Mapping of Address and Port Using Encapsulation

The MAP-E feature provides rules to define the mapping between an IPv6 prefix and an IPv4 address or between a shared IPv4 address and an IPv6 prefix/address. The MAP-E feature is supported by the Stateless NAT64 feature and does not change the system flow of the NAT64 client.

- Feature Information for Mapping of Address and Port Using Encapsulation, on page 1
- Restrictions for Mapping of Address and Port Using Encapsulation, on page 1
- Information About Mapping of Address Port Using Encapsulation, on page 2
- How to Configure Mapping of Address Port Using Encapsulation, on page 4
- Configuration Examples for Mapping of Address and Port Using Encapsulation, on page 10
- Additional References for Mapping of Address and Port Using Encapsulation, on page 11

Feature Information for Mapping of Address and Port Using Encapsulation

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.

Restrictions for Mapping of Address and Port Using Encapsulation

- The MAP-E feature supports only a single basic mapping rule (BMR) per IPv6 prefix. This requires you to configure different mapping rules for every address and port translation.

- Default mapping rule (DMR) with 128 prefix must be configured before starting the MAP-E BMR configuration.

- This feature does not support BMR prefix length of 64, fragmentation, and local packet generation.
Information About Mapping of Address Port Using Encapsulation

Mapping of Address and Port Using Encapsulation

MAP-E refers to Mapping of Address and Port Encapsulation (MAP-E). The MAP-E feature enables you to configure mapping rules for translation between IPv4 and IPv6 addresses. Each mapping of address and port using MAP-E domain uses a different mapping rule. A MAP-E configuration comprises of one basic mapping rule (BMR), one default mapping rule (DMR), and one or more forwarding mapping rules (FMRs) for each MAP-E domain.

A BMR configures the MAP IPv6 address or prefix. You can configure only one BMR per IPv6 prefix. The MAP-E CE uses the BMR to configure itself with an IPv4 address, an IPv4 prefix, or a shared IPv4 address from an IPv6 prefix. A BMR can also be used for forwarding packets in such scenarios where an IPv4 source address and source port are mapped into an IPv6 address/prefix. Every MAP-E node (CE device is a MAP-E node) must be provisioned with a BMR. The BMR prefix along with the port parameter is used as tunnel source address. You can use the `port-parameters` command to configure port parameters for the MAP-E BMR.

A DMR prefix which matches with the interface address is recognized as hosts and a DMR prefix with a prefix length of 128 is recognized as the tunnel source address. A border relay IPv6 address is used as the tunnel destination address.

When you boot up a Customer Edge (CE) device for the first time, the CE sends an HTTP request to the rule server to acquire the MAP-E rules. After the CE receives the MAP-E rules, it saves a copy of the rules in a persistent storage, such as bootflash. When you reboot the router subsequently, the CE then detects the copy of MAP-E rules in the bootflash, so it does not send the HTTP request immediately. For a fixed IP in IP, the CE sends the request to the rule server only after the Dynamic Domain Name System (DDNS) reply is successfully received from the address resolution server.

Note

In a fixed IP in IP, the IP in IP tunnel interface is used instead of a NAT64 configuration. Use the `nat64 provisioning mode` command to enable the tunnel interface.

Map Rule Request

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Specifications</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>HTTP</td>
<td>Versions: 1.0, 1.1, 2.0</td>
</tr>
<tr>
<td>2</td>
<td>HTTP</td>
<td>Method is GET</td>
</tr>
<tr>
<td>3</td>
<td>Communicate to IPv6 obtained by name resolution</td>
<td>IPv6 on the rule distribution server side is variable, so do not cache AAAA records.</td>
</tr>
<tr>
<td>4</td>
<td>Embed ipv6Prefix and ipv6PrefixLength in a query parameter.</td>
<td>ipv6Prefix=2001:0DB8:XXX:YYYY:YY</td>
</tr>
<tr>
<td>5</td>
<td>Embed API key in a query parameter.</td>
<td>Ex) code=Abag9k2RFgerkdjgsirSDEFgwadu</td>
</tr>
</tbody>
</table>
### Map Rule Server Transmission of Data

