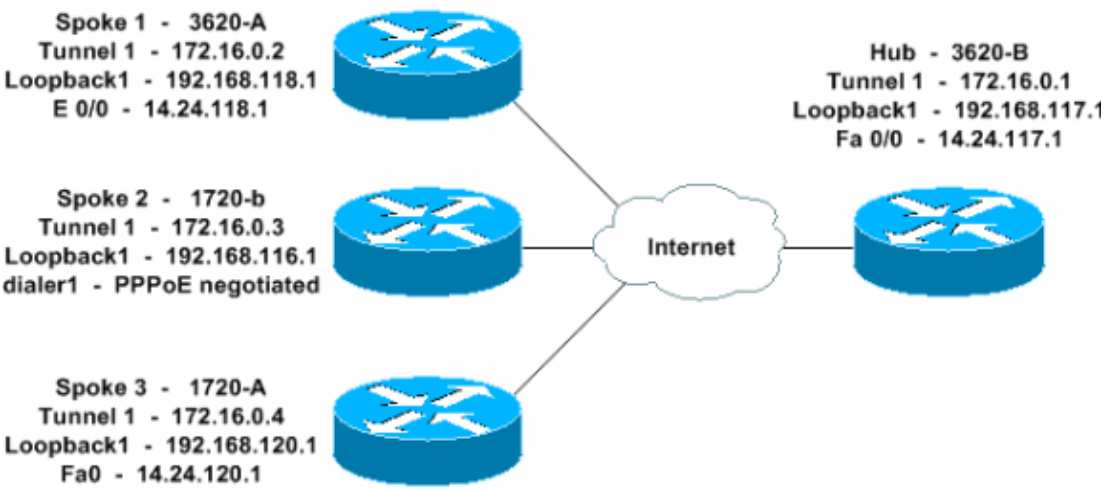
Configure

In this section, you are presented with the information to configure the features described in this document.

Note: Use the Command Lookup Tool (registered customers only) to obtain more information on the commands used in this section.

Network Diagram

This document uses this network setup.



Configurations

This document uses these configurations.

