

Shortcut Switching Enhancements for NHRP in DMVPN Networks

Routers in a Dynamic Multipoint VPN (DMVPN) Phase 3 network use Next Hop Resolution Protocol (NHRP) Shortcut Switching to discover shorter paths to a destination network after receiving an NHRP redirect message from the hub. This allows the routers to communicate directly with each other without the need for an intermediate hop.

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Information About Shortcut Switching Enhancements for NHRP

DMVPN Phase 3 Networks Overview

In a DMVPN Phase 3 network, separate regional DMVPN networks are connected together into a single hierarchical DMVPN network. Spokes in different regions use NHRP to build direct spoke-to-spoke tunnels with each other, bypassing both the regional and the central hubs. When building spoke-to-spoke tunnels within a region, only the regional hubs are involved in the tunnel setup. When building spoke-to-spoke tunnels between regions, the regional and the central hubs are involved in the tunnel setup.

DMVPN Phase 3 provides improvements over a DMVPN Phase 2 network. For a DMVPN spoke-to-spoke network, the main improvements from Phase 2 are in the increased flexibility in laying out the base DMVPN network. DMVPN Phase 3 allows a hierarchical hub design whereas DMVPN Phase 2 relies on “daisy-chaining” of hubs for scaling the network. DMVPN Phase 3 also removes some of the restrictions on the routing protocols required by Phase 2 (OSPF broadcast mode and non split-tunneling). DMVPN Phase 3 is not expected to change the number of spokes that a single DMVPN hub can support but it may reduce the CPU load of the routing protocol on the hub.

Benefits of NHRP Shortcut Switching Enhancements

Cisco has developed NHRP shortcut switching model enhancements that allow for more scalable DMVPN implementations. This model provides the following benefits:

- Allows summarization of routing protocol updates from hub to spokes. The spokes no longer need to have an individual route with an IP next hop of the tunnel IP address of the remote spoke for the networks behind all the other spokes. The spoke can use summarized routes with an IP next hop of the tunnel IP address of the hub and still be able to build spoke-to-spoke tunnels. It can reduce the load on the routing protocol running on the hub router. You can reduce the load because, when you can summarize the networks behind the spokes to a few summary routes or even one summary route, the hub routing protocol only has to advertise the few or one summary route to each spoke rather than all of the individual spoke routes. For example, with 1000 spokes and one router per spoke, the hub receives 1000 routes but only has to advertise one summary route to each spoke (equivalent to 1000 advertisements, one per spoke) instead of the 1,000,000 advertisements it had to process in the prior implementation of DMVPN.
- Provides better alternatives to static daisy-chaining of hubs for expanding DMVPN spoke-to-spoke networks. The hubs must still be interconnected, but they are not restricted to just a daisy-chain pattern. The routing table is used to forward data packets and NHRP control packets between the hubs. The routing table allows efficient forwarding of packets to the correct hub rather than having request and reply packets traversing through all of the hub routers.
- Allows for expansion of DMVPN spoke-to-spoke networks with OSPF as the routing protocol beyond two hubs. Because the spokes can use routes with the IP next-hop set to the hub router (not the remote spoke router as before), you can configure OSPF to use point-multipoint network mode rather than broadcast network mode. Configuring OSPF to use point-multipoint network mode removes the DR and BDR requirements that restricted the DMVPN network to just two hubs. When using OSPF, each spoke still has all individual routes, because the DMVPN network must be in a single OSPF area but you cannot summarize routes within an OSPF area.
- Allows routing protocols such as ODR to be used and still retain the ability to build dynamic spoke-to-spoke tunnels.
- Allows for hierarchical (greater than one level) and more complex tree-based DMVPN network topologies. Tree-based topologies allow the capability to build DMVPN networks with regional hubs that are spokes of central hubs. This architecture allows the regional hub to handle the data and NHRP control traffic for its regional spokes, but still allows spoke-to-spoke tunnels to be built between any spokes within the DMVPN network, whether they are in the same region or not.
- Enables the use of Cisco Express Forwarding to switch data packets along the routed path until a spoke-to-spoke tunnel is established.

