# Configure NAT64

**Note** To achieve simplification and consistency, the Cisco SD-WAN solution has been rebranded as Cisco Catalyst SD-WAN. In addition, from Cisco IOS XE SD-WAN Release 17.12.1a and Cisco Catalyst SD-WAN Release 20.12.1, the following component changes are applicable: **Cisco vManage** to **Cisco Catalyst SD-WAN Manager**, **Cisco vAnalytics** to **Cisco Catalyst SD-WAN Analytics**, **Cisco vBond** to **Cisco Catalyst SD-WAN Validator**, **Cisco vSmart** to **Cisco Catalyst SD-WAN Controller**, and **Cisco Controllers** to **Cisco Catalyst SD-WAN Control Components**. See the latest Release Notes for a comprehensive list of all the component brand name changes. While we transition to the new names, some inconsistencies might be present in the documentation set because of a phased approach to the user interface updates of the software product.



# Configure NAT64

A NAT64 configuration allows you to translate IPv6 addresses to IPv4 addresses for connecting IPv6 and IPv4 networks.

Traffic origination is always from the transport-side (WAN) to the service-side (LAN) in the overlay network.

# NAT64 Direct Internet Access

*Table 1: Feature History*

| Feature Name | Release Information | Description |
|---|---|---|
| NAT64 DIA for Cisco IOS XE Catalyst SD-WAN Devices | Cisco IOS XE Catalyst SD-WAN Release 16.12.1b<br>Cisco vManage Release 19.2.1 | The NAT64 Direct Internet Access (DIA) feature supports routing of traffic from branch sites directly to the internet instead of tunneling the internet traffic to a central site or data center for internet access.<br>NAT64 DIA allows IPv6 clients from a branch site to access IPv4 enterprise application servers in a data center or locally in the branch. IPv6 clients can also access IPv4 servers from the branch directly using the internet. |

## Information About NAT64 DIA

NAT64 DIA allows an IPv4 server to access an IPv6 server either from a remote branch or from a data center.

The traffic flow for NAT64 DIA is from the LAN to DIA.

## How NAT64 DIA Works

1. Enable IPv4 and IPv6 using a **Cisco VPN Interface Ethernet** template.
2. Configure an IPv6 route in a **Cisco VPN** template, which is the service-side VPN.

   The source and destination IPv6 addresses are translated.
3. Because NAT IPv4 DIA is configured, the source IPv4 address gets translated because of interface overload. The destination IPv4 address remains the same.

## Benefits of NAT64 DIA

- Enables good application performance
- Contributes to reduced bandwidth consumption and latency
- Contributes to lower bandwidth cost
- Enables improved branch office user experience by providing DIA at remote site locations

## Restrictions for NAT64 DIA

- NAT64 DIA uses interface overload only.
- NAT DIA pool or loopback is not supported with NAT64.

### Restrictions for a NAT64 DIA Route

- You can use the following NAT64 DIA routes for installing routes in the routing table:

  Example of a NAT64 DIA route for a /128 prefix:

  ```
  nat64 route vrf 4 64:FF9B::1E00:102/128 global
  ```

  Example of a NAT64 DIA route for a /96 prefix:

  ```
  nat64 route vrf 4 64:FF9B::/96 global
  ```

- You cannot use the following NAT64 DIA route configurations for installing routes in the routing table:

  ```
  nat64 route vrf 4 64:ff9b::/64 global
  ```

  ```
  nat64 route vrf 4 ::0/0 global
  ```

# Configure NAT64 DIA and a DIA Route

### Workflow for Enabling NAT64 DIA

1. Enable NAT64 using a **Cisco VPN Interface Ethernet** template for both IPv4 and IPv6.

   **Note** NAT64 IPv4 DIA uses interface overload by default.

   When configuring NAT64 for IPv6 DIA, interface overload is already configured.

   A **Cisco VPN Interface Ethernet** template is a transport interface.
2. Configure a NAT64 DIA IPv6 route using a **Cisco VPN** template, which is the service VPN.

## Configure NAT64 DIA

### Configure NAT64 DIA with Interface Overload

1. From the Cisco SD-WAN Manager menu, choose **Configuration** > **Templates**.
2. Click **Feature Templates**.

   **Note** In Cisco vManage Release 20.7.x and earlier releases, **Feature Templates** is titled **Feature**.
3. Edit a **Cisco VPN Interface Ethernet** template by clicking **. . .** and then clicking **Edit**.
4. In the **Interface Name** field, choose an interface.
5. Click **NAT** and choose **IPv4**.
   a. Change the scope from **Default** to **Global**.
   b. Click **On** to enable NAT for IPv4.

   a. In the **NAT Type** field, click **Interface** for interface overload.

Ensure that the **Interface** option is set to **On** for IPv4.

