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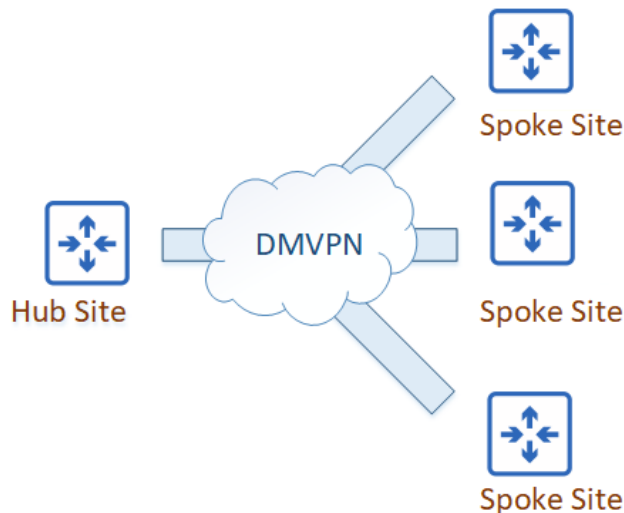
1 of 22

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## DMVPN (Dynamic Multipoint VPN):

- DMVPN is a term, which stands for Dynamic Multipoint Virtual Private Network.
- DMVPN is Cisco solution to build easy, dynamic and scalable IPsec and GRE VPNs.
- DMVPN is used to connect multiple sites in Partial or Full Mesh network topology.
- **DMVPN is Cisco tunnel technology with Hub-and-Spoke and Spoke to Spoke tunnels.**
- Hub-to-Spoke tunnels are always up, Spoke-to-Spoke are "On Demand" dynamically.
- **Cisco DMVPN's are a highly scalable, and easy to manage tunnel solution and method.**
- **Encryption is supported through IPsec which makes DMVPN a popular choice for connecting different sites using regular Internet connections.**
- **DMVPN keeping costs low, minimizing configuration complexity and increasing flexibility.**
- DMVPN, one central Router, usually placed at the **head office, undertakes the role of Hub.**
- Other **branch Routers are Spokes connect** to Hub Router to access Organizations resources.
- **Hub Router** undertakes the role of the **server** while the **spoke routers act as the clients.**
- **Hub maintains special NHRP database with public IP Addresses of all configured spokes.**
- The hub must have a known (Static) IP, while the spokes may use dynamic addressing.
- To secure the traffic passed over the Internet, IPSEC is used to encrypt the packets
- Direct spoke-to-spoke traffic is supported
- **DMVPN uses a combination of Multipoint GRE Tunnels (mGRE), Next Hop Resolution Protocol (NHRP), IPsec Crypto Profiles & Routing.**



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## DMVPN Terminology:

### NBMA Address:

- NBMA stands for Non-Broadcast Multiple Access Address.
- **NBMA IP Address, typically a public IP address** on Internet facing interface.

### Next Hop Client (NHC):

- Dynamic Multipoint Virtual Private Network Spoke Router(s) or Router on Spoke site.
- Registers its NBMA/protocol address mapping to NHS with NHRP registration messages.

### NHRP (Next Hop Resolution Protocol):

- We need something that helps our branch1 router figure out what the public IP address is of the branch2 router, we do this with a protocol called NHRP (Next Hop Resolution Protocol).

