Design Guide

Large Scale DMVPN Deployment: 7200 Server Farm Behind 7600

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1. OVERVIEW

This document provides configuration guidance for users of Cisco® Dynamic Multipoint VPN (DMVPN) technology on Cisco 7200 and 7600 series routers. The testing was performed on Cisco 7200 Series Network Processing Engine G1s (NPE-G1s) running Cisco IOS® Software Release 12.3(11)T6 and Cisco 7600 Series routers with the Supervisor Engine 720 (SUP-720-3BXL) and the VPN Services Module (VPNSM), running Cisco IOS Software Release 12.2(18)SXE. The objective of the testing was to configure and test DMVPN on a Cisco 7600/7200 series router combination when configured as a large-scale DMVPN hub.

Advantage: The advantage of using a server farm design is to split the DMVPN function onto different devices. The Cisco 7600 Series router can perform encryption and decryption functions while the Cisco 7200 Series router can handle all tasks related to Next-Hop Resolution Protocol (NHRP) and multipoint generic routing encapsulation (MGRE). While the NPE-G1 is a faster processor than the Multilayer Switch Feature Card (MSFC), encryption/decryption can slow it down considerably. Secondly, the VPN Acceleration Module 2+ (VAM2+), with 250 Mbps maximum throughput, is no match for the VPNSM or shared port adapter (SPA), with Gbps throughput. By taking the burden of encryption/decryption off of the Cisco 7200 Series processor, we allow it to perform better in routing protocol and NHRP handling. To increase the scalability of routing protocols hubs can be configured in daisy chains. The traffic between hubs is configured to traverse a backend LAN for added bandwidth.

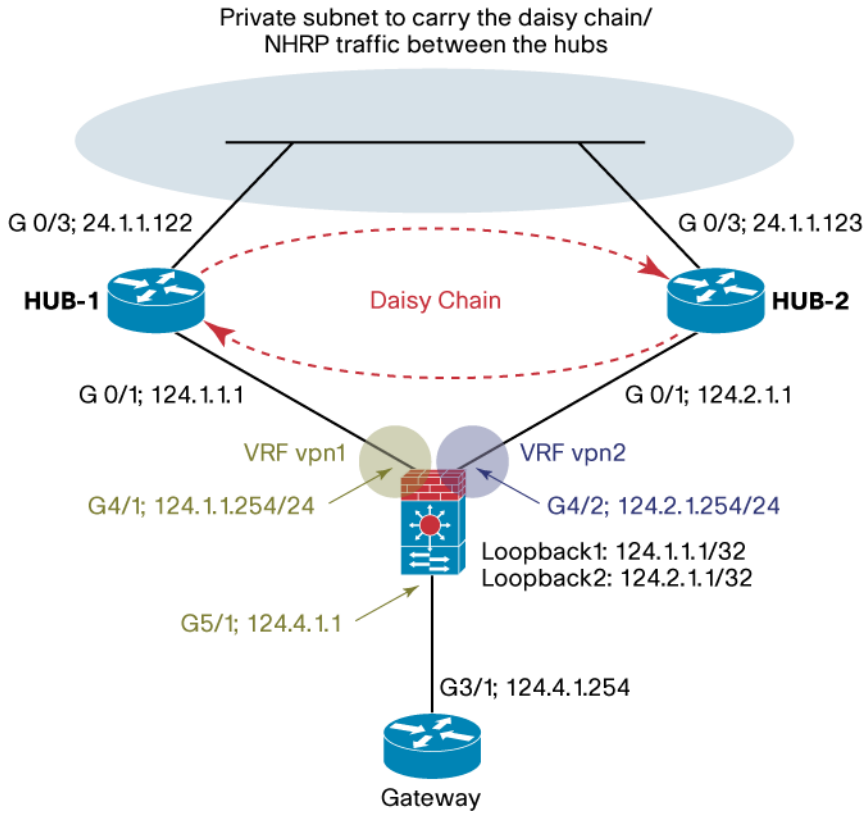
What makes it work: The Cisco 7600 Series router is configured with virtual routing and forwarding (VRF)-aware IPSec. The IP addresses on the hubs are configured as the global loopback interfaces on the Cisco 7600 Series router. These loopbacks are used as crypto endpoints. The 7600 is configured with dynamic crypto to accept any spoke with any proxies. After decryption, the GRE packet comes out in appropriate VRF and is forwarded to the hub in that VRF. Therefore, even with overlapping addresses, we are using VRFs to separate the routing tables. To use different pre-shared keys for different VRFs (hence different hubs), recently introduced “local-address <interface>” command on Cisco IOS Software is used to tie a crypto endpoint to a keyring as well as an ISAKMP profile.