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Map Rule Specifications</td>
<td>Essential information to generate Basic Mapping Rule (BMR) according to draft-ietf-softwire-map-03.</td>
</tr>
<tr>
<td>- Rule IPv6 prefix</td>
<td></td>
</tr>
<tr>
<td>- Rule IPv6 prefix Length</td>
<td></td>
</tr>
<tr>
<td>- Rule IPv4 prefix</td>
<td></td>
</tr>
<tr>
<td>- Rule IPv4 prefix Length</td>
<td></td>
</tr>
<tr>
<td>- EA</td>
<td></td>
</tr>
<tr>
<td>- bits length</td>
<td></td>
</tr>
<tr>
<td>- PSID offset</td>
<td></td>
</tr>
<tr>
<td>- BR IPv6 Address</td>
<td></td>
</tr>
<tr>
<td>256</td>
<td>The maximum number of MAP rules that can be included in the transmitted data.</td>
</tr>
<tr>
<td>content-length</td>
<td>XXX (body size)</td>
</tr>
<tr>
<td>content-type</td>
<td>application/json; charset=utf-8</td>
</tr>
</tbody>
</table>

### Map Rule Server URL Specification

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>URI</td>
<td></td>
</tr>
<tr>
<td><a href="https://rule.map.ocn.ad.jp/?ipv6Prefix=">https://rule.map.ocn.ad.jp/?ipv6Prefix=</a>&lt;address&gt;&amp;ipv6PrefixLength=&lt;prefixLength&gt;&amp;code=&lt;API Key&gt;</td>
<td>• Example of URI: <a href="https://rule.map.ocn.ad.jp/?ipv6Prefix=2400:4050">https://rule.map.ocn.ad.jp/?ipv6Prefix=2400:4050</a>: XXX:&amp;ipv6PrefixLength=YY&amp;code=Abag9k2RFgerklsjgsirSDEFgwada</td>
</tr>
</tbody>
</table>

The query parameter specification is as shown in the table below:

### Map Rule Server Transmission of Data

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Map Rule Specifications:</td>
<td>Information to generate Basic Mapping Rule (BMR).</td>
</tr>
<tr>
<td>- Rule IPv6 prefix</td>
<td></td>
</tr>
<tr>
<td>- Rule IPv6 prefix length</td>
<td></td>
</tr>
<tr>
<td>- Rule IPv4 prefix</td>
<td></td>
</tr>
</tbody>
</table>
Map Rule Server Response Parameters

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Type</th>
<th>Byte</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>brIpv6 Address</td>
<td>BRIPv6 address</td>
<td>string</td>
<td>39 (max)</td>
<td>Compliant with RFC 5952</td>
</tr>
<tr>
<td>eaBitLength</td>
<td>EA bit Length</td>
<td>string</td>
<td>2 (max)</td>
<td>Example: 25</td>
</tr>
<tr>
<td>ipv4Prefix</td>
<td>User IPv4 Prefix</td>
<td>string</td>
<td>15 (max)</td>
<td>Example: 10.0.0.0</td>
</tr>
<tr>
<td>ipv4PrefixLength</td>
<td>User IPv4 Prefix Length</td>
<td>string</td>
<td>2 (max)</td>
<td>Example: 16</td>
</tr>
<tr>
<td>ipv6Prefix RFC 5952</td>
<td>User IPv6 Prefix</td>
<td>String</td>
<td>39 (max)</td>
<td>Compliant with RFC 5952</td>
</tr>
<tr>
<td>ipv6PrefixLength</td>
<td>User IPv6 Prefix Length</td>
<td>string</td>
<td>2 (max)</td>
<td>Example: 35</td>
</tr>
<tr>
<td>psIdOffset</td>
<td>PSID Offset</td>
<td>string</td>
<td>2 (max)</td>
<td>Example: 6</td>
</tr>
</tbody>
</table>