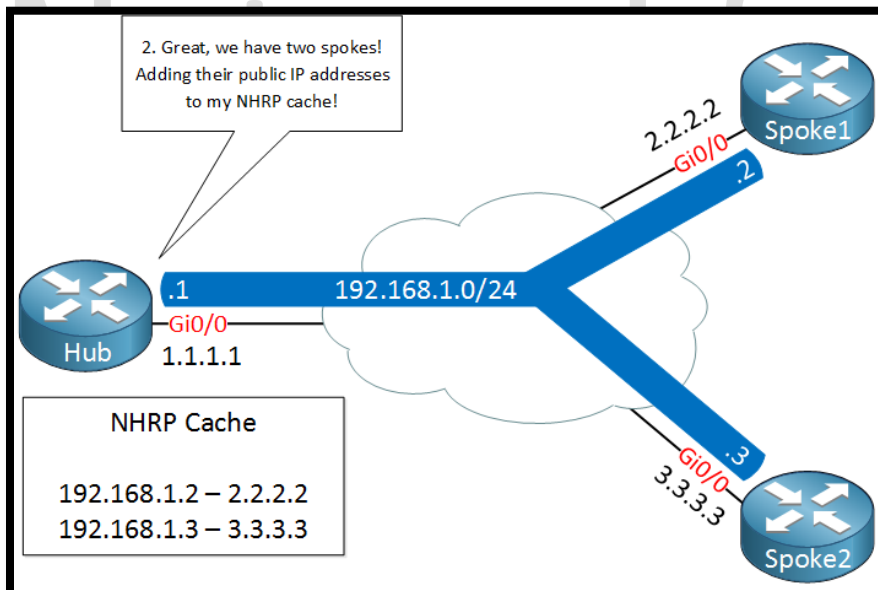
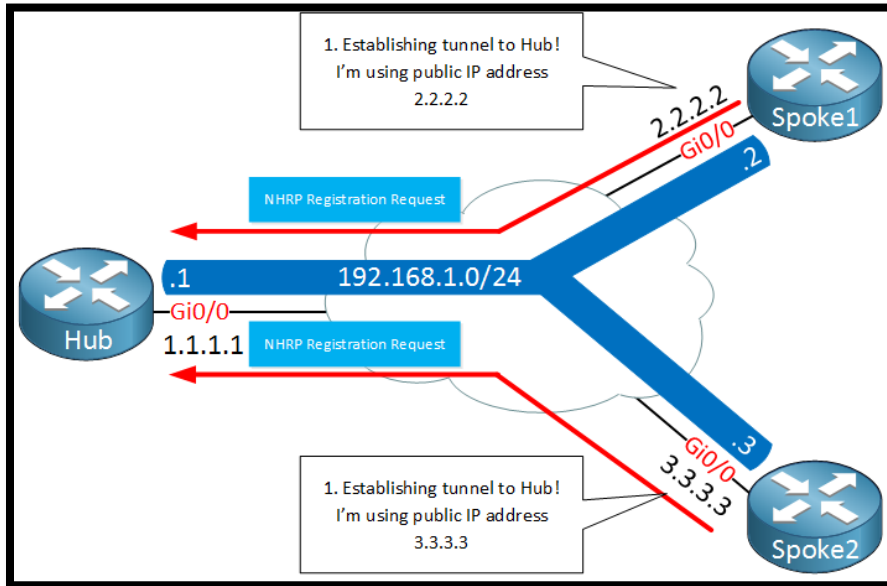
Here's an explanation of how NHRP works:

- One router will be the NHRP server.
- All other routers will be NHRP clients.
- NHRP clients register themselves with the NHRP server and report their public IP address.
- The NHRP server keeps track of all public IP addresses in its cache.
- When one router wants to tunnel something to another router, it will request the NHRP server for the public IP address of the other router.
- Since NHRP uses this server and client's model, it makes sense to use a hub and spoke topology for multipoint GRE. Our hub router will be the NHRP server and all other routers will be the spokes.

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3 of 22

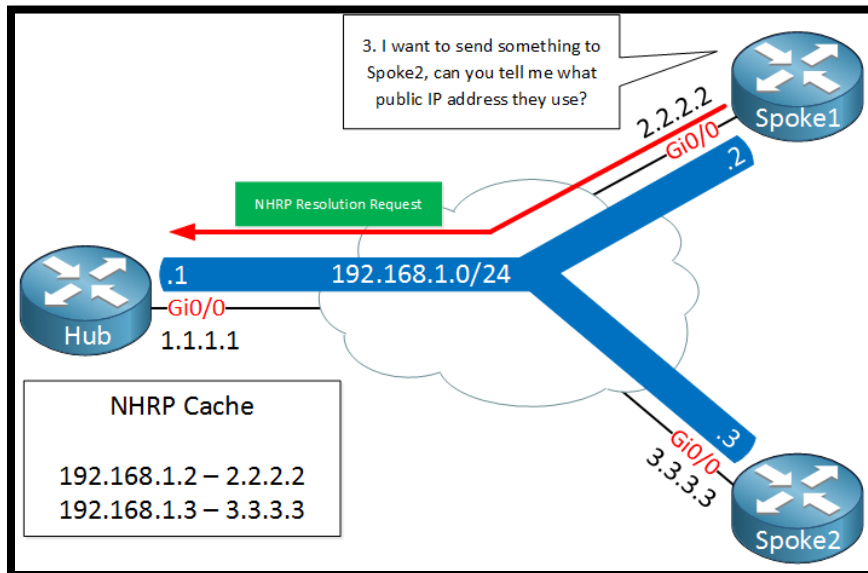
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4 of 22

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### DMVPN Deployment:

- Dynamic Multipoint Virtual Private Network can be **deployed in three different ways.**
- Dynamic Multipoint Virtual Private Network can be **deployed in phase 1, phase 2 or phase 3.**
- **Phase 1: Hub and Spoke mGRE at the Hub and Point-to-Point p2p GRE at Branch Routers.**
- **Phase 2: Hub and Spoke with Spoke-to-spoke tunnels (mGRE at the Hub & Branch Routers). (Summary route problem)**
- **Phase 3: Same as Phase 2 but now Spoke Routers can also respond to NHRP Requests. (Summary Route problem Solve)**
- Phase 2 allow spokes to build a spoke-to-spoke tunnel on demand with some restrictions.
- DMVPN Phase 2 supports spoke to spoke but requires a certain routing design to apply.
- Phase3 allow spokes to build spoke-to-spoke tunnel & overcomes the phase 2 restriction.
- Phase 3 is latest & flexible design supporting both hub-to-spoke & spoke-to-spoke tunnels.
- DMVPN using three different technologies- mGRE, Next-Hop Resolution Protocol & IPSec.

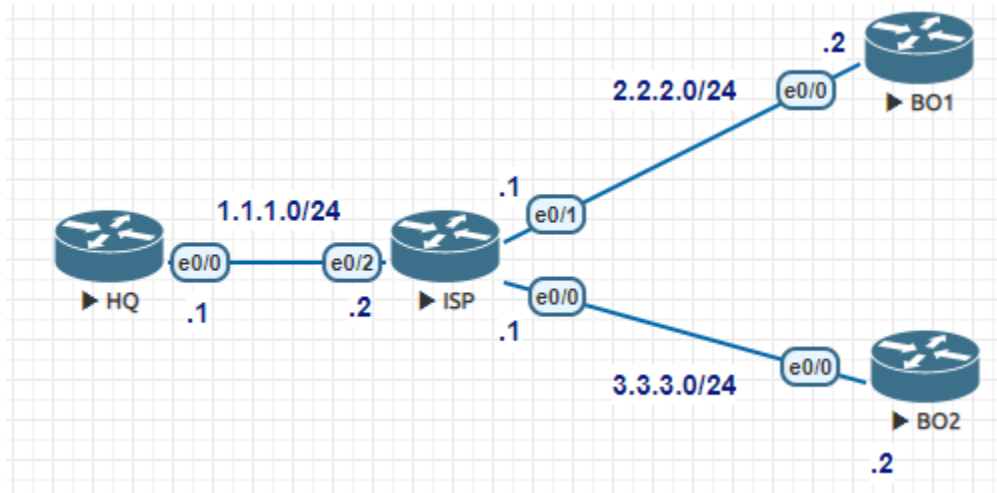
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5 of 22

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## Lab Time for DMVPN:



HQ Basic Configuration:	BO1 Basic Configuration:
<pre>en config t hostname HQ  int e0/0 ip add 1.1.1.1 255.255.255.0 no sh  ip route 0.0.0.0 0.0.0.0 1.1.1.2</pre>	<pre>en config t hostname BO1  int e0/0 ip add 2.2.2.2 255.255.255.0 no sh  ip route 0.0.0.0 0.0.0.0 2.2.2.1</pre>
ISP Configuration:	BO2 Basic Configuration:
<pre>en config t hostname ISP  int e0/2 ip add 1.1.1.2 255.255.255.0 no sh  int e0/1 ip add 2.2.2.1 255.255.255.0 no sh</pre>	<pre>en config t hostname BO2  int e0/0 ip add 3.3.3.2 255.255.255.0 no sh  ip route 0.0.0.0 0.0.0.0 3.3.3.1</pre>

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```
int e0/0
ip add 3.3.3.1 255.255.255.0
no sh
```

### Phase 1 – Hub to Spoke Design:

- Phase 1 was original implementation of DMVPN, based entirely on hub & spoke model.
- Spokes use NHRP & register with hub; hub router builds mGRE tunnel to connect all spokes.
- In DMVPN each spoke builds a regular GRE tunnel, and will only connect to the hub router.
- mGRE tunnel is configured at Hub and GRE tunnel is configured on the spoke's routers.
- Phase 1 DMVPN allows spoke routers to dynamically register with hub routers.
- Hub to Spoke design Multicast or Unicast traffic flow between Hub & Spokes only.
- In DMVPN **Phase 1 Hub to Spoke Design No Spoke-to-Spoke traffic flow is allowed.**
- In DMVPN **Phase 1 Hub to Spoke, Spoke-to-Spoke traffic traverse via the Hub router.**
- In **Phase 1 there is no way for spokes to directly communicate with each other.**
- **If spoke-1 wants to communicate with Spoke-3, traffic needs to flow via the hub.**
- traffic arrives at hub, needs to be decapsulated, then be encapsulated again & sent.
- Spoke routers only need summary or default route to hub to reach other spoke routers.

HQ Phase 1 Configuration:	BO1 Phase 1 Configuration:
<pre>interface Tunnel 0 ip address 172.16.123.1 255.255.255.0 tunnel mode gre multipoint tunnel source e0/0 ip nhrp authentication abc ip nhrp map multicast dynamic ip nhrp network-id 1</pre>	<pre>interface tunnel 0 ip address 172.16.123.2 255.255.255.0 ip nhrp authentication abc ip nhrp map 172.16.123.1 1.1.1.1 ip nhrp map multicast 1.1.1.1 ip nhrp network-id 1 ip nhrp nhs 172.16.123.1 tunnel source e0/0 tunnel destination 1.1.1.1</pre>
BO2 Phase 1 Configuration:	
<pre>interface tunnel 0 ip address 172.16.123.3 255.255.255.0 ip nhrp authentication abc ip nhrp map 172.16.123.1 1.1.1.1 ip nhrp map multicast 1.1.1.1 ip nhrp network-id 1 ip nhrp nhs 172.16.123.1</pre>	<pre>R1#show dmvpn R1#show ip nhrp</pre>

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```
tunnel source e0/0  
tunnel destination 1.1.1.1
```

