

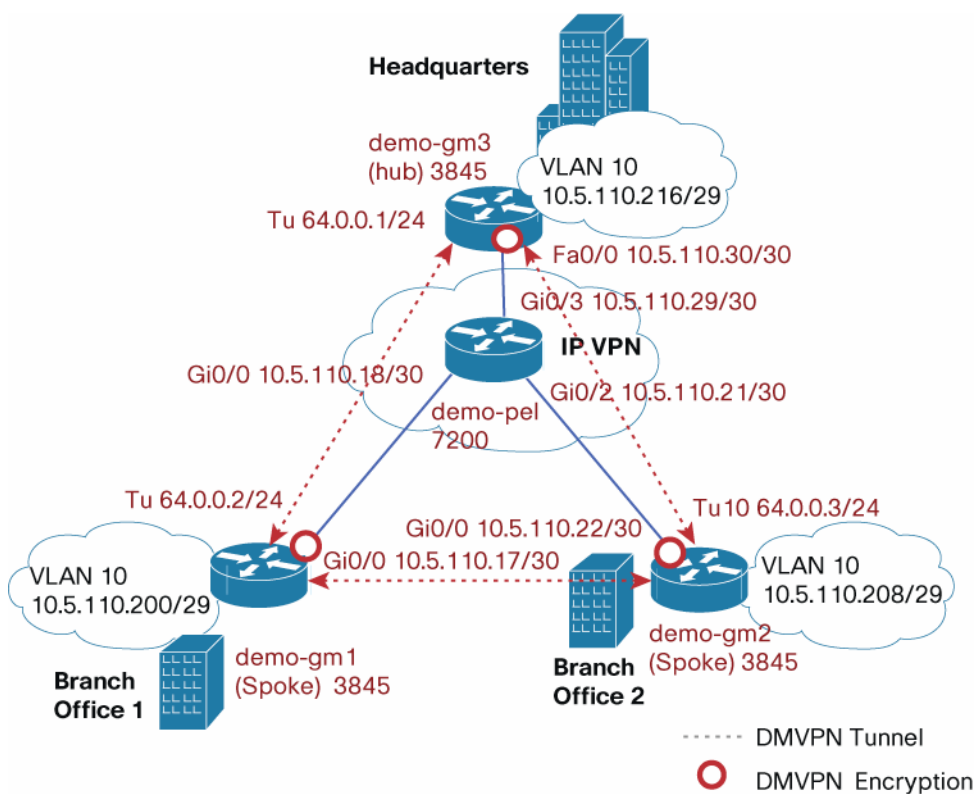
DMVPN to Group Encrypted Transport VPN Migration

This document provides the steps for Dynamic Multipoint VPN (DMVPN) to Group Encrypted Transport VPN migration.

DMVPN to Group Encrypted Transport VPN Migration

Following are the steps involved in migrating from DMVPN to Group Encrypted Transport VPN:

1. Hub-and-spoke and spoke-to-spoke DMVPN (multipoint generic routing encapsulation [mGRE]) tunnels are established with IP Security (IPsec) protection. Tunnel protection is applied to the tunnel interface.
2. The key server is introduced to the IP VPN.
3. Routing metrics are modified on the tunnel interfaces.
4. The routed path is modified to include the Group Encrypted Transport-enabled core.
5. Symmetric routing between branch offices is enabled in the hub. Headquarters is transitioned to use Group Encrypted Transport VPN encryption first. The Group Domain of Interpretation (GDOI) cryptography map excludes Encapsulating Security Payload (ESP) traffic (that is, Generic Routing Encapsulation [GRE] + IPsec) so that traffic is not encrypted twice (once by DM

Figure 1. =DMVPN Topology Diagram

```
router bgp 100
  no synchronization
  bgp log-neighbor-changes
  network 10.5.110.16 mask 255.255.255.252
  network 10.5.110.20 mask 255.255.255.252
  network 10.5.110.28 mask 255.255.255.252
  neighbor 10.5.110.17 remote-as 200
  neighbor 10.5.110.22 remote-as 300
  neighbor 10.5.110.30 remote-as 400
  no auto-summary
!
```