2. AUDIENCE

This configuration guide is targeted for Cisco systems engineers and customer support engineers to provide configuration guidelines and best practices for large-scale DMVPN customer deployments.

3. NETWORK TOPOLOGY

Figure 1. DMVPN Topology



4. SYSTEM COMPONENTS

4.1 7600 Hardware Requirements

- 7600 Enhanced Chassis with enough power to support VPNSM (or SPA) and SUP-720
- SUP-720-3BXL (3B shall work too) with a minimum of 512 MB RAM; 1024 MB preferred
- VPNSM

4.2 7200 Hardware Requirements

- 7200 VXR NPE-G1 (can use 7301)
- Minimum of 512 MB RAM

4.3 7600 Software Requirements

- Feature set: ADVENTERPRISEK9 Release: 12.2(18)SXE

4.4 7200 Software Requirements

- Release: 12.3(11)T6 or later

4.5 Spoke Software Requirements

- Release: 12.3(11)T6 or later

5. CONFIGURATION ON THE 7600

5.1 VRF Configuration

```
ip vrf vpn1
 rd 100:1
!
ip vrf vpn2
 rd 100:2
```

5.2 Loopback Configuration

```
!
! The addresses defined here will reside on the 7200 HUBs (in VRFs)
!
interface Loopback1
 ip address 124.1.1.1 255.255.255.255
!
interface Loopback2
ip address 124.2.1.1 255.255.255.255
```

5.3 IPSec Configuration

5.3.1 ISAKMP Policy

```
crypto isakmp policy 10
 encr 3des
 authentication pre-share
 group 2
 lifetime 14400
!
```

5.3.2 ISAKMP Keepalive (DPD)

```
crypto isakmp keepalive 60
!
```

5.3.3 IPSec Transform Set

```
crypto ipsec transform-set gre esp-3des esp-sha-hmac
 mode transport
!
```

5.3.4 ISAKMP Keyrings

```
! Using the local-address command we are typing all the spoke connections coming in
! to Loopback1's address with keyring vpn1 and Loopback2's address with keyring vpn2

crypto keyring vpn1
  local-address Loopback1
pre-shared-key address 0.0.0.0 0.0.0.0 key Cisco123
!
crypto keyring vpn1
  local-address Loopback2
pre-shared-key address 0.0.0.0 0.0.0.0 key Cisco456
!
```

5.3.5 ISAKMP Profiles

```
! Using local-address command, we are tying all the spokes with destination pointing
! to different Loopbacks' addresses together.
!
crypto isakmp profile vpn1
   vrf vpn1
   keyring vpn1
   match identity address 0.0.0.0
   local-address Loopback1
crypto isakmp profile vpn2
   vrf vpn2
   keyring vpn2
   match identity address 0.0.0.0
   local-address Loopback2
!
```

5.3.6 Dynamic Crypto Maps

```
! RRI is turned on to install routes for remote endpoints in VRFs. The addresses can
! be advertised to the HUB by redistributing into any routing protocol running
! between 7600 and HUBs. Another alternative would be to define default routes on
! HUBs pointing back to 7600.
!
crypto dynamic-map vpn1-dyna 10
 set transform-set gre
 set isakmp-profile vpn1
 reverse-route remote-peer
!
crypto dynamic-map vpn2-dyna 10
 set transform-set gre
```

```
 set isakmp-profile vpn2
 reverse-route remote-peer
!
```

5.3.7 Crypto Maps

```
!
! Each crypto map is tied to different Loopback to define separate VPN termination
! addresses
!
crypto map vpn1 local-address Loopback1
crypto map vpn1 10 ipsec-isakmp dynamic vpn1-dyna
!
crypto map vpn2 local-address Loopback2
crypto map vpn2 10 ipsec-isakmp dynamic vpn2-dyna
!
```