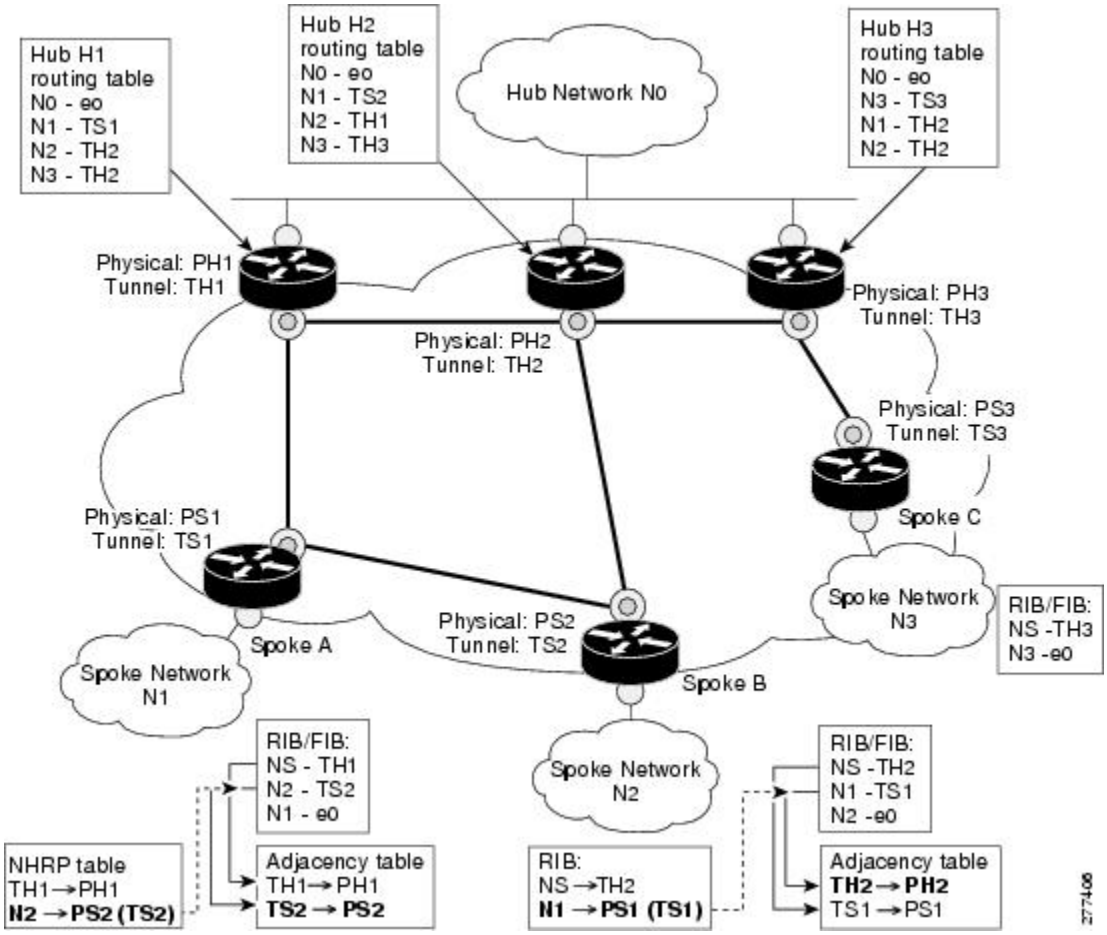
NHRP as a Route Source

To implement shortcut switching, NHRP works as a route source and installs shortcut paths, as NHRP routes, directly into the Routing Information Base (RIB). This means that shortcut paths appear as routes in the routing table and NHRP works in lieu of the routing protocol (for example, RIP, OSPF or EIGRP). The shortcut routes in the RIB are distributed into the Fowarding Information Base (FIB). When a spoke discovers a shortcut path, it adds the path as an NHRP route to its routing table. The RIB and FIB have no special behaviour for shortcut switching and shortcut routes are treated like any other route.

NHRP acts as a route producer to the RIB, but it does not function as a full routing protocol. NHRP manages the route registration, resolution, and purge messages but it does not discover or maintain NHRP neighbors, advertise NHRP routing messages, or inform the network of any network topology changes.