*Table 2: NAT IPv4 Parameters*

| Parameter Name | Description |
|---|---|
| **NAT** | Specify if NAT translation is used.<br>The default is **Off**. |
| **NAT Type** | Specify the NAT translation type for IPv4.<br>Available options include: **Interface**, **Pool**, and **Loopback**.<br>The default is the **Interface** option. The **Interface** option is supported for NAT64. |
| **UDP Timeout** | Specify when NAT translations over UDP sessions time out.<br>Range: 1–536870 seconds<br>Default: 300 seconds (5 minutes)<br>**Note** Starting from Cisco IOS XE Catalyst SD-WAN Release 17.6.1a and Cisco vManage Release 20.6.1, the default **UDP Timeout** value for NAT64 has been changed to 300 seconds (5 minutes). |
| **TCP Timeout** | Specify when NAT translations over TCP sessions time out.<br>Enter a timeout value.<br>Default: 3600 seconds (1 hour)<br>**Note** Starting from Cisco IOS XE Catalyst SD-WAN Release 17.6.1a and Cisco vManage Release 20.6.1, the default **TCP Timeout** value for NAT64 has been changed to 3600 seconds (1 hour). |

6. Repeat Step 5, but choose **IPv6** to enable NAT for IPv6.

**Note** Configure both IPv4 and IPv6 for NAT64 DIA.

7. In the **NAT Selection** field, click **NAT64** to enable NAT64.

**Note** For IPv6, interface overload is already configured.

*Table 3: NAT IPv6 Parameters*

| Parameter Name | Description |
|---|---|
| **NAT** | Specify if NAT translation is used.<br>The default is **Off**. |
| **NAT Selection** | Specify NAT64.<br>The default is the **NAT66** option. |

8. Click **Update**.

## Configure a NAT64 DIA Route

### Configure a NAT64 DIA Route Using a Cisco VPN Template

1. From the Cisco SD-WAN Manager menu, choose **Configuration** > **Templates**.
2. Click **Feature Templates**.

**Note** In Cisco vManage Release 20.7.x and earlier releases, **Feature Templates** is titled **Feature**.

3. Edit a **Cisco VPN** feature template by clicking **. . .** and then clicking **Edit**.

**Note** You configure an IPv6 DIA route in a **Cisco VPN** feature template, which is the service-side VPN.

4. Click **IPv6 Route**.
5. Click **New IPv6 Route**.
6. In the **Prefix** field, enter the well-known prefix, `64:FF9B::/96`.
7. In the **Gateway** field, click **VPN**.
8. In the **Enable VPN** field, change the scope from **Default** to **Global**, and click **On** to enable VPN.
9. In the **NAT** field, click **NAT64**.
10. Click **Update**.

# Configure a NAT64 DIA Route Using the CLI

### Example: Configure a NAT64 DIA Route

```
Device(config)# nat64 route vrf 4 64:FF9B::1E00:102/128 global
```

# Verify NAT64 DIA Route Configuration

### Example 1

The following is a sample output from the **show ipv6 route vrf** command, which is for the service VPN:

```
Device# show ipv6 route vrf 4
IPv6 Routing Table - 4 - 5 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, R - RIP, H - NHRP, I1 - ISIS L1
       I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D - EIGRP
       EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE - Destination
       NDr - Redirect, RL - RPL, O - OSPF Intra, OI - OSPF Inter
       OE1 - OSPF ext 1, OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1
       ON2 - OSPF NSSA ext 2, la - LISP alt, lr - LISP site-registrations
       ld - LISP dyn-eid, lA - LISP away, le - LISP extranet-policy
       lp - LISP publications, a - Application, m - OMP
m   64:FF9B::/96 [251/0]
     via 172.16.255.15%default, Sdwan-system-intf%default
```

In this example, `64:FF9B::/96`, is the NAT64 well-known prefix for translating IPv6 to IPv4 addresses.

### Example 2

Because NAT64 DIA is configured in the transport VPN, the routing table in the transport VPN appears as the following:

```
Device# show ipv6 route
IPv6 Routing Table - default - 2 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, R - RIP, H - NHRP, I1 - ISIS L1
       I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D - EIGRP
       EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE - Destination
       NDr - Redirect, RL - RPL, O - OSPF Intra, OI - OSPF Inter
       OE1 - OSPF ext 1, OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1
       ON2 - OSPF NSSA ext 2, la - LISP alt, lr - LISP site-registrations
       ld - LISP dyn-eid, lA - LISP away, le - LISP extranet-policy
       lp - LISP publications, a - Application, m - OMP, Nd - Nat-Route DIA
S   64:FF9B::/96 [1/0]
```

# Configuration Example for NAT64 DIA

This example shows what is configured for NAT64 DIA.

```
interface GigabitEthernet1
          no shutdown
          arp timeout 1200
          ip address 10.1.15.15 10.255.255.255
          no ip redirects
          ip mtu    1500
          ip nat outside
          load-interval 30
          mtu           1500
          negotiation auto
          nat64 enable
```

```
          !
          nat64 v6v4 list nat64-global-list interface GigabitEthernet1 overload
          !
          ip nat inside source list nat-dia-vpn-hop-access-list interface GigabitEthernet1
overload
```