5.3.8 Crypto Engine Mode

```
crypto engine mode vrf
```

5.3.9 Crypto Interface Configuration

```
interface GigabitEthernet5/1
 description TO Internet Gateway
 ip address 124.4.1.1 255.255.255.0
 speed nonegotiate
 crypto engine slot 1
!
! VLANs with dummy addresses for applying crypto maps
!
interface Vlan101
 ip vrf forwarding vpn1
 ip address 192.70.1.1 255.255.255.0
 crypto map vpn1
 crypto engine slot 1
!
interface Vlan102
 ip vrf forwarding vpn2
 ip address 192.70.2.1 255.255.255.0
 crypto map vpn2
 crypto engine slot 1
!
```

5.4 Uplinks to Hubs

```
interface GigabitEthernet4/1
 description TO G0/1 DMVPN1-G1-1
 ip vrf forwarding vpn1
 ip address 124.1.1.254 255.255.255.0
 speed nonegotiate
!
interface GigabitEthernet4/2
 description TO G0/1 DMVPN1-G1-2
 ip vrf forwarding vpn2
 ip address 124.2.1.254 255.255.255.0
 speed nonegotiate
!
```

5.5 VPNSM Interfaces

```
! The interfaces appear when we insert VPNSM in the chassis. The VLANs get added
! automatically due to crypto engine slot and crypto connect commands.

interface GigabitEthernet1/1
 switchport
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 1,101-102,1002-1005
 switchport mode trunk
 mtu 4500
 no ip address
 flowcontrol receive on
 flowcontrol send off
 spanning-tree portfast trunk
!
interface GigabitEthernet1/2
 switchport
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 1,1002-1005
 switchport mode trunk
 mtu 4500
 no ip address
 flowcontrol receive on
 flowcontrol send off
 spanning-tree portfast trunk
!
```

5.6 Routing Protocol Configuration

```
!
! OSPF running in different VRFs to advertise IPSec endpoints routes, learnt via RRI
! to hubs
!
router ospf 10 vrf vpn1
 log-adjacency-changes
 redistribute static metric 100 subnets
 network 124.1.1.0 0.0.0.255 area 0
!
router ospf 20 vrf vpn2
 log-adjacency-changes
 redistribute static metric 100 subnets
 network 124.2.1.0 0.0.0.255 area 0
!
```

6. CONFIGURATION ON THE 7200

6.1 DMVPN Tunnel Configuraiton

```
! Multipoint GRE interface. Bandwidth set to a value more than the aggregate
! bandwidth defined on the spoke GRE interfaces. IP MTU set to 1400 for
! fragmentation before encryption. Hold-Queues are increased to a value more than
! the number of neighbors.

interface Tunnel1
 bandwidth 10000000
 ip address 172.20.1.254 255.255.0.0
 no ip redirects
 ip mtu 1440
 no ip next-hop-self eigrp 10
 ip nhrp authentication nsite
 ip nhrp map multicast dynamic
 ip nhrp map 172.20.2.254 124.2.1.1
 ip nhrp map multicast 124.2.1.1
 ip nhrp network-id 101
 ip nhrp holdtime 600
 ip nhrp nhs 172.20.2.254
 no ip split-horizon eigrp 10
 tunnel source GigabitEthernet0/1
 tunnel mode gre multipoint
 hold-queue 500 in
 hold-queue 500 out
!
```

6.2 Interface Configuration

```
! Gig5/1 interface connects 7600 to Internet. "crypto connect vlan 2" command ties
! this interface to VLAN 2, which is the source of MGRE tunnel.

interface GigabitEthernet0/1
 description to 7600
 ip address 124.1.1.1 255.255.255.0
 duplex full
 speed 1000
 media-type gbic
 no negotiation auto
 hold-queue 500 in
 hold-queue 500 out
!
interface GigabitEthernet0/2
 description Private Network on corporate side
 ip address 192.24.1.1 255.255.255.0
 duplex auto
 speed auto
 media-type rj45
 no negotiation auto
 no keepalive
!
interface GigabitEthernet0/3
 description Private Subnet for NHRP traffic
 ip address 24.1.1.122 255.255.255.0
 duplex auto
 speed auto
 media-type rj45
 no negotiation auto
!
```