Consider Spoke A in the figure below. It discovers a shortcut path to N2 via Spoke 2's tunnel (overlay) address TS2. It installs the shortcut path in its NHRP mapping table via the entry N2-PS2 (TS2) and it also adds the route to the RIB. The new route in the RIB is then distributed into the FIB and the FIB installs the corresponding adjacency TS2-PS2 in the adjacency table. The new route TS2-PS2 can now be used for forwarding. Note the consistency between the RIB, the FIB, and the adjacency table.

Figure 1: NHRP As A Route Source



Next Hop Overrides

If an NHRP route in the RIB is identical to another route (owned by another protocol) in the RIB then NHRP overrides the other protocol's next hop entries by installing shortcut next hops in the RIB. NHRP installs shortcut paths into the routing table, not as NHRP routes but as local forwarding paths. The other routing protocols continue to function as normal managing route redistribution and advertisement. NHRP only overrides local forwarding decisions by installing alternate or backup next hops into the routing table.

NHRP Route Watch Infrastructure

In a DMVPN full-mesh design, the hub creates summary routes to each of the spokes (Interior Gateway Protocol (IGP) routes). Specific NHRP shortcuts are installed at the spokes by NHRP as and when required. These shortcuts can be viewed as a refinement of the route summaries because they deal with a specific subnet while the summary routes represent super-nets. If the summary route is absent, NHRP cannot discover a shortcut path.

The summary route, or “covering prefix”, governs the existence of the NHRP route in the RIB. The removal of a covering prefix in the RIB would lead to the removal of the all the corresponding NHRP routes, that were learnt via this covering prefix, from the RIB. The tracking of covering prefixes is done via the Route Watch infrastructure.

A "watched prefix" is a route that immediately precedes an NHRP route. For example, if an NHRP route is 172.16.3.0/24, then the watch-prefix corresponding to it would be 172.16.2.0/23. Each “watched prefix” and its associated “covering prefixes” are tracked by the Route Watch service. A “covering prefix” is defined as the longest matching IGP route in the RIB which is less specific than the “watched prefix”. The validity of each NHRP shortcut is determined by the following events:

- If a “covering prefix” is removed so that there is no other IGP route in the RIB "covering" the watched prefix, (the watched prefix is unreachable), then the corresponding NHRP shortcut route is removed.
- If a new IGP route, which is more specific than the covering prefix but less specific than watched prefix, is installed in RIB, then it will become the covering prefix for the watched prefix. If the new covering prefix has a different next hop associated with it, the original shortcut is removed.

In summary, the validity of an NHRP route in the RIB is determined by the less specific, longest match IGP route present in the RIB. NHRP shortcuts are refinements to the routing topology, so shortcut paths are added to the RIB without modifying the routing topology.

From Cisco IOS XE Release 17.10.1a, NHRP supports the Route Watch attribute for the next hop of a cache entry that has a destination of a different subnet. This behavior is automatically triggered and does not depend on whether Route Watch is enabled or not. Therefore, a cache entry can now have two Route Watch instances: One Route Watch instance for the prefix entry and another Route Watch instance for the next hop.

Supporting the Route Watch attribute for next hop entries ensures that cache entries are cleaned up and monitored when route details disappear or are modified therefore preventing traffic drops.

NHRP Purge Request Reply

When an NHRP hub replies to a resolution request, it creates a local NHRP mapping entry. The local mapping entry is a network entry for which NHRP has sent a reply. The local mapping entry maintains a list of requesters. When a network entry is modified or deleted in the routing table, NHRP is notified of the event. NHRP finds the local cache entry for the network and sends a purge request to the requesters that the network to which it previously replied has changed. The receivers of the purge message delete the corresponding NHRP mapping entry from its table and send a purge reply indicating that the purge message was processed successfully.