**Note** GigabitEthernet1 is a transport VPN interface.

## Advertise NAT64 Routes Through OMP

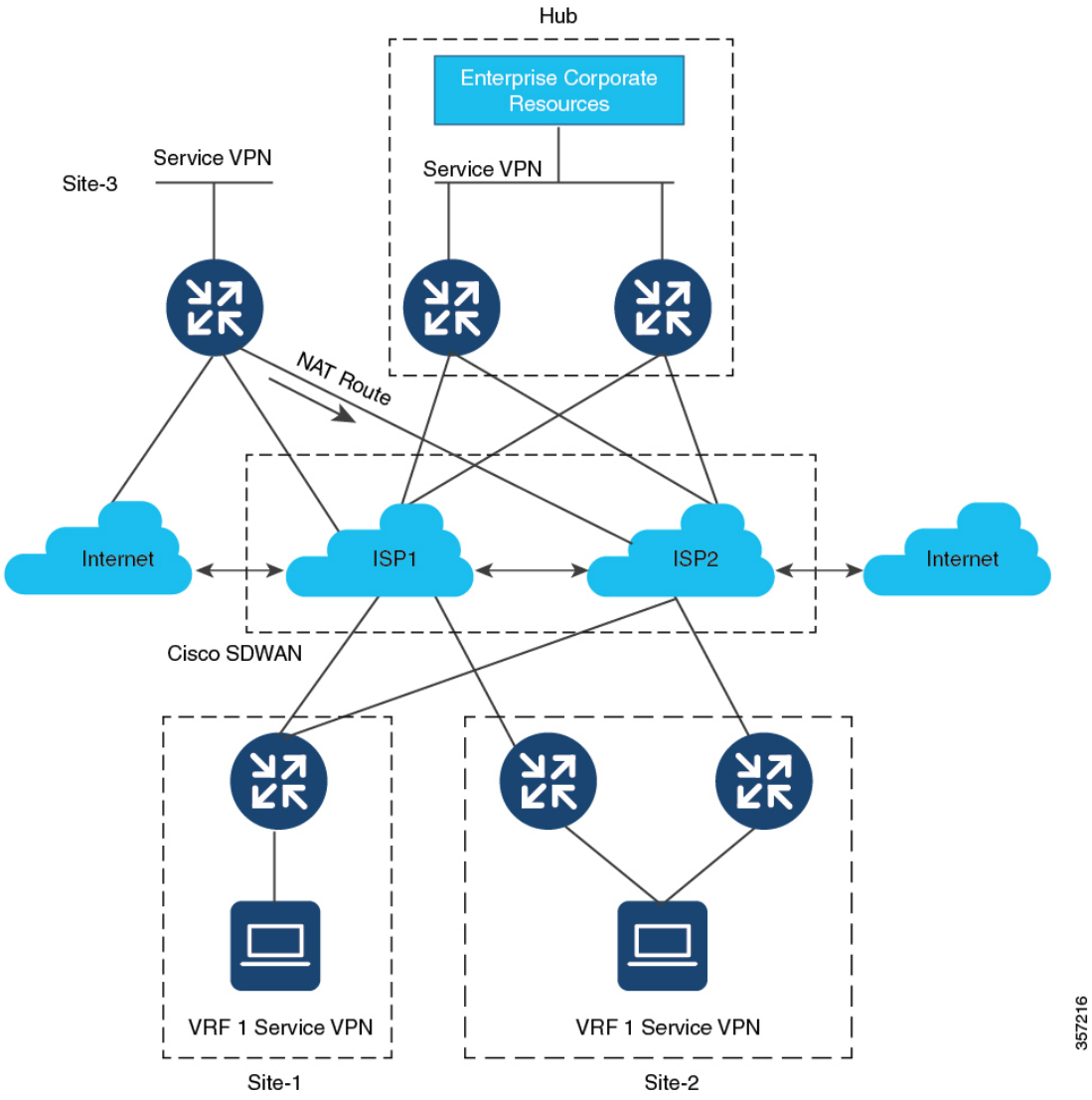
Supported through Cisco IOS XE Catalyst SD-WAN Release 17.12.x

When NAT64 DIA advertisement is configured on any designated Cisco IOS XE Catalyst SD-WAN device on the network, OMP advertises the NAT default route to the branches. The branches receive the default route and use it to reach the hub for all DIA traffic. The Cisco IOS XE Catalyst SD-WAN device acts as the internet gateway for all DIA traffic.

**Note** By default, NAT64 IPv4 pool addresses and the NAT64 well-known prefix are received as an OMP route.

For more information on advertising NAT64 routes through OMP, see Information About Advertising NAT Routes Through OMP.

*Figure 1: Advertising NAT Routes Using OMP*



# Service-Side NAT64

*Table 4: Feature History*

| Feature Name | Release Information | Description |
|---|---|---|
| Service-Side NAT64 for Cisco IOS XE Catalyst SD-WAN Devices | Cisco IOS XE Catalyst SD-WAN Release 16.12.1b<br>Cisco vManage Release 19.2.1 | The service-side Network Address Translation (NAT) 64 feature translates a source IPv6 address to available IPv4 addresses in a NAT pool. The destination IPv6 address is translated to the server's actual IPv4 address since the destination IPv6 address is an IPv4 embedded IPv6 address.<br>Service-side NAT64 allows IPv4 servers to communicate with IPv6 clients. |

# Information About Service-Side NAT64

With the dwindling IPv4 public address space and the growing need for more routable addresses, service providers and enterprises continue to build and roll out IPv6 networks. As the IPv4 internet is going to stay for a while, communication between IPv4 and IPv6 networks is an important requirement for a seamless end-user experience.

