Configuring Unicast and Multicast over Point-to-Multipoint GRE

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Prerequisites for Unicast and Multicast over Point-to-Multipoint GRE

- Before configuring multicast routing over multipoint Generic Routing Encapsulation (mGRE), you should be familiar with the concepts of IP multicast routing technology and mGRE tunneling.

Restrictions for Unicast and Multicast over Point-to-Multipoint GRE

- This feature is not supported on the C9500-12Q, C9500-16X, C9500-24Q, C9500-40X models of the Cisco Catalyst 9500 Series Switches.
- IPv6 multicast over mGRE tunnel is not supported.
- mGRE tunnel maximum transmission unit (MTU) does not get auto updated upon IP MTU change in the underlying network. Tunnel MTU has to be updated manually.
- mGRE can use only IPv4 as the transport protocol, and can tunnel both IPv4 and IPv6 packets across the underlying network infrastructure.
- Only IPv4 Next Hop Resolution Protocol (NHRP) is supported, , and as a result, an non-broadcast multiple access network (NBMA) can only be IPv4.
- Bidirectional Protocol Independent Multicast (PIM) is not supported.

- Tunnel source can be a Layer 3 etherchannel, loopback, physical, or Switched Virtual Interface (SVI).
- No feature interactions such as access control list (ACL), Cisco Discovery Protocol, Crypto support, IPSec, or quality of service (QoS) are supported on the mGRE tunnel.
- All routing protocol that uses mutlicast requires additional configurations.

Information About Unicast and Multicast over Point-to-Multipoint GRE

Information About NHRP

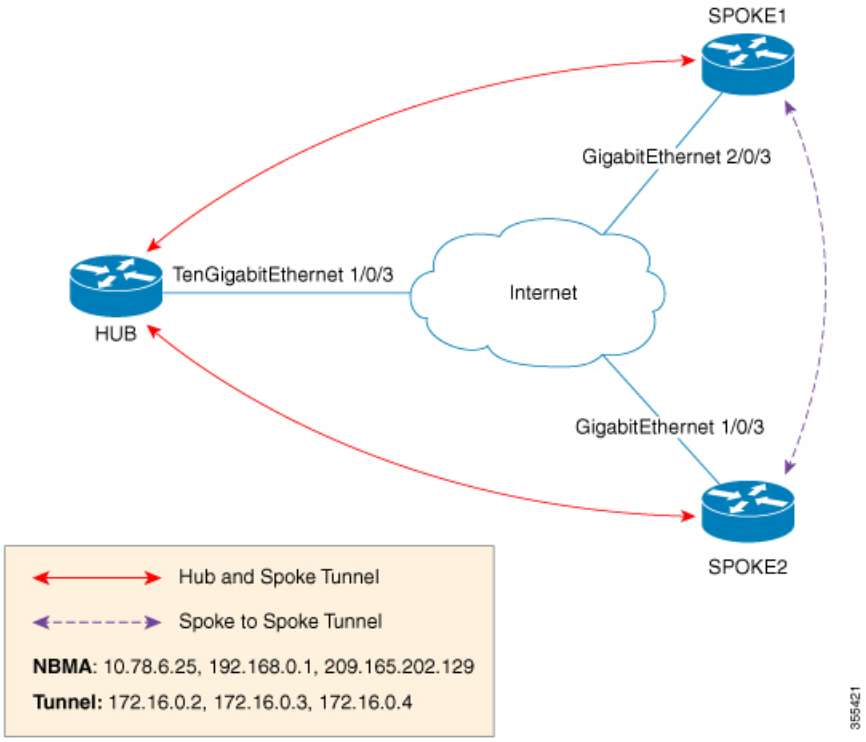
The Next Hop Resolution Protocol (NHRP) is like the Address Resolution Protocol (ARP) that dynamically maps a non-broadcast multiaccess (NBMA) network instead of manually configuring all the tunnel end points. With NHRP, systems attached to an NBMA network can dynamically learn the NBMA physical address of other systems that are part of that network, allowing these systems to directly communicate.