How to Configure Shortcut Switching for NHRP

NHRP Smart Defaults

NHRP Smart default commands are:

- **ip|ipv6 nhrp map multicast dynamic**
- **ip|ipv6 nhrp registration no-unique**
- **ip|ipv6 nhrp holdtime 600**—default hold time is 6 mins and registrations are sent every 2 mins
- **ip|ipv6 nhrp shortcut**—enabled or disabled by default according to whether or not the interface is multipoint or p2p
- **ip|ipv6 nhrp network-id** —enabled by default where ID is the tunnel key or the tunnel interface number (in the absence of a tunnel key)
- **ip|ipv6 nhrp path preference** —the preference is 255 by default, meaning spoke-spoke routes are always ECMP irrespective of the spoke-hub cost ratio (unless the preference ratio is configured to match the IGP metric ratio). NHRP cache entries are created with a preference that is received in the packet. The preference that is sent in the packet is based on what is configured on the interface using **ip|ipv6 nhrp path preference <1-255>**. The ratio of preferences for cache entries created for the same prefix also decides the ratio of metric of NHRP routes (ratio of metric is the inverse ratio of preference). Hence, CEF load balances traffic over multiple paths in the ratio of the corresponding cache preferences. This can be used for egress load-balancing (equal or unequal cost) or ingress traffic engineering over a dynamic spoke-spoke tunnel. The default value of the cache preference is changed to 255 from 0.



Note The default values do not display when you use the **show run** command but are displayed when you use **show run all** command. However, user configured values override default values.

Enabling NHRP Shortcut Switching on an Interface

Perform this task to enable shortcut switching for NHRP for an interface on a router.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ip nhrp shortcut**
5. **end**
6. **show ip nhrp shortcut**
7. **show ip route nhrp**
8. **show ip route next-hop-override**

DETAILED STEPS

Procedure

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

	Command or Action	Purpose
	`Router> enable`	
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Router(config)# interface Tunnel 0`	Enters interface configuration mode.
Step 4	**ip nhrp shortcut** **Example:** `Router(config-if)# ip nhrp shortcut`	Enables NHRP shortcut switching on an interface.
Step 5	**end** **Example:** `Router(config-if)# end`	Ends the configuration session.
Step 6	**show ip nhrp shortcut** **Example:** `Router# show ip nhrp shortcut`	(Optional) Displays only the NHRP cache entries that have an NHRP route or an NHRP next-hop override associated with them.
Step 7	**show ip route nhrp** **Example:** `Router# show ip route nhrp`	(Optional) Displays the routes added to the routing table by NHRP.
Step 8	**show ip route next-hop-override** **Example:** `Router# show ip route next-hop-override`	(Optional) Displays the NHRP next-hop overrides associated with a particular route, along with the corresponding default next hops.

Clearing NHRP Cache Entries on an Interface

Perform this optional task to clear NHRP cache entries that have associated NHRP routes and next-hop overrides on an interface on a router.

SUMMARY STEPS

1. **enable**
2. **configure terminal**

3. **clear ip nhrp shortcut** *interface-name*
4. **end**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**clear ip nhrp shortcut** *interface-name* **Example:** `Router(config)# clear ip nhrp shortcut Tunnel0`	Clears NHRP cache entries on an interface.
Step 4	**end** **Example:** `Router(config)# end`	Ends the configuration session.

Configuration Examples for Shortcut Switching Enhancements for NHRP

Configuring NHRP Shortcut Switching Example

The following example configures NHRP shortcut switching on tunnel interface 1:

```
Router(config)#
interface Tunnel 1
Router(config-if)#
ip nhrp shortcut
```

The following example shows the output of the **show ip route** and **show ip route nhrp** commands. These commands can be used to show the current state of the routing table. NHRP entries are flagged “H”.

```
Router#
show ip route
Codes: 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, H - NHRP
Gateway of last resort is not set
     10.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
C       10.1.1.0/24 is directly connected, Tunnel0
C       172.16.22.0 is directly connected, Ethernet1/0
H       172.16.99.0 [250/1] via 1.1.1.99, 00:11:43, Tunnel0
     10.2.2.0/24 is subnetted, 1 subnets
C       10.11.11.0 is directly connected, Ethernet0/0
Router#
show ip route nhrp
H       172.16.99.0 [250/1] via 10.1.1.99, 00:11:43, Tunnel0
```

The following sample output displays the NHRP next-hop overrides associated with a particular route and the corresponding default next hops, when the following next-hop override is added:

- IP address: 10.50.10.0
- Mask: 255.255.255.0
- Gateway: 10.1.1.1
- Interface: Tunnel0

```
Router#
show ip route
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, H - NHRP
       + - replicated route
Gateway of last resort is not set
      10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        10.2.1.0/24 is directly connected, Loopback1
L        10.2.1.1/32 is directly connected, Loopback1
      10.50.0.0/24 is subnetted, 1 subnets
% S        10.50.10.0 is directly connected, Tunnel0
      10.30.0.0/24 is subnetted, 1 subnets
S        10.30.11.0 is directly connected, Ethernet0/0
Router#
show ip route next-hop-override
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, H - NHRP
       + - replicated route
Gateway of last resort is not set
      10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        10.2.1.0/24 is directly connected, Loopback1
L        10.2.1.1/32 is directly connected, Loopback1
      10.50.0.0/24 is subnetted, 1 subnets
% S        10.50.10.0 is directly connected, Tunnel0
```

```
                  [NHO][1/0] via 10.1.1.1, Tunnel0
      10.30.0.0/24 is subnetted, 1 subnets
S        10.30.11.0 is directly connected, Ethernet0/0
Router#
show ip cef
Prefix               Next Hop             Interface
10.2.1.255/32         receive              Loopback110.10.10.0/24
10.50.10.0/24       10.1.1.1             Tunnel0
10.30.11.0/24       attached            Ethernet0/0
127.0.0.0/8           drop
```

The following example displays the output of the **show ip route** and **show ip route next-hop-override** commands after the following next-hop override is deleted:

- IP address: 10.50.10.0
- Mask: 255.255.255.0
- Gateway: 10.1.1.1
- Interface: Tunnel0

```
Router#
show ip route
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, H - NHRP
       + - replicated route
Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        10.2.1.0/24 is directly connected, Loopback1
L        10.2.1.1/32 is directly connected, Loopback1
      10.50.0.0/24 is subnetted, 1 subnets
% S        10.50.10.0 is directly connected, Tunnel0
      10.30.0.0/24 is subnetted, 1 subnets
S        10.30.11.0 is directly connected, Ethernet0/0
Router#
show ip route next-hop-override
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, H - NHRP
       + - replicated route

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        10.2.1.0/24 is directly connected, Loopback1
L        10.2.1.1/32 is directly connected, Loopback1
      10.50.0.0/24 is subnetted, 1 subnets
S        10.50.10.0 is directly connected, Tunnel0
      10.30.0.0/24 is subnetted, 1 subnets
S        10.30.11.0 is directly connected, Ethernet0/0
Router#
```

```
show ip cef
Prefix              Next Hop            Interface
10.2.1.255/32        receive             Loopback110.10.10.0/24
10.50.10.0/24       attached            Tunnel0
10.30.11.0/24       attached            Ethernet0/0
127.0.0.0/8         drop
```

The following sample output shows the information displayed by the **show ip nhrp** command when a cache entry has an associated NHRP next-hop override in the RIB. Note that the flags for the entry are displayed as “router rib” and not “router candidate”.

```
Router#
show ip nhrp
10.1.1.22/32 via 10.1.1.22
   Tunnel0 created 00:00:06, expire 00:02:23
   Type: dynamic, Flags: router implicit
   NBMA address: 10.11.11.22
10.1.1.99/32 via 10.1.1.99
   Tunnel0 created 4d04h, never expire
   Type: static, Flags: used
   NBMA address: 10.11.11.99
172.16.11.0/24 via 10.1.1.11
   Tunnel0 created 00:00:06, expire 00:02:23
   Type: dynamic, Flags: router unique local
   NBMA address: 10.11.11.11
    (no-socket)
172.16.22.0/24 via 10.1.1.22
   Tunnel0 created 00:00:05, expire 00:02:24
   Type: dynamic, Flags: router rib
   NBMA address: 10.11.11.22
```

The following example shows the output displayed by the **show ip nhrp** command when a cache entry has an NHRP next-hop override added to the RIB. If the corresponding cache entry has an associated NHRP next-hop override in the RIB, the flags are displayed as “router rib nho”.

```
Router#
show ip nhrp
10.1.1.22/32 via 10.1.1.22
   Tunnel0 created 00:00:06, expire 00:02:23
   Type: dynamic, Flags: router implicit
   NBMA address: 10.11.11.22
10.1.1.99/32 via 10.1.1.99
   Tunnel0 created 4d04h, never expire
   Type: static, Flags: used
   NBMA address: 10.11.11.99
172.16.11.0/24 via 10.1.1.11
   Tunnel0 created 00:00:06, expire 00:02:23
   Type: dynamic, Flags: router unique local
   NBMA address: 10.11.11.11
    (no-socket)
172.16.22.0/24 via 10.1.1.22
   Tunnel0 created 00:00:05, expire 00:02:24
   Type: dynamic, Flags: router rib nho
   NBMA address: 10.11.11.22
```