NAT IPv6 to IPv4, or NAT64, technology facilitates communication between IPv6 and IPv4 networks.

The service-side NAT64 feature translates a source IPv6 address to available IPv4 addresses in a NAT pool. The destination IPv6 address is translated to the server's actual IPv4 address since the destination IPv6 address is an IPv4-embedded IPv6 address.

Cisco IOS XE Catalyst SD-WAN devices use stateful NAT64 for translating IPv6 addresses to IPv4 addresses and IPv4 addresses to IPv6 addresses. Stateful NAT64 with NAT overload provides a 1:*n* mapping between IPv4 and IPv6 addresses.

## How Service-Side NAT64 Works

1. An IPv6 client attempts to connect to an IPv4 server.
2. The IPv6 client makes an IPv6 AAAA record DNS query, which is an IPv6 query for an IPv4 address.

   The DNS64 server responds with an IPv4-embedded IPv6 address.

   Example:

   ```
   64:ff9b::c000:0201
   ```

   which uses the NAT64 well-known prefix (WKP), `64:FF9B::/96`. The WKP is used for algorithmic mapping between address families.

   An IPv4-embedded IPv6 address consists of a variable length prefix, an embedded IPv4 address, and a variable length suffix. The last 32 bits are the hexadecimal representation of the original IPv4 address, which is 192.0.2.1 in this example.
3. The IPv6 client now tries to connect to the IPv4 server.

4. An IPv6 to IPv4 translation is performed.

   A source IPv6 address is translated to one of the available IPv4 addresses in the pool.

   A destination IPv6 address is translated to the server's actual IPv4 address since the destination IPv6 address is an IPv4-embedded IPv6 address.

## Benefits of Service-Side NAT64

- Supports communication between IPv6 clients in the service VPN with IPv4 servers on the internet
- Provides translation of IPv6 to IPv4 addresses for maintaining dual access to IPv6 and IPv4 networks
- Requires little or no changes to existing IPv4 network infrastructures when using stateful NAT64
- Provides a seamless internet experience for IPv6 users accessing IPv4 internet services, thus maintaining IPv4 business continuity
- Supports configuration of NAT64 without having to configure a data policy

## Use Cases for Service-Side NAT64

Supported traffic flow is from the IPv6 client on the remote site, in the data center, or in another branch site, to the IPv4 client or server on the local LAN.

**Note** Traffic origination is always from the transport-side (WAN) to the service-side (LAN) in the overlay network.

# Prerequisites for Service-Side NAT64

- For Domain Name System (DNS) traffic to work, you must have a separate working installation of DNS64.

# Restrictions for Service-Side NAT64

- Traffic must always originate on the remote branch site and go to the IPv4 server on the local LAN.
- Traffic cannot originate from the IPv4 server to any IPv6 client in the data center or to a remote branch site.

### IPv4 Address Restrictions for Service-Side NAT64

- For more information on the usable IPv4 destination IP addresses, see the Deployment Guidelines, RFC 6052, Section 3.1.
- The well-known prefix (WKP) must not be used to represent non-global IPv4 addresses, such as those listed in the Deployment Guidelines, Section 3 of RFC 5735.

  For example, the following IPv4 prefixes are not allowed:

  - 0.0.0.0/8

- 10.0.0.0/8
- 127.0.0.0/8
- 169.254.0.0/16

- You cannot use a private IPv4 address range on the service-side (LAN).

# Configure Service-Side NAT64

The following sections provide information about configuring service-side NAT64.

## Enable Service-Side NAT64 Using a Feature Template

1. From the Cisco SD-WAN Manager menu, choose **Configuration** > **Templates**.
2. Click **Feature Templates**.

**Note** In Cisco vManage Release 20.7.x and earlier releases, **Feature Templates** is titled **Feature**.

3. Edit a **Cisco VPN Interface Ethernet** template by clicking **. . .** and then clicking **Edit**.

**Note** The **Cisco VPN Interface Ethernet** template is a service-side interface.

4. Click **NAT** and choose **IPv6** for NAT64.
5. Change the scope from **Default** to **Global**.
6. In the **NAT64** field, click **On** to enable NAT64.
7. Click **Update**.

## Configure a Service-Side NAT64 Pool

### Before You Begin

1. You must have enabled service-side NAT64 using a **Cisco VPN Interface Ethernet** template before configuring a NAT64 IPv4 pool.
2. Create a new **Cisco VPN** feature template or edit an existing **Cisco VPN** feature template. The **Cisco VPN** feature template corresponds to the service-side VPN you want to configure NAT64 for.

### Configure a Service-Side NAT64 Pool

1. From the Cisco SD-WAN Manager menu, choose **Configuration** > **Templates**.
2. Click **Feature Templates**.

**Note** In Cisco vManage Release 20.7.x and earlier releases, **Feature Templates** is titled **Feature**.

3. Edit a **Cisco VPN** template by clicking **. . .** and then clicking **Edit**.
4. Click **NAT**.
5. Click **NAT64 v4 Pool**.
6. Click **New NAT64 v4 Pool**.
7. In the **NAT64 Pool name** field, specify the pool name.