Customer Equipment Configuration

The configuration used in **demo-gm1** follows:

```
hostname demo-gm1
ip dhcp pool demo
  network 10.5.110.200 255.255.255.248
  default-router 10.5.110.201
! DMVPN related configuration
crypto isakmp policy 10
  encr aes 256
  authentication pre-share
crypto isakmp key cisco123 address 10.5.110.30
crypto isakmp key cisco123 address 10.5.110.22
crypto isakmp keepalive 30 5
crypto isakmp nat keepalive 30
!
crypto ipsec transform-set t1 esp-aes 256 esp-sha-hmac
  mode transport require
!
crypto ipsec profile demo-dmvpn-profile
  set transform-set t1
!
interface Tunnel10
  bandwidth 2000
  ip address 64.0.0.2 255.255.255.0
  no ip redirects
  ip mtu 1400
```

```
ip pim sparse-dense-mode
ip nhrp map multicast 10.5.110.30
ip nhrp map 64.0.0.1 10.5.110.30
ip nhrp network-id 100000
ip nhrp nhs 64.0.0.1
ip nhrp shortcut
ip nhrp redirect
ip tcp adjust-mss 1360
delay 2000
qos pre-classify
tunnel source GigabitEthernet0/0
tunnel mode gre multipoint
tunnel key 100000
tunnel protection ipsec profile demo-dmvpn-profile
interface GigabitEthernet0/0
description Connected to demo-pel
ip address 10.5.110.17 255.255.255.252
! PC and phones connected to this port
interface FastEthernet0/1/1
switchport access vlan 10
spanning-tree portfast
!
interface Vlan10
ip address 10.5.110.201 255.255.255.248
no autostate
!
router eigrp 44
network 10.5.110.200 0.0.0.7
network 64.0.0.0 0.0.0.255
no auto-summary
!
router bgp 200
no synchronization
bgp log-neighbor-changes
neighbor 10.5.110.18 remote-as 100
no auto-summary
```

```
! default route
ip route 0.0.0.0 0.0.0.0 10.5.110.18
```

The configuration used in **demo-gm2** follows:

```
hostname demo-gm2
!
ip dhcp pool demo
    network 10.5.110.208 255.255.255.248
    default-router 10.5.110.209
! DMVPN related configuration
crypto isakmp policy 10
    encr aes 256
    authentication pre-share
crypto isakmp key cisco123 address 10.5.110.30
crypto isakmp key cisco123 address 10.5.110.17
crypto isakmp keepalive 30 5
crypto isakmp nat keepalive 30
!
crypto ipsec transform-set t1 esp-aes 256 esp-sha-hmac
    mode transport require
!
crypto ipsec profile demo-dmvpn-profile
    set transform-set t1
!
interface Tunnel10
    bandwidth 2000
    ip address 64.0.0.3 255.255.255.0
    no ip redirects
    ip mtu 1400
    ip pim sparse-dense-mode
    ip nhrp map multicast 10.5.110.30
    ip nhrp map 64.0.0.1 10.5.110.30
    ip nhrp network-id 100000
    ip nhrp nhs 64.0.0.1
    ip nhrp shortcut
    ip nhrp redirect
    ip tcp adjust-mss 1360
```

```
delay 2000
qos pre-classify
tunnel source GigabitEthernet0/0
tunnel mode gre multipoint
tunnel key 100000
tunnel protection ipsec profile demo-dmvpn-profile
!
interface GigabitEthernet0/0
description connected to demo-pel
! PC and phones connected to this port
interface FastEthernet0/1/0
switchport access vlan 10
spanning-tree portfast
!
interface Vlan10
ip address 10.5.110.209 255.255.255.248
no autostate
!
router eigrp 44
network 10.5.110.208 0.0.0.7
network 64.0.0.0 0.0.0.255
no auto-summary
!
router bgp 300
no synchronization
bgp log-neighbor-changes
neighbor 10.5.110.21 remote-as 100
no auto-summary
!
! default route
ip route 0.0.0.0 0.0.0.0 10.5.110.21
```