This protocol provides an ARP-like solution which allow station data-link addresses to dynamically determine NHRP as a client and server protocol, where the hub is the Next Hop Server (NHS) and the spokes are the Next Hop Clients (NHCs). The hub maintains an NHRP database of public interface addresses of each spoke. Each spoke registers its non-NBMA (real) address when it boots up and queries the NHRP database for addresses of the destination spokes to build direct tunnels.

Information About mGRE

The traditional implementation of a GRE tunnel involves the configuration of a point-to-point tunnel going between two sites. This type of configuration works well when there are limited number of tunnels that need to be configured. However, if there are a large number of spoke sites, the configuration of the hub router and the number of independent IP address ranges (one per tunnel) can quickly get excessive. In such cases, you can use Multipoint GRE (mGRE) at the hub site and normal point-to-point GRE configuration at the spokes. mGRE is configured over an IPv4 core/underlying network and allows multiple destinations to be grouped into a single multipoint interface.

Figure 1: Sample mGRE Configuration at Hub and Spokes



There are two different ways to configure mGRE on the hub and leave a normal GRE configuration on spokes:

- Static NHRP mapping statements on the hub router
- Dynamic NHRP mapping on the hub router

In static mappings, the hub router is manually configured with the spoke IP in the NHRP configuration and spokes are configured as point-to-point GRE tunnels. But if there are several branch routers, the configuration on the hub router becomes lengthy, and dynamic NHRP is used on the hub router. When using dynamic NHRP, the hub router requires that each of the spoke routers be configured to register with a Next Hop Server (NHS), which would also typically be the hub router. This NHS keeps track of the NHRP mappings so that the hub device knows where to send traffic (sent to multiple tunnel destinations). For this configuration to work correctly the IP address of the NHS server must also be statically mapped on spoke routers.

With the above hub-spoke topology, the only available way for spokes to send traffic to other spokes is to forward traffic through the hub. This requires an extra hop that may not be required when forwarding traffic. Each of the spokes has the ability to forward traffic directly to each other on the underlying IP network. When this happens, it will be more efficient for the spoke-to-spoke traffic to be routed directly between the spokes without having to jump through the hub router.

If both the hub and spokes are configured to use mGRE then the ability to set up dynamic spoke-to-spoke tunnels is permitted. With this configuration, each spoke still use the hub as an NHS which allows the hub to keep track of each of the spoke sites. It also allows mGRE and NHRP to work together to inform the spokes what the forwarding information is for the other spokes. This information can then be used for each of the spokes to dynamically set up mGRE tunnels between each of the other spokes, as required.

How to Configure Unicast and Multicast over Point-to-Multipoint GRE

Configuring Unicast mGRE for Hub

Perform this task to configure unicast mGRE for a hub:

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device>enable`	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device#configure terminal`	Enters global configuration mode.
Step 3	**interface tunnel** *tunnel-number* **Example:** `Device(config)#interface tunnel 1`	Configures an interface and enters interface configuration mode.
Step 4	**tunnel mode gre multipoint** **Example:** `Device(config-if)#tunnel mode gre multipoint`	Configures multipoint GRE as the tunnel mode.
Step 5	**ip ospf network point-to-multipoint** **Example:** `Device(config-if)#ip ospf network point-to-multipoint`	If the underlying protocol is OSPF, execute this command to set the network type to point-to-multipoint.
Step 6	**ip address** *address mask* **Example:** `Device(config-if)#ip address 10.1.1.1 255.255.255.255`	Configures the IP address of the tunnel.
Step 7	**ipv6 address** *address prefix* **Example:** `Device(config-if)#ipv6 address 2001:DB8:1::1`	Configures the IPv6 address of the tunnel.