**Note** You have to specify a number for the pool name.

8. In the **NAT 64 v4 Pool Range Start** field, specify the IPv4 address for the start of the pool range.
9. In the **NAT 64 v4 Pool End Start** field, specify the IPv4 address for the end of the pool range.
10. From the drop-down list, choose **Global**.
11. Click **On** to enable **NAT 64 Overload**.

**Note** **NAT 64 Overload** is set to **Off** by default.

12. Click **Add**.
13. Click **Update** to push the configuration to the device.

# Configure Service-Side NAT64 Using the CLI

***Table 5: Feature History***

| Feature Name | Release Information | Description |
|---|---|---|
| IPv6 Support for NAT64 Devices | Cisco IOS XE Catalyst SD-WAN Release 16.12.1b | This feature supports NAT64 to facilitate communication between IPv4 and IPv6 on Cisco IOS XE Catalyst SD-WAN devices. |

### Enable Service-Side NAT64 Using the CLI

This section provides an example CLI configuration for enabling service-side NAT64.

Enable service-side NAT64 on the LAN interface, which is equivalent to the **Service VPN** template on Cisco SD-WAN Manager.

The IPv4 application server is on the local LAN site and the IPv6 client is in the data center or on the remote site of the LAN.

```
Device# interface GigabitEthernet 5.104
nat64 enable
```

### Configure a Service-Side NAT64 Pool Using the CLI

This section provides an example CLI configuration for configuring a service-side NAT64 pool.

```
Device# nat64 v4 pool pool10 192.0.2.0 192.0.2.254
nat64 v6v4 list global-list_nat64 pool pool10 vrf 4 overload
```

# Verify Configuration of Service-Side NAT64

### Example - What Displays in the Routing Table for the Specified Device

The following is a sample output from the **show ipv6 route vrf** command:

```
Device# show ipv6 route vrf 4
IPv6 Routing Table - 4 - 5 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, R - RIP, H - NHRP, I1 - ISIS L1
       I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D - EIGRP
       EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE - Destination
       NDr - Redirect, RL - RPL, O - OSPF Intra, OI - OSPF Inter
       OE1 - OSPF ext 1, OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1
       ON2 - OSPF NSSA ext 2, la - LISP alt, lr - LISP site-registrations
       ld - LISP dyn-eid, lA - LISP away, le - LISP extranet-policy
       lp - LISP publications, a - Application, m - OMP, Nd - Nat-Route DIA
Nd  64:FF9B::/96 [6/0]
     via Null0%default, directly connected
m   2001:DB8:AA:A::/64 [251/0]
     via 172.16.255.16%default, Sdwan-system-intf%default
C   2001:DB8:BB:A::/64 [0/0]
     via GigabitEthernet5.104, directly connected
L   2001:DB8:BB:A::1/128 [0/0]
     via GigabitEthernet5.104, receive
L   FF00::/8 [0/0]
     via Null0, receive
```

In this example, the NAT64 well-known prefix, `64:FF9B::/96`, displays in the IPv6 routing table of a service VPN.

The following is a sample output from the **show ip route vrf 4** command:

```
Device# show ip route vrf 4
Routing Table: 4
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, m - OMP
       n - NAT, Ni - NAT inside, No - NAT outside, Nd - NAT DIA
       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
       H - NHRP, G - NHRP registered, g - NHRP registration summary
       o - ODR, P - periodic downloaded static route, l - LISP
       a - application route
       + - replicated route, % - next hop override, p - overrides from PfR
       & - replicated local route overrides by connected
```

The NAT64 IPv4 pool address is installed in the routing table as `nat inside route` in the IPv4 routing table of a service VPN.

### Example - What Displays in the Routing Table on OMP

The following is a sample output from the **show ipv6 route vrf** command:

```
Device# show ipv6 route vrf 4
IPv6 Routing Table - 4 - 5 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, R - RIP, H - NHRP, I1 - ISIS L1
       I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D - EIGRP
       EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE - Destination
       NDr - Redirect, RL - RPL, O - OSPF Intra, OI - OSPF Inter
       OE1 - OSPF ext 1, OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1
       ON2 - OSPF NSSA ext 2, la - LISP alt, lr - LISP site-registrations
       ld - LISP dyn-eid, lA - LISP away, le - LISP extranet-policy
       lp - LISP publications, a - Application, m - OMP
m   64:FF9B::/96 [251/0]
     via 172.16.255.15%default, Sdwan-system-intf%default
C   2001:DB8:AA:A::/64 [0/0]
     via GigabitEthernet5.104, directly connected
L   2001:DB8:AA:A::1/128 [0/0]
     via GigabitEthernet5.104, receive
m   2001:DB8:BB:A::/64 [251/0]
     via 172.16.255.15%default, Sdwan-system-intf%default
L   FF00::/8 [0/0]
     via Null0, receive
```

In this example, the NAT64 well-known prefix, `64:FF9B::/96`, is received as an Overlay Management Protocol (OMP) route.

The NAT64 IPv4 pool addresses are received as an OMP route.