- Hub − 3620−B
- Spoke 1 − 3620−A
- Spoke 2 − 1720−b
- Spoke 3 − 1720−A

Hub − 3620−B

```
W2N-6.16-3620-B#write terminal
Building configuration...

Current configuration : 2613 bytes
!
version 12.2
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname W2N-6.16-3620-B
!
logging queue-limit 100
!
memory-size iomem 10
```

```
ip subnet-zero
!
!
ip cef
no ip domain lookup
!

!--- This is the Cisco IOS Firewall configuration and what to inspect.
!--- This is applied outbound on the external interface.

ip inspect name in2out rcmd
ip inspect name in2out ftp
ip inspect name in2out tftp
ip inspect name in2out tcp timeout 43200
ip inspect name in2out http
ip inspect name in2out udp
ip audit po max-events 100
!
!
!

!--- Create an Internet Security Association and Key Management
!--- Protocol (ISAKMP) policy for Phase 1 negotiations.

crypto isakmp policy 5
 authentication pre-share
 group 2

!--- Add dynamic pre-shared key.

crypto isakmp key dmvpnkey address 0.0.0.0 0.0.0.0
crypto isakmp nat keepalive 20
!
!

!--- Create the Phase 2 policy for actual data encryption.

crypto ipsec transform-set dmvpnset esp-3des esp-sha-hmac
!

!--- Create an IPsec profile to be applied dynamically
!--- to the GRE over IPsec tunnels.

crypto ipsec profile dmvpnprof
 set transform-set dmvpnset
!
!
!
!
!
!
!
!
!
!
!
no voice hpi capture buffer
no voice hpi capture destination
!
!
mta receive maximum-recipients 0
!
!
!

!--- This is the inbound interface.
```

```
interface Loopback1
 ip address 192.168.117.1 255.255.255.0
 ip nat inside
!

!--- Create a GRE tunnel template to be applied
!--- to all the dynamically created GRE tunnels.

interface Tunnel1
 description MULTI-POINT GRE TUNNEL for BRANCHES
 bandwidth 1000
 ip address 172.16.0.1 255.255.255.0
 no ip redirects
 ip mtu 1416
 ip nhrp authentication dmvpn
 ip nhrp map multicast dynamic
 ip nhrp network-id 99
 ip nhrp holdtime 300
 no ip route-cache
 ip ospf network broadcast
 no ip mroute-cache
 delay 1000
 tunnel source FastEthernet0/0
 tunnel mode gre multipoint
 tunnel key 100000
 tunnel protection ipsec profile dmvpnprof
!

!--- This is the outbound interface.

interface FastEthernet0/0
 ip address 14.24.117.1 255.255.0.0
 ip nat outside
 ip access-group 100 in
 ip inspect in2out out
 no ip mroute-cache
 duplex auto
 speed auto
!
interface Serial0/0
 no ip address
 shutdown
 clockrate 2000000
 no fair-queue
!
interface FastEthernet0/1
 no ip address
 no ip mroute-cache
 duplex auto
 speed auto
!

!--- Enable a routing protocol to send/receive dynamic
!--- updates about the private networks.

router ospf 1
 log-adjacency-changes
 network 172.16.0.0 0.0.0.255 area 0
 network 192.168.117.0 0.0.0.255 area 0
!

!--- Except the private network traffic from the NAT process.

ip nat inside source route-map nonat interface FastEthernet0/0 overload
ip http server
```

```
no ip http secure-server
ip classless
ip route 0.0.0.0 0.0.0.0 14.24.1.1
ip route 2.0.0.0 255.0.0.0 14.24.121.1
!
!
!

!--- Allow ISAKMP, ESP, and GRE traffic inbound.
!--- Cisco IOS Firewall opens other inbound access as needed.

access-list 100 permit udp any host 14.24.117.1 eq 500
access-list 100 premit esp any host 14.24.117.1
access-list 100 permit gre any host 14.24.117.1
access-list 100 deny ip any any


!--- Except the private network traffic from the NAT process.

access-list 110 deny   ip 192.168.117.0 0.0.0.255 192.168.118.0 0.0.0.255
access-list 110 deny   ip 192.168.117.0 0.0.0.255 192.168.116.0 0.0.0.255
access-list 110 deny   ip 192.168.117.0 0.0.0.255 192.168.120.0 0.0.0.255
access-list 110 permit ip 192.168.117.0 0.0.0.255 any
!

!--- Except the private network traffic from the NAT process.

route-map nonat permit 10
 match ip address 110
!
call rsvp-sync
!
!
mgcp profile default
!
dial-peer cor custom
!
!
!
!
!
line con 0
 exec-timeout 0 0
line aux 0
line vty 0 4
 login
!
!
end

W2N-6.16-3620-B#
```