6.3 Routing Protocol Configuration

```
!
! EIGRP running over the MGRE tunnel
!
router eigrp 10
 network 172.20.0.0
 network 192.24.1.0
 no auto-summary
!
```

```
! OSPF running to 7600 for learning public IP addresses of the spokes
!
router ospf 254
 log-adjacency-changes
 network 124.1.1.0 0.0.0.255 area 0
!
! Static Route to force NHRP/daisy-chained traffic over G0/3
!
ip route 124.2.1.1 255.255.255.255 24.1.1.123
!
```

7. 7600 CONFIGURATION VERIFICATION

7.1 Modules

Show module

```
Mod Ports Card Type                              Model              Serial No.
--- ----- -------------------------------------- ------------------ -----------
  1    2  IPSec VPN Accelerator                  WS-SVC-IPSEC-1     SAD0626000D
  4   24  CEF720 24 port 1000mb SFP              WS-X6724-SFP       SAD084700TJ
  5    2  Supervisor Engine 720 (Active)         WS-SUP720-3BXL     SAL09137GMT

Mod MAC addresses                       Hw    Fw           Sw           Status
--- ----------------------------------- ------ ------------ ------------ -------
  1  0030.f271.d5d9 to 0030.f271.d5dc   1.0   7.2(1)       8.5(0.46)ROC Ok
  4  0011.9299.af44 to 0011.9299.af5b   2.1   12.2(14r)S5  12.2(ROCKIES Ok
  5  0013.7f0b.507c to 0013.7f0b.507f   4.3   8.1(3)       12.2(ROCKIES Ok

Mod Sub-Module                  Model              Serial        Hw     Status
--- --------------------------- ------------------ ------------ ------- -------
  4 Centralized Forwarding Card WS-F6700-CFC       SAL08435709   2.0    Ok
  5 Policy Feature Card 3       WS-F6K-PFC3BXL     SAL09159788   1.6    Ok
  5 MSFC3 Daughterboard         WS-SUP720          SAL09137EC4   2.3    Ok

Mod Online Diag Status
--- -------------------
  1 Pass
  4 Pass
  5 Pass
```

7.2 VLANs

Show vlan

```
VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active
3    INSIDE                           active
24   MGMT_VLAN                        active
101  vpn1_crypto_vlan                 active
102  vpn2_crypto_vlan                 active
1002 fddi-default                     act/unsup
1003 token-ring-default               act/unsup
1004 fddinet-default                  act/unsup
1005 trnet-default                    act/unsup
```

7.3 RRI Installed Routes

show ip route vrf vpn1

```
      112.0.0.0/32 is subnetted, 1 subnets
S        112.1.1.1 [1/0] via 0.0.0.0, Vlan101
      124.0.0.0/24 is subnetted, 1 subnets
C        124.1.1.0 is directly connected, GigabitEthernet4/1
C     192.70.1.0/24 is directly connected, Vlan101
      105.0.0.0/32 is subnetted, 500 subnets
S        105.4.1.100 [1/0] via 0.0.0.0, Vlan101
S        105.3.1.99 [1/0] via 0.0.0.0, Vlan101
```

7.4 ISAKMP SAs

show crypto isakmp sa

```
124.1.1.1       112.1.1.1       QM_IDLE           211    0
124.1.1.1       105.11.1.28     QM_IDLE          1120    0
124.2.1.1       105.15.1.100    QM_IDLE          1124    0
```

7.5 IPSec SAs

show crypto eli

```
Hardware Encryption Layer :   ACTIVE
 Number of crypto engines = 1 .

 CryptoEngine-VPNSM(1) (slot-1) details.
 Capability-IPSec : No-IPPCP, 3DES, NoAES, RSA
```

```
 IKE-Session   :     5 active, 10921 max, 0 failed
 DH-Key        :     0 active,  9999 max, 0 failed
 IPSec-Session :    10 active, 21842 max, 0 failed
```