The configuration used in **demo-gm3** follows:

```
hostname demo-gm3
!
ip dhcp pool demo
network 10.5.110.216 255.255.255.248
```

```
default-router 10.5.110.217
! DMVPN related configuration
crypto isakmp policy 10
  encr aes 256
  authentication pre-share
crypto isakmp key cisco123 address 10.5.110.17
crypto isakmp key cisco123 address 10.5.110.22
!
crypto ipsec transform-set t1 esp-aes 256 esp-sha-hmac
  mode transport require
!
crypto ipsec profile demo-dmvpn-profile
  set transform-set t1
!
interface Tunnel15
  bandwidth 2000
  ip address 64.0.0.1 255.255.255.0
  no ip redirects
  ip mtu 1400
  ip pim nbma-mode
  ip pim sparse-dense-mode
  ip nhrp map multicast dynamic
  ip nhrp network-id 100000
  ip nhrp redirect
  ip tcp adjust-mss 1360
  no ip split-horizon eigrp 44
  delay 2000
  qos pre-classify
  tunnel source FastEthernet0/0
  tunnel mode gre multipoint
  tunnel key 100000
  tunnel protection ipsec profile demo-dmvpn-profile
!
interface FastEthernet0/0
  description Connected to demo-pel
  ip address 10.5.110.30 255.255.255.252
! PC and phone connected to this port
```

```

interface FastEthernet0/1/0
  switchport access vlan 10
  spanning-tree portfast
!
interface Vlan10
  ip address 10.5.110.217 255.255.255.248
  no autostate
!
router eigrp 44
  ! redistribute corporate network
  redistribute static
  network 10.5.110.216 0.0.0.7
  network 64.0.0.0 0.0.0.255
  no auto-summary
!
router bgp 400
  no synchronization
  bgp log-neighbor-changes
  neighbor 10.5.110.29 remote-as 100
  no auto-summary

```

DMVPN Encryption Verification

DMVPN operation is verified using the following commands from the headquarters router demo-gm3:

```
demo-gm3#show dmvpn
```

Legend: Attrb --> S - Static, D - Dynamic, I - Incomplete

N - NATed, L - Local, X - No Socket

Ent --> Number of NHRP entries with same NBMA peer

NHS Status: E --> Expecting Replies, R --> Responding

UpDn Time --> Up or Down Time for a Tunnel

```
=====
```

Interface: Tunnel5, IPv4 NHRP Details

Type:Hub, NHRP Peers:2,

#

EIGRP routes to private networks are verified in headquarters and branch offices as follows:

```
demo-gm3#show ip route eigrp
      10.0.0.0/8 is variably subnetted, 11 subnets, 3 masks
D       10.5.110.200/29 [90/1794560] via 64.0.0.2, 00:05:52, Tunnel15
D       10.5.110.208/29 [90/1794560] via 64.0.0.3, 00:06:32, Tunnel15
```

DMVPN encryption from headquarters to branch-office 1 is verified as follows:

```
demo-gm3#show crypto ipsec sa | incl ecaps
      #pkts decaps: 415, #pkts decrypt: 415, #pkts verify: 415
```

The PC connected to the private network in branch-office 1 is pinged:

```
demo-g
```

The route to the private network at the headquarters (demo-gm3) router is checked as follows:

```
demo-gm1#show ip route 10.5.110.217
Routing entry for 10.5.110.216/29
  Known via "eigrp 44", distance 90, metric 1794560, type internal
  Redistributing via eigrp 44
  Last update from 64.0.0.1 on Tunnel10, 00:16:48 ago
  Routing Descriptor Blocks:
    * 64.0.0.1, from 64.0.0.1, 00:16:48 ago, via Tunnel10
```

Step 2: Key Server Introduced to IP VPN

Add a Group Encrypted Transport VPN key server (KS) to the IP VPN network as shown in the network topology diagram in Figure 2.

Figure 2. Adding Key Server to IP VPN

```
neighbor 10.5.110.13 remote-as 800
!
```

The key system configuration follows:

The configuration added in **demo-ks1** follows:

```
hostname demo-ks1
! IKE Policy
crypto isakmp policy 1
  encr 3des
  authentication pre-share
  group 2
! Preshared keys
crypto isakmp key dGvPnPsK address 10.5.110.17
crypto isakmp key dGvPnPsK address 10.5.110.22
crypto isakmp key dGvPnPsK address 10.5.110.30
crypto isakmp keepalive 15 periodic
!   Crypto GDOI attributes
crypto ipsec profile getvpn-profile
  set security-association lifetime seconds 900      ! TEK lifetime
  set transform-set aes128
!
crypto gdoi group GETVPN-DEMO
  identity number 1357924756                        ! group id
  server local                                       ! Key server
  rekey algorithm aes 128                          ! rekey algorithm
  rekey lifetime seconds 28800                      ! KEK lifetime