Spoke 1 − 3620−A

```
W2N-6.16-3620-A#write terminal
Building configuration...

Current configuration : 2678 bytes
!
version 12.2
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname W2N-6.16-3620-A
```

```
!
boot system flash slot0:c3620-ik9o3s7-mz.122-15.T1.bin
logging queue-limit 100
!
memory-size iomem 15
ip subnet-zero
!
!
ip cef
no ip domain lookup
!

!--- This is the Cisco IOS Firewall configuration and what to inspect.
!--- This is applied outbound on the external interface.

ip inspect name in2out rcmd
ip inspect name in2out tftp
ip inspect name in2out udp
ip inspect name in2out tcp timeout 43200
ip inspect name in2out realaudio
ip inspect name in2out vdolive
ip inspect name in2out netshow
ip audit po max-events 100
!
!
!

!--- Create an ISAKMP policy for
!--- Phase 1 negotiations.

crypto isakmp policy 5
 authentication pre-share
 group 2

!--- Add dynamic pre-shared key.

crypto isakmp key dmvpnkey address 0.0.0.0 0.0.0.0
!
!

!--- Create the Phase 2 policy for actual data encryption.

crypto ipsec transform-set dmvpnset esp-3des esp-sha-hmac
!

!--- Create an IPsec profile to be applied dynamically
!--- to the GRE over IPsec tunnels.

crypto ipsec profile dmvpnprof
 set transform-set dmvpnset
!
!
!
!
!
!
!
!
!
!
!
no voice hpi capture buffer
no voice hpi capture destination
!
!
mta receive maximum-recipients 0
```

```
!
!
!

!--- This is the inbound interface.

interface Loopback1
 ip address 192.168.118.1 255.255.255.0
 ip nat inside
!

!--- Create a GRE tunnel template to be applied to
!--- all the dynamically created GRE tunnels.

interface Tunnel1
 description HOST DYNAMIC TUNNEL
 bandwidth 1000
 ip address 172.16.0.2 255.255.255.0
 no ip redirects
 ip mtu 1416
 ip nhrp authentication dmvpn
 ip nhrp map multicast dynamic
 ip nhrp map 172.16.0.1 14.24.117.1
 ip nhrp map multicast 14.24.117.1
 ip nhrp network-id 99
 ip nhrp holdtime 300
 ip nhrp nhs 172.16.0.1
 no ip route-cache
 ip ospf network broadcast
 no ip mroute-cache
 delay 1000
 tunnel source Ethernet0/0
 tunnel mode gre multipoint
 tunnel key 100000
 tunnel protection ipsec profile dmvpnprof
!

!--- This is the outbound interface.

interface Ethernet0/0
 ip address 14.24.118.1 255.255.0.0
 ip nat outside
 ip access-group 100 in
 ip inspect in2out out
 no ip mroute-cache
 half-duplex
!
interface Ethernet0/1
 no ip address
 half-duplex
!
interface Ethernet0/2
 no ip address
 shutdown
 half-duplex
!
interface Ethernet0/3
 no ip address
 shutdown
 half-duplex
!

!--- Enable a routing protocol to send/receive dynamic
!--- updates about the private networks.

router ospf 1
```

```
 log-adjacency-changes
 redistribute connected
 network 172.16.0.0 0.0.0.255 area 0
 network 192.168.118.0 0.0.0.255 area 0
!

!--- Except the private network traffic from the NAT process.

ip nat inside source route-map nonat interface Ethernet0/0 overload
ip http server
no ip http secure-server
ip classless
ip route 0.0.0.0 0.0.0.0 14.24.1.1
ip route 2.0.0.0 255.0.0.0 14.24.121.1

!
!
!

!--- Allow ISAKMP, ESP, and GRE traffic inbound.
!--- Cisco IOS Firewall opens inbound access as needed.

access-list 100 permit udp any host 14.24.118.1 eq 500
access-list 100 premit esp any host 14.24.118.1
access-list 100 permit gre any host 14.24.118.1
access-list 100 deny ip any any


!--- Except the private network traffic from the NAT process.

access-list 110 deny   ip 192.168.118.0 0.0.0.255 192.168.117.0 0.0.0.255
access-list 110 deny   ip 192.168.118.0 0.0.0.255 192.168.116.0 0.0.0.255
access-list 110 deny   ip 192.168.118.0 0.0.0.255 192.168.120.0 0.0.0.255
access-list 110 permit ip 192.168.118.0 0.0.0.255 any
!

!--- Except the private network traffic from the NAT process.

route-map nonat permit 10
 match ip address 110
!
call rsvp-sync
!
!
mgcp profile default
!
dial-peer cor custom
!
!
!
!
!
line con 0
 exec-timeout 0 0
line aux 0
line vty 0 4
 login
!
!
end

W2N-6.16-3620-A#
```