7.6 IPSec SAs

show crypto ipsec sa peer 112.1.1.1

```
interface: Vlan101
    Crypto map tag: vpn1, local addr. 124.1.1.1

   protected vrf: vpn1
   local  ident (addr/mask/prot/port): (124.1.1.1/255.255.255.255/47/0)
   remote ident (addr/mask/prot/port): (112.1.1.1/255.255.255.255/47/0)
   current_peer: 112.1.1.1:500
     PERMIT, flags={}
    #pkts encaps: 6591, #pkts encrypt: 6591, #pkts digest: 6591
    #pkts decaps: 3908, #pkts decrypt: 3908, #pkts verify: 3908
    #pkts compressed: 0, #pkts decompressed: 0
    #pkts not compressed: 0, #pkts compr. failed: 0
    #pkts not decompressed: 0, #pkts decompress failed: 0
    #send errors 0, #recv errors 0

     local crypto endpt.: 124.1.1.1, remote crypto endpt.: 112.1.1.1
     path mtu 1500, media mtu 1500
     current outbound spi: F4989EFF

     inbound esp sas:
      spi: 0xEC50D6E3(3964720867)
        transform: esp-3des esp-sha-hmac ,
        in use settings ={Transport, }
        slot: 1, conn id: 12395, flow_id: 1469, crypto map: vpn1
        crypto engine type: Hardware, engine_id: 2
        sa timing: remaining key lifetime (k/sec): (330301/2270)
        ike_cookies: 5EB3B2E8 2BC1457F DFA91869 2F20321A
        IV size: 8 bytes
        replay detection support: Y

     inbound ah sas:

     inbound pcp sas:

     outbound esp sas:
      spi: 0xF4989EFF(4103642879)
```

```
        transform: esp-3des esp-sha-hmac ,
        in use settings ={Transport, }
        slot: 1, conn id: 12396, flow_id: 1470, crypto map: vpn1
        crypto engine type: Hardware, engine_id: 2
        sa timing: remaining key lifetime (k/sec): (330245/2270)
        ike_cookies: 5EB3B2E8 2BC1457F DFA91869 2F20321A
        IV size: 8 bytes
        replay detection support: Y

     outbound ah sas:

     outbound pcp sas:
```

8. 7200 CONFIGURATION VERIFICATION

8.1 Routes

Show ip route ospf

```
     124.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
S       124.2.1.1/32 [1/0] via 24.1.1.123
    112.0.0.0/32 is subnetted, 1 subnets
O E2    112.1.1.1 [110/100] via 124.1.1.254, 04:46:03, GigabitEthernet0/1
     105.0.0.0/32 is subnetted, 404 subnets
O E2    105.4.1.100 [110/100] via 124.1.1.254, 04:46:03, GigabitEthernet0/1
O E2    105.3.1.99 [110/100] via 124.1.1.254, 04:46:03, GigabitEthernet0/1
```

8.2 NHRP

Show ip NHRP dynamic

```
172.20.112.1/32 via 172.20.112.1, Tunnel1 created 04:23:16, expire 00:06:41
  Type: dynamic, Flags: authoritative unique registered
NBMA address: 112.1.1.1
172.20.1.1/32 via 172.20.1.1, Tunnel1 created 00:01:16, expire 00:13:43
  Type: dynamic, Flags: authoritative unique registered
  NBMA address: 105.1.1.1
172.20.1.2/32 via 172.20.1.2, Tunnel1 created 00:01:16, expire 00:13:43
  Type: dynamic, Flags: authoritative unique registered
NBMA address: 105.1.1.2
```

9. LIMITATIONS/CAVEATS/INTEGRATION ISSUES/GUIDELINES

- Hold queues need to be increased to avoid routing protocol and NHRP packet drops in large networks.
- Buffer tuning is generally not required but if buffer failures are seen in a large network, appropriate buffer tuning must be performed, especially on the hubs.
- Reverse Route Injection (RRI) and routing protocol are not required and a default route can be configured on the hub. If the hub already has a default route pointing to some other interface, then the RRI/RP combination will be helpful.