**Tunnel mode:** by default the tunnel mode will be point-to-point GRE, we require a multipoint interface on the hub.

**Tunnel source:** The tunnel destinations will be dynamic but we still have to configure the source, our e0/0 interface.

**ip nhrp authentication:** We can authenticate our NHRP traffic, it's optional but a good idea to enable. I'm using pre-shared key "abc".

**ip nhrp map multicast dynamic:** This command tells the hub (HQ) router where to forward multicast packets to. Since the IP addresses of the spoke routers are unknown, we use dynamic to automatically add their IP addresses to the multicast destination list when the spokes register themselves.

**ip nhrp network-id:** When you use multiple DMVPN networks, you need the network ID to differentiate between the two networks. This value is only locally significant but for troubleshooting reasons it's best to use the same value on all routers.

**ip nhrp nhs:** This is where we specify the NHRP server, our HQ (Hub) router.

```
B02#traceroute 172.16.123.2  
Type escape sequence to abort.  
Tracing the route to 172.16.123.2  
VRF info: (vrf in name/id, vrf out name/id)  
 1 172.16.123.1 8 msec 2 msec 2 msec  
 2 172.16.123.2 2 msec 2 msec *
```

```
B01#traceroute 172.16.123.3  
Type escape sequence to abort.  
Tracing the route to 172.16.123.3  
VRF info: (vrf in name/id, vrf out name/id)  
 1 172.16.123.1 8 msec 3 msec 2 msec  
 2 172.16.123.3 4 msec 5 msec *
```

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## Phase 2 – Spoke to Spoke Design:

- Biggest limitation in Phase 1 was the lack of direct communication between spokes.
- Phase 2 is an improvement on Phase 1, It retains dynamic spoke registration.
- Add mGRE on spoke side, this means enables direct communication between spokes.
- Phase-2 Spoke routers can now communicate directly without traffic traversing hub.
- In DMVPN Phase 2, Hub and all Spokes will be configured with mGRE tunnel.
- In DMVPN Phase 2, Spoke-to-Spoke traffic traverse via direct dynamic VPN tunnel.
- In DMVPN Phase 2, Spoke starts by sending an NHRP Resolution Request to the hub.
- The hub looks into its cache of NBMA address mappings and finds the correct entry.
- Router caches info request & then sends NHRP Resolution Response back to original spoke.
- The response contains the NBMA address details of the destination spoke router.
- The spoke router now knows the NBMA address details of the remote spoke router.
- In DMVPN the hub forwards the resolution request to the remote spoke router.
- In DMVPN Phase 2, Route Summarization not feasible at Hub Router.

## DMVPN Phase 2 Configuration:

- The configuration of DMVPN phase 1 and 2 is similar except for two key items.
- Spoke routers use **multipoint GRE interfaces instead of point-to-point GRE interfaces.**
- Also, **no need to configure a manual destination anymore on the spoke (Branchs) routers.**
- **Removed tunnel destination command & added tunnel mode command GRE multipoint.**
- These two changes make the difference between running DMVPN phase 1 or phase 2.