# Configuration Examples for Service-Side NAT64

This example shows the configuration of service-side NAT64.

```
nat64 v4 pool 1-4 192.0.2.0 192.0.2.254
nat64 v6v4 list nat64-list pool 1-4 vrf 4 overload
!
interface GigabitEthernet5.104
 encapsulation dot1Q 104
 vrf forwarding 4
 ip address 10.1.19.15 10.255.255.255
 ip mtu 1496
 ip ospf network broadcast
 ip ospf 4 area 0
 nat64 enable
end
```

This example shows the configuration of a NAT64 pool.

```
nat64 v4 pool 1-4 192.0.2.0 192.0.2.254
nat64 v6v4 list nat64-list pool 1-4 vrf 4 overload
!
interface GigabitEthernet5.104
 encapsulation dot1Q 104
 vrf forwarding 4
 ip address 10.1.19.15 10.255.255.255
 ip mtu 1496
 ip ospf network broadcast
 ip ospf 4 area 0
 nat64 enable
end
```

# Mapping of Address and Port Using Encapsulation with NAT64

*Table 6: Feature History*

| Feature Name | Release Information | Description |
|---|---|---|
| Mapping of Address and Port Using Encapsulation (MAP-E) with NAT64 | Cisco IOS XE Catalyst SD-WAN Release 17.10.1a | This feature provides support for an IPv4 client to access IPv4 servers when using an IPv6-only network. IPv4 traffic is routed to the internet over an IPv6 tunnel.<br><br>With this feature, you can configure a MAP-E domain and MAP-E parameters for transporting IPv4 packets over an IPv6 network using IP encapsulation. When the MAP-E customer edge (CE) device starts or when an IPv4 address changes, the device obtains the MAP-E parameters automatically from the MAP-E rule server using HTTP.<br><br>This feature lets you configure a MAP-E domain and MAP-E parameters for transporting IPv4 packets over an IPv6 network using IP encapsulation. When the MAP-E customer edge (CE) device starts or when an IPv4 address changes, the device obtains the MAP-E parameters automatically from the MAP-E rule server using HTTP. |

## Information About MAP-E with NAT64

Minimum supported release: Cisco IOS XE Catalyst SD-WAN Release 17.10.1a

Mapping of Address and Port with Encapsulation (MAP-E) is an Internet Engineering Task Force (IETF) draft that describes a mechanism for transporting IPV4 packets over an IPv6-only network using encapsulation.

Within the MAP-E domain, IPv4 packets are exchanged between MAP-E CE devices and the public IPv4 internet by encapsulating and transporting the packets through the IPv6-only network.

The MAP-E with NAT64 feature supports the following configurations:

- Shared-IPv4 configuration

  MAP-E enables multiple MAP-E CE devices within a MAP-E domain to share a single IPv4 address. Each MAP-E CE device with the same IPv4 address has to use a different TCP or UDP port. MAP-E provides IPv4 connectivity using shared IPv4 addresses in an IPv6-only network.

- Fixed-IPv4 configuration

  In a fixed-IPv4 configuration, one MAP-E CE device uses a fixed-IPv4 address.

### Components of a MAP-E Configuration with NAT64

Minimum supported release: Cisco IOS XE Catalyst SD-WAN Release 17.10.1a

Each mapping of address and port using a MAP-E domain uses a different mapping rule. A MAP-E configuration contains the following:

- Basic mapping rule (BMR)

  A BMR configures the MAP-E IPv6 address or prefix. You can configure only one BMR per IPv6 prefix. The MAP-E CE device uses the BMR to configure itself with an IPv4 address, an IPv4 prefix, or a shared IPv4 address from an IPv6 prefix. You can also use a BMR for forwarding packets in use cases where an IPv4 source address and source port are mapped to an IPv6 address or prefix. Every MAP-E CE must be provisioned with a BMR.

  The BMR IPv6 prefix along with the port parameter is used as a tunnel source address.

- One default mapping rule (DMR)

  A DMR prefix that matches with the interface address is recognized as a host and a DMR prefix with a prefix length of 128 is recognized as the tunnel source address. A border router IPv6 address is the tunnel destination address.

- Port-set ID (PSID)

  The PSID identifies the allowed ports to use.

  The border router checks whether the PSID and the port set match. If the port-set ID and port set match, the DMR matches the packet destination of the IPv6 packet. Based on the BMR, the border router constructs the IPv4 source address and extracts the IPv4 destination address from the IPv6 destination address. The IPv6 packet uses the NAT64 IPv6-to-IPv4 translation engine to construct the IPv4 packet from the IPv6 packet.

Configure the MAP-E parameters automatically from the MAP-E rule server using HTTP when the MAP-E CE device starts or whenever an IPv6 address changes.

To configure a MAP-E domain and MAP-E parameters, use the **nat64 provisioning** command. For more information on configuring a MAP-E domain and MAP-E parameters, see the Cisco IOS XE SD-WAN Qualified Command Reference Guide.

For information on the MAP-E rule REST API specifications, see the IP Addressing: NAT Configuration Guide.

## Benefits of MAP-E with NAT64

- Supports IPv4 traffic flow over an IPv6-only network.
- Supports efficient traffic delivery with lower latency without requiring additional hardware at the border router.
- Supports an easy-to-use and scalable solution for migrating to IPv6.