10. RELATED DOCUMENTS

Cisco.com documentation: http://www.cisco.com/warp/public/732/Tech/security/ipsec/dmvpn/

11. APPENDIX A

11.1 7600 Configuration

```
version 12.2
service timestamps debug uptime
service timestamps log datetime msec localtime
no service password-encryption
service counters max age 10
!
hostname DMVPN1-7600
!
!
no aaa new-model
clock timezone EST -5
clock summer-time edt recurring
ip subnet-zero
!
!
!
ip vrf vpn1
 rd 100:1
!
ip vrf vpn2
 rd 100:2
!
ipv6 mfib hardware-switching replication-mode ingress
mls ip multicast flow-stat-timer 9
no mls flow ip
no mls flow ipv6
no mls acl tcam share-global
mls cef error action freeze
no scripting tcl init
no scripting tcl encdir
!
```

```
!
!
crypto keyring vpn1
  local-address Loopback1
  pre-shared-key address 0.0.0.0 0.0.0.0 key cisco123
crypto keyring vpn2
  local-address Loopback2
  pre-shared-key address 0.0.0.0 0.0.0.0 key cisco456
!
crypto isakmp policy 10
 encr 3des
 authentication pre-share
 group 2
 lifetime 14400
crypto isakmp keepalive 60
crypto isakmp profile vpn1
   vrf vpn1
   keyring vpn1
   match identity address 0.0.0.0
   local-address Loopback1
crypto isakmp profile vpn2
   vrf vpn2
   keyring vpn2
   match identity address 0.0.0.0
   local-address Loopback2
!
crypto ipsec transform-set gre esp-3des esp-sha-hmac
 mode transport
!
crypto dynamic-map vpn1-dyna 10
 set transform-set gre
 set isakmp-profile vpn1
 reverse-route remote-peer
!
crypto dynamic-map vpn2-dyna 10
 set transform-set gre
 set isakmp-profile vpn2
 reverse-route remote-peer
!
!
crypto map vpn1 local-address Loopback1
crypto map vpn1 10 ipsec-isakmp dynamic vpn1-dyna
!
```

```
crypto map vpn2 local-address Loopback2
crypto map vpn2 10 ipsec-isakmp dynamic vpn2-dyna
!
!
crypto engine mode vrf
!
!
!
!
!
!
redundancy
 mode sso
 main-cpu
  auto-sync running-config
spanning-tree mode pvst
no spanning-tree optimize bpdu transmission
diagnostic cns publish cisco.cns.device.diag_results
diagnostic cns subscribe cisco.cns.device.diag_commands
!
vlan internal allocation policy ascending
vlan access-log ratelimit 2000
!
!
interface Loopback1
 ip address 124.1.1.1 255.255.255.255
!
interface Loopback2
 ip vrf forwarding vpn2-out
 ip address 124.2.1.1 255.255.255.255
!
interface GigabitEthernet1/1
 switchport
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 1,101-102,1002-1005
 switchport mode trunk
 mtu 4500
 no ip address
 flowcontrol receive on
 flowcontrol send off
 spanning-tree portfast trunk
!
interface GigabitEthernet1/2
```

```
 switchport
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 1,1002-1005
 switchport mode trunk
 mtu 4500
 no ip address
 flowcontrol receive on
 flowcontrol send off
 spanning-tree portfast trunk
!
interface GigabitEthernet4/1
 description TO G0/1 DMVPN1-G1-1
 ip vrf forwarding vpn1
 ip address 124.1.1.254 255.255.255.0
 speed nonegotiate
!
interface GigabitEthernet4/2
 description TO G0/1 DMVPN1-G1-2
 ip vrf forwarding vpn2
 ip address 124.2.1.254 255.255.255.0
 speed nonegotiate
!
!
interface GigabitEthernet5/1
 description TO GW
 ip address 124.4.1.1 255.255.255.0
 load-interval 30
 speed nonegotiate
 crypto engine slot 1
!
interface GigabitEthernet5/2
 description TO DMVPN-AGG-1 GIG 5/1 FOR MGMT
 switchport
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 24
 switchport mode trunk
 no ip address
 load-interval 30
!
interface Vlan1
 no ip address
 shutdown
!
```

```
interface Vlan24
 ip address 24.1.1.125 255.255.255.0
!
interface Vlan101
 ip vrf forwarding vpn1
 ip address 192.70.1.1 255.255.255.0
 crypto map vpn1
 crypto engine slot 1
!
interface Vlan102
 ip vrf forwarding vpn2
 ip address 192.70.2.1 255.255.255.0
 crypto map vpn2
 crypto engine slot 1
!
router ospf 10 vrf vpn1
 log-adjacency-changes
 redistribute static metric 100 subnets
 network 124.1.1.0 0.0.0.255 area 0
!
router ospf 20 vrf vpn2
 log-adjacency-changes
 redistribute static metric 100 subnets
 network 124.2.1.0 0.0.0.255 area 0
!
ip classless
ip route 0.0.0.0 0.0.0.0 124.4.1.254
!
no ip http server
!
logging 24.1.1.192
!
line con 0
 exec-timeout 0 0
 stopbits 1
line vty 0 4
 exec-timeout 0 0
 password lab
 login
!
!
monitor event-trace timestamps
```

```
no cns aaa enable
end
```