```

```

description Connected to demo-pel
ip address 10.5.110.13 255.255.255.252
!
router bgp 800
no synchronization
bgp log-neighbor-changes
network 10.5.110.12 mask 255.255.255.252
network 10.5.110.88 mask 255.255.255.255
neighbor 10.5.110.14 remote-as 100
no auto-summary
! GDOI Encryption policy
ip access-list extended sa-acl
deny    udp any eq 848 any eq 848      ! GDOI in clear
deny    tcp any any eq ssh             ! Secure Shell control traffic in clear
deny    tcp any eq ssh any             ! Secure Shell control traffic in clear
deny    esp any any                   ! Exclude ESP traffic (GRE+IPSec)
deny    tcp any eq bgp any             ! Exclude BGP
deny    tcp any any eq bgp            ! Exclude BGP
deny    udp any eq isakmp any eq isakmp ! Exclude IKE control traffic
deny    eigrp any any                 ! Exclude EIGRP control traffic
deny    igmp any any                  ! Exclude IGMP
deny    pim any 224.0.0.13             ! Exclude PIM control
deny    ip any 224.0.0.0 0.0.255.255   ! Exclude link-layer control protocols
deny    udp any any eq ntp             ! Exclude N
```

```

Redundancy                : Configured
  Local Address            : 10.5.110.88
  Local Priority            : 20
  Local KS Status          : Alive
Group Rekey Lifetime       : 28800 secs
Group Rekey
  Remaining Lifetime       : 24224 secs
Rekey Retransmit Period   : 10 secs
Rekey Retransmit Attempts: 2
Group Retransmit
  Remaining Lifetime       : 0 secs
IPSec SA Number           : 1
IPSec SA Rekey Lifetime   : 900 secs
Profile Name              : getvpn-profile
Replay method             : Time Based
Replay Window Size        : 5
SA Rekey
  Remaining Lifetime       : 275 secs
ACL Configured            : access-list sa-acl
Group Server list         : Local

```

Step 3: Routing Metrics Modified on Tunnel Interfaces

Multiprotocol Label Switching (MPLS) service providers typically use the BGP routing protocol. We need to advertise routes in customer equipment to the provider VPN with the BGP routing protocol to make Group Encrypted Transport VPN group members (GMs) work effectively. When private network routes in headquarters and branch offices are advertised through BGP, BGP routes take precedence over EIGRP because the BGP

Verifying the Routing Metrics Modified on Tunnel Interfaces

The administrative distance of EIGRP routes for the private network set to 15 (instead of default value 90) is verified by executing the following CLI in demo-gm3:

```
demo-gm3#show ip route eigrp
      10.0.0.0/8 is variably subnetted, 10 subnets, 3 masks
D       10.5.110.200/29 [15/1794560] via 64.0.0.2, 00:08:41, Tunnel5
D       10.5.110.208/29 [15/1794560] via 64.0.0.3, 00:08:42, Tunnel5
```

Step 4: Routed Path Modified to Include Group Encrypted Transport-Enabled Core

Next we need to advertise routes of physical interfaces connected to the provider edge, and routes of the private network used in headquarters and branch-office customer edge routers using the BGP routing protocol as follows:

Redistributing via eigrp 44

Last update from 64.0.0.2 on Tunnel5, 00:03:12 ago

Routing Descriptor Blocks:

* 64.0.0.2, from 64.0.0.2, 00:03:12 ago, via Tunnel5

Route metric is 1794560, traffic share count is 1

Total delay is 20100 microseconds, minimum bandwidth is 2000 Kbit

Reliability 255/255, minimum MTU 1400 bytes

Loading 2/255, Hops 1

```

set group GETVPN-DEMO          ! Group membership

The following configuration is added in demo-gm3 to add a local private network to
BGP:

router bgp 400
network 10.5.110.216 mask 255.255.255.248