# Restrictions for MAP-E with NAT64

Minimum supported release: Cisco IOS XE Catalyst SD-WAN Release 17.10.1a

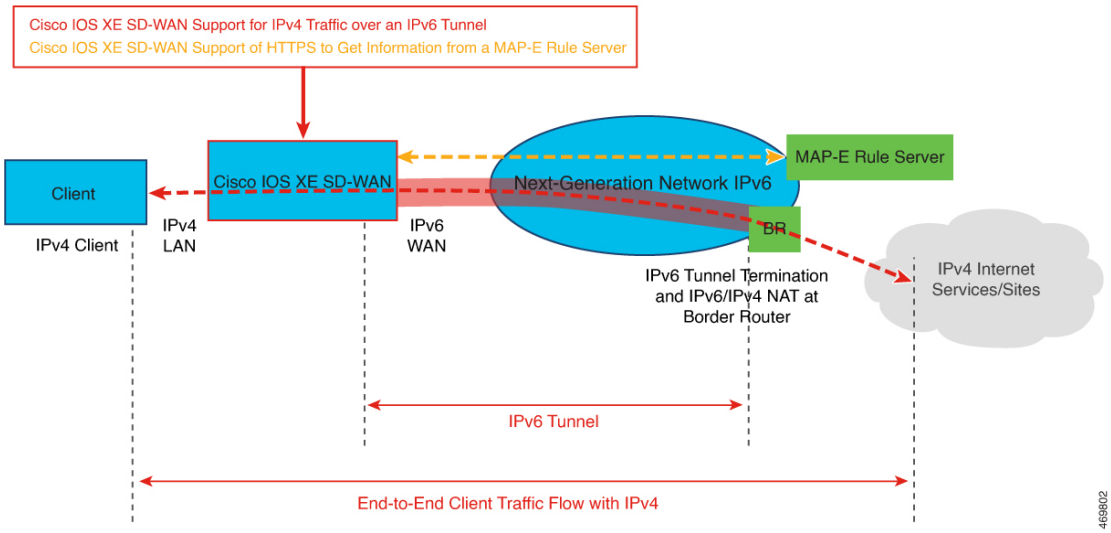
- Support for a single BMR per a MAP-E CE device. Configure different mapping rules for every address and port translation.
- No support for a BMR prefix length of 64, fragmentation, and local packet generation.

# Workflow for MAP-E with NAT64

Minimum supported release: Cisco IOS XE Catalyst SD-WAN Release 17.10.1a

The following diagram describes the end-to-end client traffic flow for an IPv4 client to reach an IPv4 server when using an IPv6-only network with MAP-E.

***Figure 2: Workflow for MAP-E with NAT64***

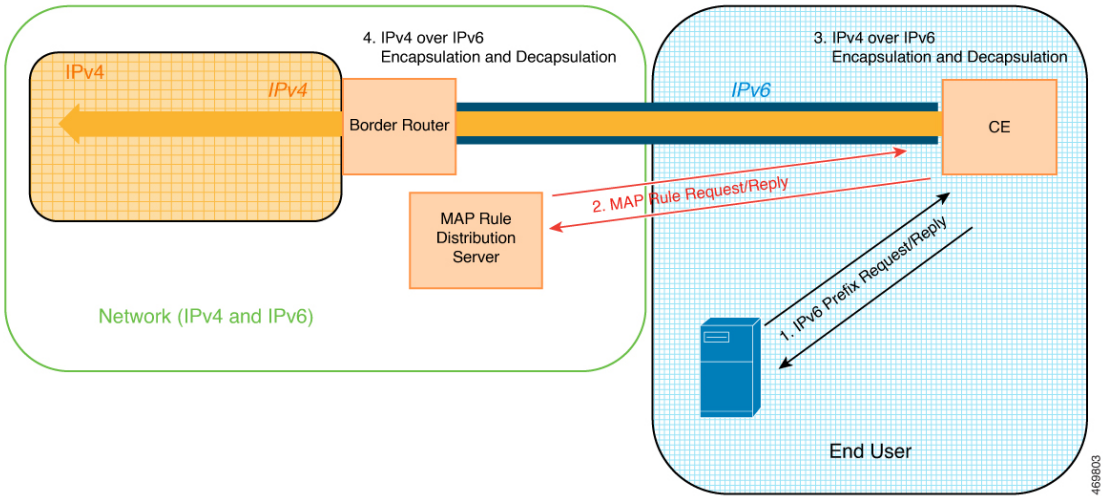



### MAP-E Interactions Between a MAP-E CE Device and a MAP-E Rule Server

1. The MAP-E rule server acquires an IPv6 prefix from an IPv6-only network.
2. A MAP-E CE device sends an HTTP request to the MAP-E rule server and receives a response.

   MAP-E enables a Cisco IOS XE Catalyst SD-WAN device to function as a MAP-E CE device.
3. Per the MAP-E rule, a MAP-E CE device performs a translation of the incoming IPv4 packets.
4. The MAP-E CE device encapsulates the IPv4 packets into IPv6 packets and sends the IPv6 packets to the border router.
5. On receiving the encoded IPv6 packets, the IPv6 packets are decapsulated by the border router according to the MAP-E rule, and the IPv6 traffic is routed to the IPv4 public internet.

*Figure 3: MAP-E Workflow*




# Configure MAP-E with NAT64 Using a CLI Template

Minimum supported release: Cisco IOS XE Catalyst SD-WAN Release 17.10.1a

For more information about using CLI templates, see CLI Add-On Feature Templates and CLI Templates.