The following example shows the output displayed by the **show ip nhrp shortcut** command. This command displays only the NHRP cache entries that have an associated NHRP route or NHRP next-hop override.

```
Router#
show ip nhrp shortcut
172.16.22.0/24 via 10.1.1.22
```

```
   Tunnel0 created 00:00:05, expire 00:02:24
   Type: dynamic, Flags: router rib
   NBMA address: 10.11.11.22
172.16.22.0/24 via 10.1.1.22
   Tunnel0 created 00:00:05, expire 00:02:24
   Type: dynamic, Flags: router rib nho
   NBMA address: 10.11.11.22
```

The following example shows the output displayed by the **show dmvpn** command. The output indicates a route installation in the attributes section of the command output.

```
Router#
show dmvpn
Legend: Attrb --> S - Static, D - Dynamic, I - Incomplete
N - NATed, L - Local, X - No Socket, T1 - Route Installed,
T2 - Nexthop-override
# Ent --> Number of NHRP entries with same NBMA peer
NHS Status: E --> Expecting Replies, R --> Responding
UpDn Time --> Up or Down Time for a Tunnel
==========================================================================
Interface: Tunnel0, IPv4 NHRP Details
IPv4 Registration Timer: 60 seconds
IPv4 NHS: 10.1.1.99 RE
Type:Spoke, Total NBMA Peers (v4/v6): 2
# Ent  Peer NBMA Addr Peer Tunnel Add State  UpDn Tm Attrb    Target Network
----- --------------- --------------- ----- -------- ----- -----------------
    2    10.11.11.22        192.1.1.22    UP 00:10:11    D        192.1.1.22/32
    0    10.11.11.22        173.1.1.22    UP 00:10:11   DT1     172.16.22.0/24
    1    10.11.11.99        173.1.1.99    UP 02:18:29    S        173.1.1.99/32
```

The example shows how to clear NHRP cache entries on tunnel interface 1 that have associated NHRP routes or nexthop overrides:

```
Router(config)# clear ip nhrp shortcut Tunnel1
```

Additional References

The following sections provide references related to NHRP and DMVPN.

Related Documents

Related Topic	Document Title
NHRP information and configuration tasks	"Configuring NHRP" module of the *Cisco IOS XE IP Addressing Services Configuration Guide* .
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
NHRP commands: complete command syntax, command mode, command history, defaults, usage guidelines, and examples	Cisco IOS IP Addressing Services Command Reference
Dynamic Multipoint VPN	"Dynamic Multipoint VPN" module

Standards

Standard	Title
No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.	--

MIBs

MIB	MIBs Link
None	To locate and download MIBs for selected platforms, Cisco IOS XE software releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFC	Title
None	--

Technical Assistance

Description	Link
The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for Shortcut Switching Enhancements for NHRP in DMVPN Networks

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.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 1: Feature Information for Shortcut Switching Enhancements for NHRP in DMVPN Networks

Feature Name	Releases	Feature Information
Next Hop Resolution Protocol (NHRP)-CEF Rewrite for DMVPN Phase 3 Networks.	Cisco IOS XE Release 2.5 Cisco IOS XE Release 3.9S	Routers in a Dynamic Multipoint VPN (DMVPN) Phase 3 network use Next Hop Resolution Protocol (NHRP) Shortcut Switching to discover shorter paths to a destination network after receiving an NHRP redirect message from the hub. This allows the routers to communicate directly with each other without the need for an intermediate hop. The following commands were introduced or modified: **clear ip nhrp shortcut, debug dmvpn, debug nhrp routing, ip nhrp shortcut**, **show dmvpn**, **show ip nhrp, show ip nhrp shortcut**, **show ip route**, **show ip route next-hop-override**.