	Command or Action	Purpose
Step 8	**tunnel source** *address* **Example:** `Device(config-if)#tunnel source TenGigabitEthernet1/0/3`	Configures the source IP address of the tunnel.
Step 9	**{ip | ipv6} nhrp network-id** *id* **Example:** `Device(config-if)#ip nhrp network-id 1`	Defines the NHRP domain which differentiates if multiple NHRP domains (GRE tunnel interfaces) are available on the same NHRP router.
Step 10	**{ip | ipv6} nhrp registration timeout** *seconds* **Example:** `Device(config-if)#ip nhrp registration timeout 30`	Changes the interval that NHRP NHCs take to send NHRP registration requests to configured NHRP NHSs.
Step 11	**{ip | ipv6} nhrp holdtime** *seconds* **Example:** `Device(config-if)#ip nhrp holdtime 400`	Changes the number of seconds that NHRP NBMA addresses are advertised as valid in positive NHRP responses.
Step 12	**{ip | ipv6} nhrp authentication** *string* **Example:** `Device(config-if)#ip nhrp authentication DMVPN`	Specifies an authentication string.
Step 13	**ip pim nbma-mode** **Example:** `Device(config-if)#ip pim nbma-mode`	Configures a multiaccess WAN interface to be in non-broadcast multiaccess (NBMA) mode.
Step 14	**end** **Example:** `Device(config-if)#end`	Exits interface configuration mode and returns to priviledged EXEC mode.

Configuring Unicast mGRE at a Spoke

Perform this task to configure unicast mGRE at spokes:

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device>enable`	Enables privileged EXEC mode. Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Device#configure terminal`	Enters global configuration mode.
Step 3	**interface tunnel** *tunnel-number* **Example:** `Device(config)#interface tunnel 1`	Configures an interface and enters interface configuration mode.
Step 4	**ip nhrp map** *ip-address nbma-address* **Example:** `Device(config-if)#ip nhrp map 10.0.0.1 192.0.0.1`	Configures static IP-to-NBMA address mapping of a hub router on the spoke.
Step 5	**{ip | ipv6} nhrp map multicast** *nbma-address* **Example:** `Device(config-if)#ip nhrp map multicast 10.0.0.2`	Enables IP multicast and broadcast packets (example: routing protocol information) to be sent from the spoke to the hub.
Step 6	**ip nhrp nhs** *nhs-address* **Example:** `Device(config-if)#ip nhrp nhs 192.0.2.1`	Enables the spoke to send NHRP registration request to the hub. • Here *nhs-address* is the tunnel address of the hub.
Step 7	**ipv6 nhrp nhs** *nhs-address* **Example:** `Device(config-if)#ipv6 nhrp nhs 2001:DB8:1::2`	Enables the spoke to send an NHRP registration request to the hub. Here *nhs-address* is the IPv6 address of the hub tunnel.
Step 8	**ipv6 nhrp map** *address/prefix nbma address* **Example:** `Device(config-if)#ipv6 nhrp map 2001:DB8:1::3 192.0.2.2`	Configures static IPv6-to-NBMA address mapping of the hub on the spoke.
Step 9	**end** **Example:** `Device(config-if)#end`	Exits interface configuration mode and returns to privileged EXEC mode.

Configuring Unicast mGRE at the Hub

Perform this task to configure unicast mGRE at the hub:

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device>enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device#configure terminal`	Enters global configuration mode.
Step 3	**interface tunnel** *tunnel-number* **Example:** `Device(config)#interface tunnel 1`	Configures an interface and enters interface configuration mode.
Step 4	**{ip | ipv6} nhrp map multicast dynamic** **Example:** `Device(config-if)#ip nhrp map multicast dynamic`	Enables the NHRP server (hub) to create a broadcast/multicast mapping for the spoke when spoke routers register their unicast NHRP mapping with the hub.
Step 5	**{ip | ipv6} next-hop-self eigrp** *number* **Example:** `Device(config-if)#ip next-hop-self eigrp 10`	Enables the hub to use the next received hop while sending routing protocol updates of one spoke to another, so that hosts behind hosts can be reached directly.
Step 6	**{ip | ipv6} split-horizon eigrp** *number* **Example:** `Device(config-if)#ip split-horizon eigrp 10`	Enables routing protocol updates of one spoke to be sent to another spoke.
Step 7	**end** **Example:** `Device(config-if)#end`	Exits interface configuration mode and returns to privileged EXEC mode.