Spoke 2 − 1720−b

```
1720-b#write terminal
Building configuration...

Current configuration : 2623 bytes
!
version 12.2
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname 1720-b
!
logging queue-limit 100
enable password cisco
!
username 7206-B password 0 cisco
ip subnet-zero
!
!
no ip domain lookup
!
ip cef

!--- This is the Cisco IOS Firewall configuration and what to inspect.
!--- This is applied outbound on the external interface.

ip inspect name in2out rcmd
ip inspect name in2out tftp
ip inspect name in2out udp
ip inspect name in2out tcp timeout 43200
ip inspect name in2out realaudio
ip inspect name in2out vdolive
ip inspect name in2out netshow
ip audit po max-events 100
vpdn-group 1
 request-dialin
  protocol pppoe
!
!
!
!
!

!--- Create an ISAKMP policy for
!--- Phase 1 negotiations.

crypto isakmp policy 5
 authentication pre-share
 group 2

!--- Add dynamic pre-shared key.

crypto isakmp key dmvpnkey address 0.0.0.0 0.0.0.0
!
!


!--- Create the Phase 2 policy for actual data encryption.

crypto ipsec transform-set dmvpnset esp-3des esp-sha-hmac
!

!--- Create an IPsec profile to be applied dynamically
!--- to the GRE over IPsec tunnels.

crypto ipsec profile dmvpnprof
```

```
 set transform-set dmvpnset
!
!
!
!
!

!--- This is the inbound interface.

interface Loopback1
 ip address 192.168.116.1 255.255.255.0
 ip nat inside
!

!--- Create a GRE tunnel template to be applied to
!--- all the dynamically created GRE tunnels.

interface Tunnel1
 description HOST DYNAMIC TUNNEL
 bandwidth 1000
 ip address 172.16.0.3 255.255.255.0
 no ip redirects
 ip mtu 1416
 ip nhrp authentication dmvpn
 ip nhrp map multicast dynamic
 ip nhrp map 172.16.0.1 14.24.117.1
 ip nhrp map multicast 14.24.117.1
 ip nhrp network-id 99
 ip nhrp holdtime 300
 ip nhrp nhs 172.16.0.1
 no ip route-cache
 ip ospf network broadcast
 no ip mroute-cache
 delay 1000
 tunnel source Dialer1
 tunnel mode gre multipoint
 tunnel key 100000
 tunnel protection ipsec profile dmvpnprof
!
interface Ethernet0
 no ip address
 half-duplex
!
interface FastEthernet0
 no ip address
 no ip mroute-cache
 speed auto
 pppoe enable
 pppoe-client dial-pool-number 1
!

!--- This is the outbound interface.

interface Dialer1
 ip address 2.2.2.10 255.255.255.0
 ip inspect in2out out
 ip access-group 100 in encapsulation ppp
 dialer pool 1
 dialer-group 1
 ppp authentication pap chap callin
!

!--- Enable a routing protocol to send/receive dynamic
!--- updates about the private networks.

router ospf 1
```

```
 log-adjacency-changes
 redistribute connected
 network 172.16.0.0 0.0.0.255 area 0
 network 192.168.116.0 0.0.0.255 area 0
!

!--- Except the private network traffic from the NAT process.

ip nat inside source route-map nonat interface Dialer1 overload
ip classless
ip route 0.0.0.0 0.0.0.0 14.24.1.1
ip route 0.0.0.0 0.0.0.0 Dialer1

no ip http server
no ip http secure-server
!
!
!

!--- Allow ISAKMP, ESP, and GRE traffic inbound.
!--- Cisco IOS Firewall opens inbound access as needed.

access-list 100 permit udp any host 14.24.116.1 eq 500
access-list 100 premit esp any host 14.24.116.1
access-list 100 permit gre any host 14.24.116.1
access-list 100 deny ip any any



!--- Except the private network traffic from the NAT process.

access-list 110 deny   ip 192.168.116.0 0.0.0.255 192.168.117.0 0.0.0.255
access-list 110 deny   ip 192.168.116.0 0.0.0.255 192.168.118.0 0.0.0.255
access-list 110 deny   ip 192.168.116.0 0.0.0.255 192.168.120.0 0.0.0.255
access-list 110 permit ip 192.168.116.0 0.0.0.255 any
dialer-list 1 protocol ip permit
!

!--- Except the private network traffic from the NAT process.

route-map nonat permit 10
 match ip address 110
!
!
line con 0
 exec-timeout 0 0
line aux 0
line vty 0 4
 login
!
no scheduler allocate
end

1720-b#
```

