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 multicast 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.
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:

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `interface type number`
4. `tunnel mode gre multipoint`
5. `ip ospf network point-to-multipoint`
6. `ip address address mask`
7. `ipv6 address address prefix`
8. `tunnel source address`
9. `{ip | ipv6} nhrp network-id id`
10. `{ip | ipv6} nhrp registration timeout seconds`
11. `{ip | ipv6} nhrp holdtime seconds`
12. `{ip | ipv6} nhrp authentication string`
13. `ip pim nbma-mode`
14. `end`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td><code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>Device&gt; <code>enable</code></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Step 2</td>
<td><code>configure terminal</code></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>Device# <code>configure terminal</code></td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td><code>interface type number</code></td>
<td>Configures an interface and enters interface configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config)# <code>interface gigabitethernet 0/1/1</code></td>
<td></td>
</tr>
<tr>
<td>Step 4</td>
<td><code>tunnel mode gre multipoint</code></td>
<td>Configures multipoint GRE as the tunnel mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step</td>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------</td>
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</tr>
<tr>
<td>5</td>
<td>ip ospf network point-to-multipoint</td>
<td>If the underlying protocol is OSPF, execute this command to set the network type to point-to-multipoint.</td>
</tr>
<tr>
<td>6</td>
<td>ip address address mask</td>
<td>Configures the IP address of the tunnel.</td>
</tr>
<tr>
<td>7</td>
<td>ipv6 address address prefix</td>
<td>Configures the IPv6 address of the tunnel.</td>
</tr>
<tr>
<td>8</td>
<td>tunnel source address</td>
<td>Configures the source IP address of the tunnel.</td>
</tr>
<tr>
<td>9</td>
<td>{ip</td>
<td>ipv6} nhrp network-id id</td>
</tr>
<tr>
<td>10</td>
<td>{ip</td>
<td>ipv6} nhrp registration timeout seconds</td>
</tr>
<tr>
<td>11</td>
<td>{ip</td>
<td>ipv6} nhrp holdtime seconds</td>
</tr>
<tr>
<td>12</td>
<td>{ip</td>
<td>ipv6} nhrp authentication string</td>
</tr>
<tr>
<td>13</td>
<td>ip pim nbma-mode</td>
<td>Configures a multiaccess WAN interface to be in non-broadcast multiaccess (NBMA) mode.</td>
</tr>
<tr>
<td>14</td>
<td>end</td>
<td>Exits interface configuration mode and returns to privileged EXEC mode.</td>
</tr>
</tbody>
</table>
Configuring Unicast mGRE at a Spoke

Perform this task to configure unicast mGRE at spokes:

SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `interface type number`
4. `ip nhrp map ip-address nbma-address`
5. `{ip | ipv6} nhrp map multicast nbma-address`
6. `ip nhrp nhs nhs-address`
7. `ipv6 nhrp nhs nhs-address`
8. `ipv6 nhrp map address/prefix nbma address`
9. `end`

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><code>enable</code></td>
<td>- Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Device&gt; <code>enable</code></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 2</th>
<th>configure terminal</th>
<th>Enters global configuration mode.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Device# <code>configure terminal</code></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 3</th>
<th>interface type number</th>
<th>Configures an interface and enters interface configuration mode.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Device(config)# <code>interface gigabitethernet 0/1/1</code></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 4</th>
<th>ip nhrp map ip-address nbma-address</th>
<th>Configures static IP-to-NBMA address mapping of a hub router on the spoke.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Device(config-if)# <code>ip nhrp map 10.0.0.1 192.0.0.1</code></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Step 5 | `{ip | ipv6} nhrp map multicast nbma-address` | Enables IP multicast and broadcast packets (example: routing protocol information) to be sent from the spoke to the hub. |
|---------|-----------------------------------------------|---------------------------------------------------------------------------|
| **Example:** | | |
| Device(config-if)# `ip nhrp map multicast 10.0.0.2` | |