**Note** By default, CLI templates execute commands in global config mode.

This section provides example CLI configurations to configure a MAP-E domain and MAP-E parameters.

1. Disable the NAT64 fragmentation header.

   ```
   nat64 settings fragmentation header disable
   ```

2. Configure a NAT64 DIA route.

   ```
   nat64 route ip-address interface-type-number
   ```

   For more information, see Configure a NAT64 DIA Route.

3. Specify the NAT64 MAP-E domain and enter MAP-E configuration mode.

   ```
   nat64 provisioning mode jp01
   ```

4. Configure the address resolution sever with a username and password.

   ```
   address-resolution-server http://ipv6-prefix/directory-path
   address-resolution-server 6 username encypted-user-name
   address-resolution-server 6 password encypted-password
   ```

   You can also specify an encryption type (2 or 6) for encrypting the address resolution server username and password.

5. Configure a MAP-E rule server.

   ```
   rule-server http://admin:admin@ipv6-prefix//directory-path
   ```

   You can also specify an encryption type (2 or 6) for encrypting the rule server URL.

6. (Optional) Configure a wait time in seconds for responses from the HTTP server.

   ```
   rule-server request wait-time value-seconds
   ```

7. Configure a host name.

   ```
   hostname hostname
   ```

   The host name is from the MAP-E rule server. In case you overwrite the host name, you can specify a new host name.

8. Configure a tunnel interface.

   ```
   tunnel interface Tunnelnumber
   tunnel source interface-type-interface-number
   ```

**Note** Configure a tunnel interface and a tunnel source for a fixed-IPv4 configuration only.

9. Configure a service prefix.

   ```
   service-prefix ipv6-prefix
   ```

**Note** The IPv6 prefix of the MAP-E rule returned from the MAP-E rule server needs to match the IPv6 service prefix configured on the MAP-E CE device.

**Note** Configure a service prefix for either a fixed-IPv4 configuration or for a shared-IPv4 configuration.

Here is a complete configuration example for configuring a MAP-E domain and parameters.

```
nat64 settings fragmentation header disable
nat64 settings v4 tos ignore
interface GigabitEthernet1
!
nat64 settings mtu minimum 1500
nat64 provisioning mode jp01
 address-resolution-server http://2001:db8:b000:0:fe7f:6ee7:33db:5013/nic/update
 address-resolution-server password encypted-password
 address-resolution-server username encypted-username
 rule-server http://admin:admin@2001:DB8:A000::1//mape-rule.json
 rule-server request wait-time 180
 hostname hostname
 tunnel interface Tunnel1
 tunnel source GigabitEthernet2
 service-prefix 2001:DB8:b800::/48
!
nat64 route 0.0.0.0/0 GigabitEthernet1
```

# Verify MAP-E with NAT64 Configuration

Minimum supported release: Cisco IOS XE Catalyst SD-WAN Release 17.10.1a

The following example is a sample output from the **show nat64 map-e** command:

```
Device# show nat64 map-e
MAP-E Domain 9126
   Mode MAP
   Border-relay-address
      Ip-v6-address 2001:DB8::9
   Basic-mapping-rule
      Ip-v6-prefix 2001:DB8:B001:80::/60
      Ip-v4-prefix 10.1.1.0/24
      Port-parameters
         Share-ratio 4   Contiguous-ports 256   Start-port 1024
         Share-ratio-bits 2   Contiguous-ports-bits 8   Port-offset-bits 6
      Port-set-id 0
```

The output above is an example of a shared-IPv4 address configuration because the ports are shared across the MAP-E CE devices. The output displays the MAP-E parameters that were returned from the MAP-E rule server.

The following example is a sample output from the **show nat64 statistics** command:

```
Device# show nat64 statistics
NAT64 Statistics

Total active translations: 0 (0 static, 0 dynamic; 0 extended)
Sessions found: 0
Sessions created: 0
Expired translations: 0
Global Stats:
   Packets translated (IPv4 -> IPv6)
      Stateless: 0
      Stateful: 0
      nat46: 0
      MAP-T: 0
      MAP-E: 5
   Packets translated (IPv6 -> IPv4)
      Stateless: 0
      Stateful: 0
      nat46: 0
      MAP-T: 0
      MAP-E: 4

Interface Statistics
   GigabitEthernet0/0/0 (IPv4 not configured, IPv6 configured):
      Packets translated (IPv4 -> IPv6)
         Stateless: 0
         Stateful: 0
         nat46: 0
         MAP-T: 0
         MAP-E: 0
      Packets translated (IPv6 -> IPv4)
         Stateless: 0
         Stateful: 0
         nat46: 0
         MAP-T: 0
         MAP-E: 4
      Packets dropped: 0
   GigabitEthernet0/0/1 (IPv4 configured, IPv6 not configured):
      Packets translated (IPv4 -> IPv6)
         Stateless: 0
         Stateful: 0
         nat46: 0
         MAP-T: 0
         MAP-E: 5
      Packets translated (IPv6 -> IPv4)
         Stateless: 0
```

```
         Stateful: 0
         nat46: 0
         MAP-T: 0
         MAP-E: 0
      Packets dropped: 0
Dynamic Mapping Statistics
   v6v4
Limit Statistics
```