Spoke 3 − 1720−A

```
W2N-6.16-1720-A#write terminal
Building configuration...

Current configuration : 2303 bytes
!
version 12.2
service timestamps debug datetime msec
service timestamps log datetime msec
```

```
no service password-encryption
!
hostname W2N-6.16-1720-A
!
logging queue-limit 100
!
memory-size iomem 25
ip subnet-zero
!
!
no ip domain lookup
!
ip cef

!--- This is the Cisco IOS Firewall configuration and what to inspect.
!--- This is applied outbound on the external interface.

ip inspect name in2out rcmd
ip inspect name in2out tftp
ip inspect name in2out udp
ip inspect name in2out tcp timeout 43200
ip inspect name in2out realaudio
ip inspect name in2out vdolive
ip inspect name in2out netshow
ip audit notify log
ip audit po max-events 100
!
!
!
!

!--- Create an ISAKMP policy for
!--- Phase 1 negotiations.

crypto isakmp policy 5
 authentication pre-share
 group 2

!--- Add dynamic pre-shared key.

crypto isakmp key dmvpnkey address 0.0.0.0 0.0.0.0
!
!

!--- Create the Phase 2 policy for actual data encryption.

crypto ipsec transform-set dmvpnset esp-3des esp-sha-hmac
!

!--- Create an IPsec profile to be applied dynamically
!--- to the GRE over IPsec tunnels.

crypto ipsec profile dmvpnprof
 set transform-set dmvpnset
!
!
!
!
!

!--- This is the inbound interface.

interface Loopback1
 ip address 192.168.120.1 255.255.255.0
 ip nat inside
!
```

```
!--- Create a GRE tunnel template to be applied to
!--- all the dynamically created GRE tunnels.

interface Tunnel1
 description HOST DYNAMIC TUNNEL
 bandwidth 1000
 ip address 172.16.0.4 255.255.255.0
 no ip redirects
 ip mtu 1416
 ip nhrp authentication dmvpn
 ip nhrp map multicast dynamic
 ip nhrp map 172.16.0.1 14.24.117.1
 ip nhrp map multicast 14.24.117.1
 ip nhrp network-id 99
 ip nhrp holdtime 300
 ip nhrp nhs 172.16.0.1
 ip ospf network broadcast
 no ip mroute-cache
 delay 1000
 tunnel source FastEthernet0
 tunnel mode gre multipoint
 tunnel key 100000
 tunnel protection ipsec profile dmvpnprof
!
interface Ethernet0
 no ip address
 no ip mroute-cache
 half-duplex
!

!--- This is the outbound interface.

interface FastEthernet0
 ip address 14.24.120.1 255.255.0.0
 ip nat outside
 ip inspect in2out out
 ip access-group 100 in
 no ip mroute-cache
 speed auto
!

!--- Enable a routing protocol to send/receive dynamic
!--- updates about the private networks.

router ospf 1
 log-adjacency-changes
 redistribute connected
 network 172.16.0.0 0.0.0.255 area 0
 network 192.168.120.0 0.0.0.255 area 0
!

!--- Except the private network traffic from the NAT process.

ip nat inside source route-map nonat interface FastEthernet0 overload
ip classless
ip route 0.0.0.0 0.0.0.0 14.24.1.1
ip route 2.0.0.0 255.0.0.0 14.24.121.1
no ip http server
no ip http secure-server
!
!
!

!--- Allow ISAKMP, ESP, and GRE traffic inbound.
!--- Cisco IOS Firewall opens inbound access as needed.
```

```
access-list 100 permit udp any host 14.24.116.1 eq 500
access-list 100 premit esp any host 14.24.116.1
access-list 100 permit gre any host 14.24.116.1
access-list 100 deny ip any any
access-list 110 permit ip 192.168.120.0 0.0.0.255 any

!--- Except the private network traffic from the NAT process.

access-list 110 deny   ip 192.168.120.0 0.0.0.255 192.168.116.0 0.0.0.255
access-list 110 deny   ip 192.168.120.0 0.0.0.255 192.168.117.0 0.0.0.255
access-list 110 deny   ip 192.168.120.0 0.0.0.255 192.168.118.0 0.0.0.255
access-list 110 permit ip 192.168.120.0 0.0.0.255 any
!

!--- Except the private network traffic from the NAT process.

route-map nonat permit 10
 match ip address 110
!
!
line con 0
 exec-timeout 0 0
line aux 0
line vty 0 4
 login
!
end

W2N-6.16-1720-A#
```

Verify

Use this section to confirm that your configuration works properly.

The Output Interpreter Tool (registered customers only) (OIT) supports certain **show** commands. Use the OIT to view an analysis of **show** command output.

- **show crypto isakmp sa** Displays the state for the ISAKMP security association (SA).
- **show crypto engine connections active** Displays the total encrypts/decrypts per SA.
- **show crypto ipsec sa** Displays the statistics on the active tunnels.
- **show ip route** Displays the routing table.
- **show ip ospf neighbor** Displays OSPF neighbor information on a per−interface basis.
- **show ip nhrp** Displays the IP Next Hop Resolution Protocol (NHRP) cache, optionally limited to dynamic or static cache entries for a specific interface.

Troubleshoot

This section provides information you can use to troubleshoot your configuration.

Troubleshooting Commands

Note: Refer to Important Information on Debug Commands before you issue **debug** commands.

- **debug crypto ipsec** Displays IPsec events.
- **debug crypto isakmp** Displays messages about IKE events.
- **debug crypto engine** Displays information from the crypto engine.

Additional information on troubleshooting IPsec can be found at IP Security Troubleshooting − Understanding and Using debug commands.

Related Information

- **Troubleshooting Cisco IOS Firewall Configurations**
- **DMVPN and Cisco IOS Overview**
- **IPsec Negotiation/IKE Protocols**
- **Technical Support & Documentation − Cisco Systems**

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