<table>
<thead>
<tr>
<th>Step 6</th>
<th>ip nhrp nhs nhs-address</th>
<th>Enables the spoke to send NHRP registration request to the hub.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Device(config-if)# <code>ip nhrp nhs 192.0.2.1</code></td>
<td>- Here <code>nhs-address</code> is the tunnel address of the hub.</td>
<td></td>
</tr>
</tbody>
</table>
### Configuring Unicast mGRE at the Hub

Perform this task to configure unicast mGRE at the hub:

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `interface type number`
4. `{ip | ipv6} nhrp map multicast dynamic`
5. `{ip | ipv6} next-hop-self eigrp number`
6. `{ip | ipv6} split-horizon eigrp number`
7. `end`

**DETAILED STEPS**

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<td>Example:</td>
<td>Device&gt; <code>enable</code></td>
<td></td>
</tr>
<tr>
<td>Step 2</td>
<td><code>configure terminal</code></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>Device# <code>configure terminal</code></td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td><code>interface type number</code></td>
<td>Configures an interface and enters interface configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config)# <code>interface gigabitethernet 0/1/1</code></td>
<td></td>
</tr>
</tbody>
</table>
### Configuring Multicast mGRE

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

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `interface type number`
4. `ip pim nbma-mode`
5. `ip pim sparse-mode`
6. `end`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
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<tbody>
<tr>
<td><strong>Step 1</strong> <code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> <code>configure terminal</code></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example: Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> <code>interface type number</code></td>
<td>Configures an interface and enters interface configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td><code>Device(config)# interface gigabitethernet 0/1/1</code></td>
<td>Configures a multiaccess WAN interface to be in NBMA mode.</td>
</tr>
<tr>
<td><strong>Step 4</strong> <code>ip pim nbma-mode</code></td>
<td>Enables IPv4 Protocol Independent Multicast (PIM) sparse mode on an interface.</td>
</tr>
<tr>
<td><strong>Example:</strong> <code>Device(config-if)# ip pim nbma-mode</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> <code>ip pim sparse-mode</code></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong> <code>Device(config-if)# ip pim sparse-mode</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> <code>end</code></td>
<td>Exits interface configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> <code>Device(config-if)# end</code></td>
<td></td>
</tr>
</tbody>
</table>

**Verifying the mGRE Configuration**

Use the following commands to verify the mGRE configuration:

**SUMMARY STEPS**

1. `enable`
2. `show ip nhrp`
3. `show ipv6 nhrp`
4. `show ip route`
5. `show ipv6 route`
6. `debug nhrp detail`
7. `debug tunnel`

**DETAILED STEPS**

**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
```
Verifying the mGRE Configuration

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
  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
```

Configuring Unicast and Multicast over Point-to-Multipoint GRE
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 gigabitethernet 0/1/1
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 gigabitethernet 0/1/1
```

Step 6  debug nhrp detail
Displays NHRP registration and packet related information.

Step 7  debug tunnel
Displays tunnel state changes and packet related information.
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 gigabitethernet 0/1/1
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 gigabitethernet 0/1/1
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:**

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

**Configuration at spoke1:**

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

Configuration at spoke2:
interface Tunnel0
ip address 172.16.0.3 255.255.255.0
no ip redirects
ip nhrp authentication DMVPN
ip nhrp map 172.16.0.2 10.78.6.25
ip nhrp map multicast 10.78.6.25
ip nhrp network-id 1
ip nhrp nhs 172.16.0.2
ip nhrp registration timeout 30
tunnel source GigabitEthernet1/0/3
tunnel mode gre multipoint
tunnel key 4
end
interface GigabitEthernet1/0/3
no switchport
ip address 192.168.0.1 255.255.255.0
end

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

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Release</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unicast and Multicast over Point-to-Multipoint GRE</td>
<td>Cisco IOS XE Fuji 16.8.1a</td>
<td>This feature was introduced.</td>
</tr>
</tbody>
</table>