12. APPENDIX B

12.1 HUB1 Configuration

```
version 12.3
service timestamps debug datetime msec localtime
service timestamps log datetime msec localtime
no service password-encryption
!
hostname HUB-1
!
enable password lab
!
clock timezone EST -5
clock summer-time edt recurring
no aaa new-model
ip subnet-zero
!
!
ip cef
no ip domain lookup
!
!
no crypto isakmp enable
!
buffers small permanent 1000
buffers small max-free 1500
buffers small min-free 500
buffers middle permanent 1000
buffers middle max-free 1500
buffers middle min-free 500
buffers big permanent 250
buffers big max-free 500
buffers big min-free 150
!
!
!
interface Tunnel1
 bandwidth 10000000
 ip address 172.20.1.254 255.255.0.0
 no ip redirects
```

```
 ip mtu 1440
 no ip next-hop-self eigrp 10
 ip nhrp authentication nsite
 ip nhrp map multicast dynamic
 ip nhrp map 172.20.2.254 124.2.1.1
 ip nhrp map multicast 124.2.1.1
 ip nhrp network-id 101
 ip nhrp holdtime 600
 ip nhrp nhs 172.20.2.254
 no ip split-horizon eigrp 10
 load-interval 30
 tunnel source GigabitEthernet0/1
 tunnel mode gre multipoint
 hold-queue 500 in
 hold-queue 500 out
!
interface GigabitEthernet0/1
 ip address 124.1.1.1 255.255.255.0
 duplex full
 speed 1000
 media-type gbic
 no negotiation auto
 hold-queue 500 in
 hold-queue 500 out
!
interface GigabitEthernet0/2
 ip address 192.24.1.1 255.255.255.0
 duplex auto
 speed auto
 media-type rj45
 no negotiation auto
 no keepalive
!
interface GigabitEthernet0/3
 description TO  NHRP Private NET
 ip address 24.1.1.122 255.255.255.0
 duplex auto
 speed auto
 media-type rj45
 no negotiation auto
!
router eigrp 10
 network 172.20.0.0
```

```
 network 192.24.1.0
 no auto-summary
!
router ospf 254
 log-adjacency-changes
 network 124.1.1.0 0.0.0.255 area 0
!
ip classless
ip route 124.2.1.1 255.255.255.255 24.1.1.123
!
!
line con 0
 exec-timeout 0 0
 stopbits 1
line aux 0
 stopbits 1
line vty 0 4
 exec-timeout 0 0
 password lab
 login
!
!
end
```