Configuring Multicast mGRE

To configure multicast mGRE, configure unicast mGRE first and then perform this task:

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:**	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
	`Device>enable`	
Step 2	**configure terminal** **Example:** `Device#configure terminal`	Enters global configuration mode.
Step 3	**interface tunnel** *tunnel-number* **Example:** `Device(config)#interface tunnel 1`	Configures an interface and enters interface configuration mode.
Step 4	**ip pim nbma-mode** **Example:** `Device(config-if)#ip pim nbma-mode`	Configures a multiaccess WAN interface to be in NBMA mode.
Step 5	**ip pim sparse-mode** **Example:** `Device(config-if)#ip pim sparse-mode`	Enables IPv4 Protocol Independent Multicast (PIM) sparse mode on an interface.
Step 6	**end** **Example:** `Device(config-if)#end`	Exits interface configuration mode and returns to priviledged EXEC mode.

Verifying the mGRE Configuration

Use the following commands to verify the mGRE configuration:

Procedure

Step 1 **enable**

Example:

```
Device>enable
```

Enables privileged EXEC mode.

- Enter your password if prompted.

Step 2 **show ip nhrp**

Displays IPv4 Next Hop Resolution Protocol (NHRP) mapping information.

Example:

```
Spoke2#show ip nhrp 10.0.0.1
```

```
10.0.0.1/32 via 10.0.0.1
   Tunnel0 created 00:03:13, expire 00:06:47
   Type: dynamic, Flags: router used nhop
   NBMA address: 192.0.0.1

Spoke2#show ip nhrp 10.0.0.3

10.0.0.3/32 via 10.0.0.3
   Tunnel0 created 22:57:58, never expire
   Type: static, Flags: used
   NBMA address: 192.0.0.3
```

Step 3 show ipv6 nhrp

Displays IPv6 Next Hop Resolution Protocol (NHRP) mapping information.

Example:

```
HUB#show running-config | interface tunnel6

Building configuration...

Current configuration : 255 bytes
!
interface Tunnel6
 no ip address
 no ip redirects
 ipv6 address 2001:DB8:1::1/64
 ipv6 eigrp 10
 no ipv6 next-hop-self eigrp 10
 no ipv6 split-horizon eigrp 10
 ipv6 nhrp network-id 1
 tunnel source FortyGigabitEthernet1/0/19
 tunnel mode gre multipoint
end

HUB#show ipv6 nhrp

2001:DB8:1::5/128 via 2001:DB8:1::5
   Tunnel6 created 02:37:30, expire 00:07:29
   Type: dynamic, Flags: registered nhop
   NBMA address: 192.168.0.2
2001:DB8:1::2A7:42FF:FE83:CEA0/128 via 2001:DB8:1::5
   Tunnel6 created 02:37:30, expire 00:07:29
   Type: dynamic, Flags: registered
   NBMA address: 192.168.0.2

HUB#

Spoke1#show running-config | interface tunnel6

Building configuration...

Current configuration : 292 bytes
!
interface Tunnel6
 no ip address
 no ip redirects
 ipv6 address 2001::5/64
 ipv6 eigrp 10
 ipv6 nhrp map multicast 192.168.0.3
 ipv6 nhrp map 2001:DB8:1::1/64 192.168.0.3
 ipv6 nhrp network-id 1
 ipv6 nhrp nhs 2001:DB8:1::1
```

```
 tunnel source FortyGigabitEthernet1/0/7
 tunnel mode gre multipoint
end

Spoke1#show ipv6 nhrp

2001:DB8:1::/64 via 2001:DB8:1::1
   Tunnel6 created 02:46:17, never expire
   Type: static, Flags:
   NBMA address: 192.168.0.3
2001:DB8:1::2A7:42FF:FE83:CFE0/128 via 2001:DB8:1::2A7:42FF:FE83:CFE0
   Tunnel6 created 02:45:39, never expire
   Type: static, Flags: nhs-ll
   NBMA address: 192.168.0.3
Spoke1#
```

Step 4 **show ip route**

Displays IPv4 content of the routing table.