```

The following configuration is added in demo-gm3 (DMVPN hub) to enable symmetric routing between branch offices during Group Encrypted Transport VPN transition. Branch offices are transitioned to use Group Encrypted Transport VPN encryption one at a time.

```

! It is possible some of the branches use DMVPN and EIGRP (non-converted sites) while
! other branches have transitioned to GETVPN (converted sites). To make symmetric
! routing between branches work, we need to redistribute non converted sites EIGRP
! routes learned by the hub into BGP routes.

! Basically this injects EIGRP routes of non-converted sites to BGP
! Makes traffic from converted sites to non-converted sites flow to hub using
! GET VPN and then via DMVPN from hub to non-converted site
!

redistribute eigrp 44

! Redistribute converted site BGP routes into EIGRP. This provide symmetric route.
! Makes traffic from non-converted sites to converted sites flow via hub using DMVPN
! tunnel and then
```

Verify Traffic Between Individual Sites Gets Encrypted by DMVPN

After adding GDOI encryption, traffic between sites flows through DMVPN tunnels. The following is done in the headquarters group member (demo-gm3) to verify it.

Verify that the route to the PC is connected to the private network in branch-office 1 from demo-gm3:

```
demo-gm3#show ip route 10.5.110.204
Routing entry for 10.5.110.200/29
  Known via "eigrp 44", distance 15, metric 1794560, type internal
  Redistributing via eigrp 44
  Last update from 64.0.0.2 on Tunnel5, 02:43:47 ago
  Routing Descriptor Blocks:
    * 64.0.0.2, from 64.0.0.2, 02:43:47 ago, via Tunnel5
      Route metric is 1794560, traffic share count is 1
      Total delay is 20100 microseconds, minimum bandwidth is 2000 K
```

Type escape sequence to abort.

Sending 10000, 100-byte ICMP Echos to 10.5.110.204, timeout is 2 seconds:

Packet sent with a source address of 10.5.110.217

!!

<output excluded>

!!

Success rate is 99 percent (9993/10000), round-trip min/avg/max = 1/1/48 ms

*Jun 11 23:21:12.251: %PIM-5-NBRCHG: neighbor 64.0.0.2

Add a private local network to the BGP routing table.

```
router bgp 200
  network 10.5.110.200 mask 255.255.255.248
!
```

Apply Group Encrypted Transport VPN group encryption to the WAN interface as follows:

```
demo-gm1(config)#int Gi0/0
demo-gm1(config-if)#crypto map demo-gdoi
demo-gm1(config-if)#end
*Jun 11 15:14:22 pst: %CRYPTO-5-GM_REGSTER: Start registration to KS 10.5.110.88 for
group GETVPN-DEMO using address 10.5.110.17
*Jun 11 15:14:22 pst: %CRYPTO-6-GDOI_ON_OFF: GDOI is ON
*Jun 11 15:14:22 pst: %GDOI-5-GM_REKEY_TRANS_2_UNI: Group GETVPN-DEMO transitioned to
Unicast Rekey.
*Jun 11 15:14:22 pst: %GDOI-5-GM_REGS_COMPL: Registration to KS 10.5.110.88 complete

```

Check the route from the branch-office 1 (demo-gm1) private network to the branch-office 2 (demo-gm2) private network as follows:

```
demo-gm1#show ip route 10.5.110.209
Routing entry for 10.5.110.208/29
  Known via "bgp 200", distance 20, metric 0
  Tag 100, type external
  Last update from 10.5.110.18 00:04:17 ago
  Routing Descriptor Blocks:
    * 10.5.110.18, from 10.5.110.18, 00:04:17 ago
      Route metric is 0, traffic share count is 1
      AS Hops 2
      Route tag 100
```

```
demo-pe1#show ip route 10.5.110.209
Routing entry for 10.5.110.208/29
  Known via "bgp 100", distance 20, metric 1794560
  Tag 400, type external
  Last update from 10.5.110.30 00:14:00 ago
  Routing Descriptor Blocks:
    * 10.5.110.30, from 10.5.110.30, 00:14:00 ago
      Route
```

```
Reliability 255/255, minimum MTU 1400 bytes
```

```
Loading 168/255, Hops 1
```

Check the reverse route from the branch-office 2 (demo-gm2) private network to the branch-office 1 (demo-gm1) private network as follows:

Traffic uses DMVPN IPsec encryption between demo-gm2 and demo-gm3, and uses GDOI encryption between demo-gm3 and demo-gm1.

```
demo-gm2#show ip route 10.5.110.204
```

```
Routing entry for 10.5.110.200/29
```

```
Known via "eigrp 44", distance 170, metric 2244096
```

```
Tag 100, type external
```

```
demo-pel#show ip route 10.5.110.204
Routing entry for 10.5.110.200/29
  Known via "bgp 100", distance 20, metric 0
  Tag 200, type external
  Last update from 10.5.110.17 01:22:50 ago
  Routing Descriptor Blocks:
    * 10.5.110.17, from 10.5.110.17, 01:22:50 ago
      Route metric is 0, traffic share count is 1
      AS Hops 1
      Route tag 200
```

Topology After Enabling Group Encrypted Transport VPN Incryption in Branch-Office 1

Figure 3 shows the topology after adding Group Encrypted Transport VPN encryption in individual sites. At this point, traffic between private networks between branch offices gets encrypted by DMVPN.

Figure 3. Topology After Adding Group Encrypted Transport VPN Encryption at Headquarters and Branch-Office 1

</

```

Tag 100, type external
Last update from 10.5.110.18 00:13:19 ago
Routing Descriptor Blocks:
* 10.5.110.18, from 10.5.110.18, 00:13:19 ago
    Route metric is 0, traffic share count is 1
    AS Hops 2
    Route tag 100

```

Now Group Encrypted Transport-enabled interfaces are confirmed operational using following CLI commands:

To check whether the group member is participating in Group Encrypted Transport VPN encryption, execute the following CLI command:

```
demo-gml#show crypto gdoi
```

GROUP INFORMATION

```

Group Name           : GETVPN-DEMO
Group Identity       : 1357924756
Rekeys received      : 0
IPSec SA Direction   : Both
Active Group Server   : 10.5.110.88
Group
```

```
access-list deny ip any 224.0.0.0 0.0.255.255
access-list deny udp any any port = 123
access-list deny udp any any port = 161
access-list deny udp any any port = 514
access-list permit ip any any
```

KEK POLICY:

```
Rekey Transport Type      : Unicast
Lifetime (secs)           : 5398
Encrypt Algorithm         : AES
Key Size                   : 128
Sig Hash Algorithm        : HMAC_AUTH_SHA
Sig Key Length (bits)     : 1024
```

TEK POLICY:**GigabitEthernet0/0:****IPsec SA:**

```
sa direction:inbound
spi: 0x9BA7DF6(163216886)
transform: esp-aes
```

```

    Anti-Replay(Time Based) : 5 sec interval
IPsec SA:
    sa direction:inbound
    spi: 0x9BA7DF6(163216886)
    transform: esp-aes esp-sha-hmac
    sa timing:remaining key lifetime (sec): (73)
    Anti-Replay(Time Based) : 5 sec interval
IPsec SA:
    sa direction:outbound
    spi: 0x9BA7DF6(163216886)
    transform: esp-aes esp-sha-hmac
    sa timing:remaining key lifetime (sec): (73)
    Anti-Replay(Time Based) : 5 sec interval
IPsec SA:
    sa direction:inbound
    spi: 0x156DAB5C(359508828)
    transform: esp-aes esp-sha-hmac
    sa timing:remaining key lifetime (sec): (857)
    Anti-Replay(Time Based) : 5 sec interval
IPsec SA:
    sa direction:outbound
    spi: 0x156DAB5C(359508828)
    transform: esp-aes esp-sha-hmac
    sa timing:remaining key lifetime (sec): (827)
    Anti-Replay(Time Based) : 5 sec interval

```

Verify the Internet Key Exchange (IKE) connection between the group member and the key system to receive rekeys:

Ping the headquarters private network address from branch-office 1 as follows:

```
demo-gm1#ping 10.5.110.217 source vlan 10 rep 100
Type escape sequence to abort.
Sending 100, 100-byte ICMP Echos to 10.5.110.217, timeout is 2 seconds:
Packet sent with a source address of 10.5.110.201
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
Success rate is 100 percent (100/100), round-trip min/avg/max = 1/3/4 ms
```

```
demo-gm1#show crypto ipsec sa | incl encaps
      #pkts encaps: 397, #pkts encrypt: 397, #pkts digest: 397
```

The previous output shows that the Internet Control Message Protocol (ICMP) traffic between branch-office 1 and headquarters is encrypted.