13. APPENDIX C

13.1 HUB2 Configuration

```
version 12.3
service timestamps debug datetime msec localtime
service timestamps log datetime msec localtime
no service password-encryption
!
hostname HUB-2
!
enable password lab
!
no aaa new-model
ip subnet-zero
!
ip cef
no ip domain lookup
!
no crypto isakmp enable
```

```
!
buffers small permanent 1000
buffers small max-free 1500
buffers small min-free 500
buffers middle permanent 1000
buffers middle max-free 1500
buffers middle min-free 500
buffers big permanent 250
buffers big max-free 500
buffers big min-free 150
!
!
!
interface Tunnel1
 bandwidth 10000000
 ip address 172.20.2.254 255.255.0.0
 no ip redirects
 ip mtu 1440
 no ip next-hop-self eigrp 10
 ip nhrp authentication nsite
 ip nhrp map multicast dynamic
 ip nhrp map multicast 124.1.1.1
 ip nhrp map 172.20.1.254 124.1.1.1
 ip nhrp network-id 101
 ip nhrp holdtime 1800
 ip nhrp nhs 172.20.1.254
 no ip split-horizon eigrp 10
 load-interval 30
 tunnel source GigabitEthernet0/1
 tunnel mode gre multipoint
 hold-queue 500 in
 hold-queue 500 out
!
interface GigabitEthernet0/1
 ip address 124.2.1.1 255.255.255.0
 load-interval 30
 duplex full
 speed 1000
 media-type gbic
 no negotiation auto
 hold-queue 500 in
 hold-queue 500 out
!
```

```
interface GigabitEthernet0/2
 description Inside traffic vlan
 ip address 192.24.2.1 255.255.255.0
 load-interval 30
 duplex full
 speed 1000
 media-type gbic
 no negotiation auto
 no keepalive
!
interface GigabitEthernet0/3
 description FOR NHRP Traffic Private NET
 ip address 24.1.1.123 255.255.255.0
 duplex auto
 speed auto
 media-type rj45
 no negotiation auto
!
router eigrp 10
 passive-interface GigabitEthernet0/2
 network 172.20.0.0
 network 192.24.2.0
 no auto-summary
!
router ospf 254
 log-adjacency-changes
 network 124.2.1.0 0.0.0.255 area 0
!
ip classless
ip route 124.1.1.1 255.255.255.255 24.1.1.122
!
no ip http server
no ip http secure-server
!
line con 0
 exec-timeout 0 0
 stopbits 1
line aux 0
 stopbits 1
line vty 0 4
 exec-timeout 0 0
 password lab
 login
```

```
!
end
```

14. APPENDIX D

14.1 Spoke Configuration

```
version 12.3
service timestamps debug datetime msec localtime
service timestamps log datetime msec localtime
no service password-encryption
!
hostname SPOKE
!
!
no aaa new-model
ip subnet-zero
ip cef
!
no ip domain lookup
!
crypto isakmp policy 10
 encr 3des
 authentication pre-share
 group 2
 lifetime 14400
crypto isakmp key cisco address 0.0.0.0 0.0.0.0
crypto isakmp keepalive 60
!
crypto ipsec transform-set gre_set esp-3des esp-sha-hmac
 mode transport
!
crypto ipsec profile gre_prof
 set transform-set gre_set
!
interface Tunnel1
 bandwidth 128
 ip address 172.20.112.1 255.255.0.0
 no ip redirects
 ip mtu 1440
 ip nhrp authentication nsite
 ip nhrp map multicast 124.1.1.1
 ip nhrp map 172.20.1.254 124.1.1.1
 ip nhrp network-id 101
```

```
 ip nhrp holdtime 600
 ip nhrp nhs 172.20.1.254
 load-interval 30
 tunnel source FastEthernet0/0
 tunnel mode gre multipoint
 tunnel protection ipsec profile gre_prof
!
interface FastEthernet0/0
 ip address 112.1.1.1 255.255.255.0
 load-interval 30
 speed 100
 full-duplex
!
interface FastEthernet0/1
 description dmvpn interface
 no ip address
 load-interval 30
 duplex auto
 speed auto
!
interface FastEthernet0/1.11
 description traffic interface
 encapsulation dot1Q 11
 ip address 12.1.1.1 255.255.255.0
!
interface FastEthernet0/1.24
 description mgmt net
 encapsulation dot1Q 24
 ip address 24.1.1.161 255.255.255.0
!
router eigrp 10
 passive-interface FastEthernet0/1.11
 network 12.1.1.0 0.0.0.255
 network 172.20.0.0
 no auto-summary
!
router ospf 254
 log-adjacency-changes
 network 112.1.1.0 0.0.0.255 area 0
!
ip classless
!
line con 0
```

```
 exec-timeout 0 0
 stopbits 1
line aux 0
 stopbits 1
line vty 0 4
 exec-timeout 0 0
 password lab
 login
end
```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