HQ Phase 2 Configuration:	BO1 Phase 2 Configuration:
<pre>interface Tunnel 0 ip address 172.16.123.1 255.255.255.0 tunnel mode gre multipoint tunnel source e0/0 ip nhrp authentication abc ip nhrp map multicast dynamic ip nhrp network-id 1</pre>	<pre>interface tunnel 0 ip address 172.16.123.2 255.255.255.0 ip nhrp authentication abc ip nhrp map 172.16.123.1 1.1.1.1 ip nhrp map multicast 1.1.1.1 ip nhrp network-id 1 ip nhrp nhs 172.16.123.1 tunnel source e0/0 <b>no tunnel destination 1.1.1.1</b> <b>tunnel mode gre multipoint</b></pre>
BO2 Phase 2 Configuration:	
<pre>interface tunnel 0 ip address 172.16.123.3 255.255.255.0</pre>	

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```

ip nhrp authentication abc
ip nhrp map 172.16.123.1 1.1.1.1
ip nhrp map multicast 1.1.1.1
ip nhrp network-id 1
ip nhrp nhs 172.16.123.1
tunnel source e0/0
no tunnel destination 1.1.1.1
tunnel mode gre multipoint

```

### Phase 3 – Spoke to Spoke Design:

- DMVPN Phase 3 is the final and most scalable phase in Dynamic Multipoint VPN.
- On spokes only need to enable NHRP shortcuts for Dynamic Multipoint VPN phase 3.
- Phase-3 adds efficient route summarization & allowing Spoke-to-Spoke communication.
- The spoke will no longer start with an NHRP Resolution Request but sending traffic directly.

### DMVPN Phase 3 Configuration:

- To change from Dynamic Multi VPN phase 2 to phase 3, only need two commands.
- There are two commands NHRP redirects on the hub (HQ), and shortcut routes on the spokes (Branches).
- The NHRP redirect command on the hub (HQ) will inform spoke routers that they can reach another spoke router directly.

HQ(config)#interface tunnel 0

HQ(config-if)#ip nhrp redirect

- The NHRP shortcut command allows the spoke routers to makes changes in the CEF entry when they receive a redirect message from the hub.

BO1 & BO2

(config)#interface Tunnel 0

(config-if)#ip nhrp shortcut

HQ Phase 3 Configuration:	BO1 Phase 3 Configuration:
interface Tunnel 0 ip address 172.16.123.1 255.255.255.0 tunnel mode gre multipoint	interface tunnel 0 ip address 172.16.123.2 255.255.255.0 ip nhrp authentication abc

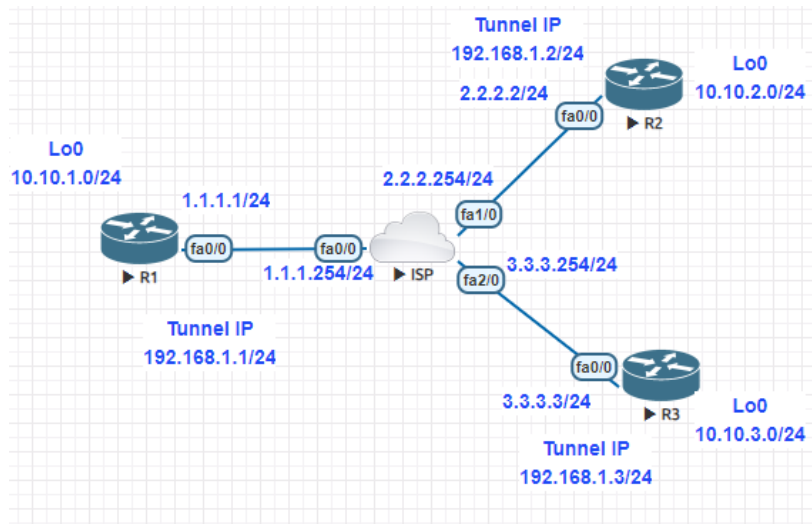
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<pre>tunnel source e0/0 ip nhrp authentication abc ip nhrp map multicast dynamic ip nhrp network-id 1 <b>ip nhrp redirect</b></pre>	<pre>ip nhrp map 172.16.123.1 1.1.1.1 ip nhrp map multicast 1.1.1.1 ip nhrp network-id 1 ip nhrp nhs 172.16.123.1 tunnel source e0/0 tunnel mode gre multipoint <b>ip nhrp shortcut</b></pre>
<b>BO2 Phase 3 Configuration:</b>	
<pre>interface tunnel 0 ip address 172.16.123.3 255.255.255.0 ip nhrp authentication abc ip nhrp map 172.16.123.1 1.1.1.1 ip nhrp map multicast 1.1.1.1 ip nhrp network-id 1 ip nhrp nhs 172.16.123.1 tunnel source e0/0 tunnel mode gre multipoint <b>ip nhrp shortcut</b></pre>	

Lab2:



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### R1(Hub) Basic Configuration:

```
en
config t
hostname Hub

int f0/0
ip add 1.1.1.1 255.255.255.0
no shutdown
interface loopback0
ip add 10.10.1.1 255.255.255.0
no shutdown
ip route 0.0.0.0 0.0.0.0 1.1.1.254
```

### R2 (Spoke1) Basic Configuration:

```
en
config t
hostname Spoke1

int f0/0
ip add 2.2.2.2 255.255.255.0
no shutdown
interface loopback0
ip add 10.10.2.1 255.255.255.0
no shutdown
ip route 0.0.0.0 0.0.0.0 2.2.2.254
```

### R3 (Spoke2) Basic Configuration:

```
en
config t
hostname Spoke2

int f0/0
ip add 3.3.3.3 255.255.255.0
no shutdown
interface loopback0
ip add 10.10.3.1 255.255.255.0
no shutdown
ip route 0.0.0.0 0.0.0.0 3.3.3.254
```

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## ISP Router Configuration:

```
en
config t
hostname ISP
int f0/0
#ip add 1.1.1.254 255.255.255.0
no shutdown
int f1/0
ip add 2.2.2.254 255.255.255.0
no shutdown
int f2/0
ip add 3.3.3.254 255.255.255.0
no shutdown
```

## R1 Hub Router Phase 1 Configuration:

```
interface Tunnel 0
ip address 192.168.1.1 255.255.255.0
tunnel mode gre multipoint
tunnel source f0/0
ip nhrp authentication abc
ip nhrp map multicast dynamic
ip nhrp network-id 1

show command:
sh dmvpn
sh ip nhrp
```

## R2 Spoke1 Router Phase 1 Configuration:

```
interface tunnel 0
ip address 192.168.1.2 255.255.255.0
ip nhrp authentication abc
ip nhrp map 192.168.1.1 1.1.1.1
ip nhrp map multicast 1.1.1.1
ip nhrp network-id 1
ip nhrp nhs 192.168.1.1
tunnel source f0/0
tunnel destination 1.1.1.1
show command:
sh dmvpn
sh ip nhrp
```

## R3 Spoke2 Router Phase 1 Configuration:

```
interface tunnel 0
```

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```
ip address 192.168.1.3 255.255.255.0
ip nhrp authentication abc
ip nhrp map 192.168.1.1 1.1.1.1
ip nhrp map multicast 1.1.1.1
ip nhrp network-id 1
ip nhrp nhs 192.168.1.1
tunnel source f0/0
tunnel destination 1.1.1.1
show command:
sh dmvpn
sh ip nhrp
```

#### **EIGRP Configuration on Hub Router:**

```
router eigrp 1
network 10.10.1.0 0.0.0.255
network 192.168.1.0
no auto-summary
```

----

In hub we need to disable split-horizon

Because RIP and EIGRP use Split-horizon rule to remove loop from network. as in HUB packet is coming from same interface and going back to same interface (as Spoke1 send to hub and hub send to Spoke2 with same interface f0/0) so they block that so we need to disable split-horizon

```
int tunnel 0
no ip split-horizon eigrp 1
```

#### **EIGRP Configuration on Spoke1 Router:**

```
router eigrp 1
network 10.10.2.0 0.0.0.255
network 192.168.1.0
no auto-summary
```

#### **EIGRP Configuration on Spoke2 Router:**

```
router eigrp 1
network 10.10.3.0 0.0.0.255
network 192.168.1.0
no auto-summary
```

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```
Spoke1#traceroute 10.10.3.1 source 10.10.2.1
```

```
Type escape sequence to abort.  
Tracing the route to 10.10.3.1
```

```
 1 192.168.1.1 32 msec 40 msec 36 msec  
 2 192.168.1.3 52 msec 64 msec *
```

```
Spoke2#traceroute 10.10.2.1 source 10.10.3.1
```

```
Type escape sequence to abort.  
Tracing the route to 10.10.2.1
```

```
 1 192.168.1.1 28 msec 40 msec 28 msec  
 2 192.168.1.2 64 msec 56 msec *
```

### DMVPN Phase 2 Configuration:

- The configuration of DMVPN phase 1 and 2 is similar except for two key items.
- Spoke routers use multipoint GRE interfaces instead of point-to-point GRE interfaces.
- Also, no need to configure a manual destination anymore on the spoke routers.
- Removed tunnel destination command & added tunnel mode command GRE multipoint.
- These two changes make the difference between running DMVPN phase 1 or phase 2.

### **R1 Hub Router Phase 2 Configuration:**

```
interface Tunnel 0  
ip address 192.168.1.1 255.255.255.0  
!no ip redirects  
tunnel mode gre multipoint  
tunnel source f0/0  
ip nhrp authentication abc  
ip nhrp map multicast dynamic  
ip nhrp network-id 1
```

show command:

```
sh dmvpn  
sh ip nhrp
```

### **R2 Spoke1 Router Phase 2 Configuration:**

```
interface tunnel 0  
ip address 192.168.1.2 255.255.255.0
```

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```
ip nhrp authentication abc
ip nhrp map 192.168.1.1 1.1.1.1
ip nhrp map multicast 1.1.1.1
ip nhrp network-id 1
ip nhrp nhs 192.168.1.1
tunnel source f0/0
tunnel destination 1.1.1.1
no tunnel destination 1.1.1.1
tunnel mode gre multipoint
show command:
sh dmvpn
sh ip nhrp
```

### R3 Spoke2 Router Phase 2 Configuration:

```
interface tunnel 0
ip address 192.168.1.3 255.255.255.0
ip nhrp authentication abc
ip nhrp map 192.168.1.1 1.1.1.1
ip nhrp map multicast 1.1.1.1
ip nhrp network-id 1
ip nhrp nhs 192.168.1.1
tunnel source f0/0
tunnel destination 1.1.1.1
no tunnel destination 1.1.1.1
tunnel mode gre multipoint
show command:
sh dmvpn
sh ip nhrp
```

### Routing on Phase 2:

- For EIGRP, need to disable split-horizon on Hub mGRE tunnel interface.
- **Disable Split-horizon on Hub tunnel Interface to ensure optimal forwarding.**
- Also need to disable the default EIGRP behavior to overwrite the next-hop as itself.

### EIGRP Configuration on Hub Router:

```
router eigrp 1
network 10.10.1.0 0.0.0.255
network 192.168.1.0
no auto-summary
----
```

In hub we need to diable split-horizon

Because RIP and EIGRP use Split-horizon rule to remove loop from network.

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16 of 22

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as in HUB packet is coming from same interface and going back to same interface (as Spoke1 send to hub and hub send to Spoke2 with same interface f0/0) so they block that so we need to disable split-horizon

**When spoke1 tries to reach spoke2, it will go through the hub. That's not what we want so let's tell EIGRP not to **change the next hop IP** address:**

```
int tunnel 0
no ip split-horizon eigrp 1
no ip next-hop-self eigrp 1
```

commands are used to prevent routing loops in a DMVPN network.

#### EIGRP Configuration on Spoke1 Router:

```
router eigrp 1
network 10.10.2.0 0.0.0.255
network 192.168.1.0
no auto-summary
```

#### EIGRP Configuration on Spoke2 Router:

```
router eigrp 1
network 10.10.3.0 0.0.0.255
network 192.168.1.0
no auto-summary
```

```
Spoke1#traceroute 10.10.3.1 source 10.10.2.1
```

```
Type escape sequence to abort.
Tracing the route to 10.10.3.1
```

```
 0 192.168.1.1 52 msec
  1 192.168.1.3 60 msec 32 msec
```

```
Spoke1#traceroute 10.10.3.1 source 10.10.2.1
```

```
Type escape sequence to abort.
Tracing the route to 10.10.3.1
```

```
 0 192.168.1.3 32 msec 36 msec *
```

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17 of 22

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```
Spoke2#sh ip route eigrp
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2
i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
ia - IS-IS inter area, * - candidate default, U - per-user static route
o - ODR, P - periodic downloaded static route, + - replicated route
```

Gateway of last resort is 3.3.3.254 to network 0.0.0.0

```
10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
D 10.10.1.0/24 [90/27008000] via 192.168.1.1, 00:03:16, Tunnel0
D 10.10.2.0/24 [90/28288000] via 192.168.1.1, 00:03:16, Tunnel0
```

After putting this command 10.10.2.0 via 192.168.1.2 before 192.168.1.1

### Int tun 0

### no ip next-hop-self eigrp 1

```
Spoke2#sh ip route eigrp
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2
i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
ia - IS-IS inter area, * - candidate default, U - per-user static route
o - ODR, P - periodic downloaded static route, + - replicated route
```

Gateway of last resort is 3.3.3.254 to network 0.0.0.0

```
10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
D 10.10.1.0/24 [90/27008000] via 192.168.1.1, 00:00:20, Tunnel0
D 10.10.2.0/24 [90/28288000] via 192.168.1.2, 00:00:18, Tunnel0
```

Some show commands:

```
R1# show ip route
R1# show ip route eigrp
R2# show ip route
R2# show ip route eigrp
R3# show ip route
R3# show ip route eigrp
R3# ping 10.10.2.1 source loopback 1
R2# ping 10.10.3.1 source loopback 1
R3# traceroute 10.10.2.1 source loopback 1
R3# traceroute 10.10.3.1 source loopback 1
```

Now if we have summary route for example, I will say I am getting 10.10.3.1,10.10.4.1,10.10.5.1,10.10.6.1 from Spoke 2

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networkforyou4@gmail.com

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So, I will do summary route for that and put that in hub as hub is going to received lot of routes

I will calculate with summary calculator available in online (just I am doing randomly to show some example)

Link for online website I use

<https://asecuritysite.com/ip/routesum>

**Route Summarization**

[IP Home][Home]

This is a Route Summarization calculator [Theory][Test1][Test2]. Please enter some route values seperated by spaces (such as 1.2.3.4 1.2.3.5), or if it is a range, enter between "-" (such as 172.16.128.0-172.16.159.255):

Enter routes:

Route Summarization:

Subnet:  Inverted mask: 0.0.7.255

00001010.00001010.00000011.00000000 (10.10.3.0)  
00001010.00001010.00000110.00000000 (10.10.6.0)

So I put that in Hub Router under interface Tunnel 0

```
Hub(config)#interface tunnel 0
```

```
Hub(config-if)#ip summary-address eigrp 1 10.10.0.0 255.255.248.0
```

As we know phase 2 is not supporting summary routes so we will have issues

**When we send any traffic from Spoke 2 to Spoke 3 then it will go with Hub to overcome this problem, we need to configure Phase 3**



```
Spoke1#traceroute 10.10.3.1 source 10.10.2.1
```

```
Type escape sequence to abort.  
Tracing the route to 10.10.3.1
```

```
1 192.168.1.1 40 msec 24 msec 20 msec  
2 192.168.1.3 84 msec 68 msec *
```

```
Spoke1#traceroute 10.10.3.1 source 10.10.2.1
```

```
Type escape sequence to abort.  
Tracing the route to 10.10.3.1
```

```
1 192.168.1.1 24 msec 32 msec 32 msec  
2 192.168.1.3 52 msec 48 msec *
```

```
Spoke1#traceroute 10.10.3.1 source 10.10.2.1
```

```
Type escape sequence to abort.  
Tracing the route to 10.10.3.1
```

```
1 192.168.1.1 20 msec 20 msec 24 msec  
2 192.168.1.3 52 msec 36 msec *
```

### R1 Hub Router Phase 3 Configuration:

```
interface Tunnel 0  
ip address 192.168.1.1 255.255.255.0  
!no ip redirects  
tunnel mode gre multipoint  
tunnel source f0/0  
ip nhrp authentication abc  
ip nhrp map multicast dynamic  
ip nhrp network-id 1  
ip nhrp redirect  
show command:  
sh dmvpn  
sh ip nhrp
```

### R2 Spoke1 Router Phase 3 Configuration:

```
interface tunnel 0  
ip address 192.168.1.2 255.255.255.0  
ip nhrp authentication abc  
ip nhrp map 192.168.1.1 1.1.1.1  
ip nhrp map multicast 1.1.1.1  
ip nhrp network-id 1  
ip nhrp nhs 192.168.1.1
```

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```
tunnel source f0/0
tunnel destination 1.1.1.1
ip nhrp shortcut
show command:
sh dmvpn
sh ip nhrp
```

### R3 Spoke2 Router Phase 3 Configuration:

```
interface tunnel 0
ip address 192.168.1.3 255.255.255.0
ip nhrp authentication abc
ip nhrp map 192.168.1.1 1.1.1.1
ip nhrp map multicast 1.1.1.1
ip nhrp network-id 1
ip nhrp nhs 192.168.1.1
tunnel source f0/0
tunnel destination 1.1.1.1
ip nhrp shortcut

show command:
sh dmvpn
sh ip nhrp
```

After Configuration of that first time it will go Hub after that they will communicated directly as show below.

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```
Spokel#traceroute 10.10.3.1 source 10.10.2.1
```

```
Type escape sequence to abort.  
Tracing the route to 10.10.3.1
```

```
1 192.168.1.1 48 msec 48 msec 24 msec  
2 192.168.1.3 64 msec 80 msec *
```

```
Spokel#traceroute 10.10.3.1 source 10.10.2.1
```

```
Type escape sequence to abort.  
Tracing the route to 10.10.3.1
```

```
1 192.168.1.3 28 msec 28 msec *
```

```
Spokel#traceroute 10.10.3.1 source 10.10.2.1
```

```
Type escape sequence to abort.  
Tracing the route to 10.10.3.1
```

```
1 192.168.1.3 28 msec 24 msec *
```

```
Spokel#sh ip route 0.0.0.0
```

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