Example:

```
Spoke2#show ip route 10.0.1.1

Routing entry for 10.0.1.1
  Known via "eigrp 10", distance 90, metric 26880256, type internal
  Redistributing via eigrp 10
  Last update from 10.0.0.3 on Tunnel0, 00:55:34 ago
  Routing Descriptor Blocks:
  * 10.0.0.3, from 10.0.0.3, 00:55:34 ago, via Tunnel0
      Route metric is 26880256, traffic share count is 1
      Total delay is 50010 microseconds, minimum bandwidth is 100 Kbit
      Reliability 255/255, minimum MTU 1472 bytes
      Loading 1/255, Hops 1

HUB#show ip route 10.0.1.2

Routing entry for 10.0.1.2/24
  Known via "eigrp 10", distance 90, metric 26880256, type internal
  Redistributing via eigrp 10
  Last update from 10.0.0.1 on Tunnel0, 00:56:45 ago
  Routing Descriptor Blocks:
  * 10.0.0.1, from 10.0.0.1, 00:56:45 ago, via Tunnel0
      Route metric is 26880256, traffic share count is 1
      Total delay is 50010 microseconds, minimum bandwidth is 100 Kbit
      Reliability 255/255, minimum MTU 1472 bytes
      Loading 1/255, Hops 1
HUB#
```

Step 5 **show ipv6 route**

Displays IPv6 content of the routing table.

Example:

```
Spoke1#show ipv6 route 2001:DB8:1::/64

Routing entry for 2001:DB8:1::/64
  Known via "eigrp 10", distance 90, metric 27008000, type internal
  Route count is 1/1, share count 0
  Routing paths:
     2001:DB8:1::2A7:42FF:FE83:CFE0, Tunnel6
      From 2001:DB8:1::2A7:42FF:FE83:CFE0
```

```
      Last updated 00:03:07 ago
Spoke1#

HUB#show ipv6 route 2001:DB8:1::/64

Routing entry for 2001:DB8:1::/64
  Known via "eigrp 10", distance 90, metric 27008000, type internal
  Route count is 1/1, share count 0
  Routing paths:
    2001:DB8:1::2A7:42FF:FE83:CEA0, Tunnel6
      From 2001:DB8:1::2A7:42FF:FE83:CEA0
      Last updated 00:01:29 ago
HUB#
```

Step 6 **debug nhrp detail**

Displays NHRP registration and packet related information.

Step 7 **debug tunnel**

Displays tunnel state changes and packet related information.

Configuration Examples for Unicast and Multicast over Point-to-Multipoint GRE

Example: Configuring Unicast mGRE for Hub

This example shows how to configure unicast mGRE for the hub:

```
Device>enable
Device#configure terminal
Device(config)#interface tunnel 1
Device(config-if)#tunnel mode gre multipoint
Device(config-if)#ip ospf network point-to-multipoint
Device(config-if)#ip address 10.1.1.1 255.255.255.255
Device(config-if)#ipv6 address 2001:DB8:1::1
Device(config-if)#tunnel source TenGigabitEthernet1/0/3
Device(config-if)#ip nhrp network-id 1
Device(config-if)#ip nhrp registration timeout 30
Device(config-if)#ip nhrp holdtime 400
Device(config-if)#ip nhrp authentication DMVPN
Device(config-if)#ip pim nbma-mode
Device(config-if)#end
```

Example: Configuring Unicast mGRE at Spoke

This example shows how to configure unicast mGRE at a spoke.

```
Device>enable
Device#configure terminal
Device(config)#interface tunnel 1
```

```
Device(config-if)#ip nhrp map 10.0.0.1 192.0.0.1
Device(config-if)#ip nhrp map multicast 10.0.0.2
Device(config-if)#ip nhrp nhs 192.0.2.1
Device(config-if)#ipv6 nhrp nhs 2001:DB8:1::2
Device(config-if)#ipv6 nhrp map 2001:DB8:1::3 192.0.2.2
Device(config-if)#end
```