Verify reachability between private networks in demo-gm1 and dem-gm2 as follows:

```

crypto isakmp key dGvPnPsK address 10.5.110.88      ! Preshared key
!
crypto gdoi group GETVPN-DEMO      ! Group encryption
  identity number 1357924756        ! Group identity for member
  server address ipv4 10.5.110.88    ! KS address to register
!
crypto map demo-gdoi 1 gdoi         ! Group Crypto map entry
  set group GETVPN-DEMO             ! Group membership

```

Add a private local network to the BGP routing table:

```

router bgp 300
  network 10.5.110.208 mask 255.255.255.248

```

Apply Group Encrypted Transport VPN group encryption to the WAN interface as follows:

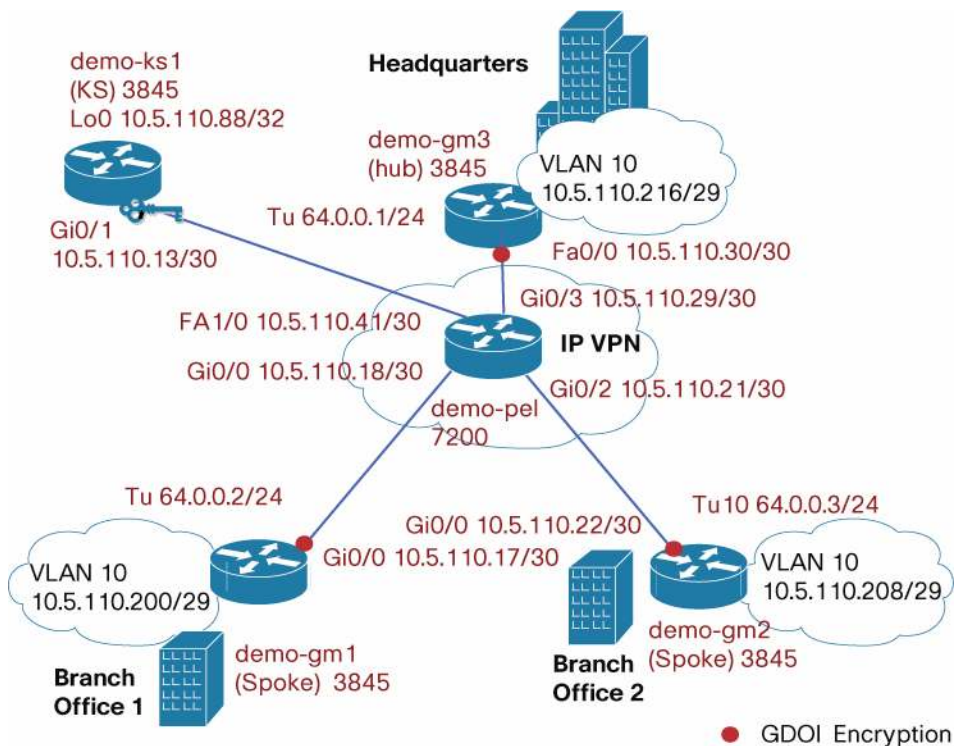
```

demo-gm2(config)#int Gi0/0
demo-gm2(config-if)#crypto map demo-gdoi
demo-gm2(config-if)#end
*Jun
```

Topology After Individual Sites Transitioned to Group Encrypted Transport VPN

Figure 4 shows the topology after individual sites are transitioned to use Group Encrypted Transport VPN encryption and DMVPN tunnels are shut down.

Figure 4. Topology After Individual Sites Are Transitioned to Use Group Encrypted Transport VPN Encryption



Clean up DMVPN configuration from the branch-office 1 group member (demo-gm2) as follows:

```
demo-gm2(config)#no router eigrp 44
demo-gm2(config)#no ip route 0.0.0.0 0.0.0.0 10.5.110.21
demo-gm2(config)#no interface Tunnel10
```

Clean up DMVPN configuration from the headquarters group members (demo-gm3) as follows:

```
demo-gm3(config)#no router eigrp 44
demo-gm3(config)#router bgp 400
demo-gm3(config-router)#no redistribute eigrp 44
demo-gm3(config)#no interface Tunnel5
```



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