Example: Configuring Unicast mGRE at Hub

This example shows how to configure unicast mGRE at the hub:

```
Device>enable
Device#configure terminal
Device(config)#interface tunnel 1
Device(config-if)#ip nhrp map multicast dynamic
Device(config-if)#ip next-hop-self eigrp 10
Device(config-if)#ip split-horizon eigrp 10
Device(config-if)#end
```

Example: Configuring Multicast mGRE

This example shows how to configure multicast mGRE:

```
Device>enable
Device#configure terminal
Device(config)#interface tunnel 1
Device(config-if)#ip pim nbma-mode
Device(config-if)#ip pim sparse-mode
Device(config-if)#end
```

Sample mGRE Configuration at Hub and Spokes

Configuration at hub:

```
Device(config)#interface Tunnel0
Device(config-if)#ip address 172.16.0.2 255.255.255.0
Device(config-if)#no ip redirects
Device(config-if)#ip nhrp authentication DMVPN
Device(config-if)#ip nhrp network-id 1
Device(config-if)#ip nhrp registration timeout 30
Device(config-if)#no ip next-hop-self eigrp 10
Device(config-if)#no ip split-horizon eigrp 10
Device(config-if)#tunnel source TenGigabitEthernet1/0/3
Device(config-if)#tunnel mode gre multipoint
Device(config-if)#tunnel key 4
Device(config-if)#end
Device(config)#interface TenGigabitEthernet1/0/3
Device(config-if)#no switchport
Device(config-if)#ip address 10.78.6.25. 255.255.255.0
Device(config-if)#end
```

Configuration at spoke1:

```
Device(config)#interface Tunnel0
Device(config-if)#ip address 172.16.0.4 255.255.255.0
Device(config-if)#no ip redirects
Device(config-if)#ip nhrp authentication DMVPN
Device(config-if)#ip nhrp map 172.16.0.2 10.78.6.25
Device(config-if)#ip nhrp map multicast 10.78.6.25
Device(config-if)#ip nhrp network-id 1
Device(config-if)#ip nhrp nhs 172.16.0.2
Device(config-if)#ip nhrp registration timeout 30
Device(config-if)#tunnel source GigabitEthernet2/0/3
Device(config-if)#tunnel mode gre multipoint
Device(config-if)#tunnel key 4
Device(config-if)#end
Device(config)#interface GigabitEthernet2/0/3
Device(config-if)#no switchport
Device(config-if)#ip address 209.165.202.129 255.255.255.0
Device(config-if)#end
```

Configuration at spoke2:

```
Device(config)#interface Tunnel0
Device(config-if)#ip address 172.16.0.3 255.255.255.0
Device(config-if)#no ip redirects
Device(config-if)#ip nhrp authentication DMVPN
Device(config-if)#ip nhrp map 172.16.0.2 10.78.6.25
Device(config-if)#ip nhrp map multicast 10.78.6.25
Device(config-if)#ip nhrp network-id 1
Device(config-if)#ip nhrp nhs 172.16.0.2
Device(config-if)#ip nhrp registration timeout 30
Device(config-if)#tunnel source GigabitEthernet1/0/3
Device(config-if)#tunnel mode gre multipoint
Device(config-if)#tunnel key 4
Device(config-if)#end
Device(config)#interface GigabitEthernet1/0/3
Device(config-if)#no switchport
Device(config-if)#ip address 192.168.0.1 255.255.255.0
Device(config-if)#end
```

Feature History and Information for Unicast and Multicast over Point-to-Multipoint GRE

This table provides release and related information for features explained in this module.

These features are available on all releases subsequent to the one they were introduced in, unless noted otherwise.

Release	Feature	Feature Information
Cisco IOS XE Fuji 16.8.1a	Unicast and Multicast over Point-to-Multipoint GRE	The Unicast and Multicast over Point-to-Multipoint GRE feature allows to configure mGRE at the hub site and normal point-to-point GRE configuration at the spokes. Support for this feature was introduced only on the C9500-32C, C9500-32QC, C9500-48Y4C, and C9500-24Y4C models of the Cisco Catalyst 9500 Series Switches.

Use Cisco Feature Navigator to find information about platform and software image support. To access Cisco Feature Navigator, go to https://cfnng.cisco.com.