How to Configure Mapping of Address Port Using Encapsulation

Enable Tunnel Interface

Perform this task to enable tunnel interface. This task shows the `ipv6 nat prefix v4-mapped` command configured on a specified interface, but the command could alternatively be configured globally:

**Step 1**

`enable`

**Example:**

```bash
cisco(config)# enable
```
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**

interface tunnel tunnel-number

**Example:**

Router(config)# interface tunnel0

Specifies the interface tunnel number.

**Step 4**

nat64-mape

**Example:**

Device(config)# nat64-mape

Specifies the MAP-E mapping rule and enters the basic mapping rule configuration mode.

**Step 5**

ipv4 ipv4-prefix

**Example:**

Device(config-nat64-mape)# 10.1.1.0

Specifies the ipv4 address from rule server.

**Step 6**

ip nat outside

**Example:**

Device(config-nat64-mape)# ip nat outside

Specifies the ipv4 nat address.

**Step 7**

ip virtual re-assembly in

**Example:**

Device(config-nat64-mape)# ip virtual re-assembly in

Configures the virtual re-assembly.

**Step 8**

ip tcp adjust-mss adjust-mss-number

**Example:**

Device(config-nat64-mape)# ip tcp adjust-mss 1300

Specifies the TCP number.

**Step 9**

tunnel source source-address

**Example:**

Enable Tunnel Interface

Mapping of Address and Port Using Encapsulation

Device(config-nat64-mape)# tunnel source 2001:22::0/128

Specifies the ipv6 tunnel source address.

Step 10  
tunnel mode  ipv6-prefix

Example:
Device(config-nat64-mape)# tunnel mode ipv6

Configures the ipv6 tunnel mode.

Step 11  
port-parameters share-ratio number port-offset-bits number| start-port port-number| no-eabits number

Example:
Device(config-nat64-mape-bmr)# port-parameters share-ratio 2 port-offset-bits 5 start-port 1024

Specifies the values for port-parameters share-ratio, contiguous ports and start-port for MAP-E Basic Mapping Rule (BMR).

• If the share ratio is greater than 1, the configuration throws an error if the start port value is incorrect. The calculation is based on the share-ratio and port-offset bits. The configuration throws error and displays the value to be configured.

• If the share ratio is 1, there are no port-offset bits as the values is automatically set to 6 and the start port is set to 1024.

Step 12  
ext

Example:
Device(config-nat64-mape-bmr)# exit

Exits basic mapping rule configuration mode and returns to MAP-E configuration mode.

Step 13  
default-mapping-rule ipv6 prefix/length

Example:
Device(config-nat64-MAP-E-dmr)# default-mapping-rule 2001:22::0/128

Specifies the values of IPv6 prefix and length for MAP-E Default Mapping Rule (DMR).

Step 14  
mode map-e

Example:
Device(config-nat64-MAP-E)# mode map-e

Specifies the value for MAP-E mode.

Step 15  
end

Example:
Device(config-route-map)# end

Exits MAP-E configuration mode and returns to privileged EXEC mode.
Automatic Configuration of Address and Port Using Encapsulation

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  nat64 provisioning mode mode id
Example:
Device(config)# nat64 provisioning mode jp01
Specifies the nat64 MAP-E domain and enters the MAP-E configuration mode.

Step 4  version draft-ietf-softwire-map-03
Example:
Device(config-nat-provisioning)# version draft-ietf-softwire-map-03
Specifies the MAP version.

Step 5  rule-server url
Example:
Device(config-nat64-provisioning)# rule server rule-server 7 121111030251434B2B39342C36262349041F1000259080A00745C5348E037C750B8050E5808E57020D555C0B054B0E4B1D34404B471316181C
Specifies the NAT64 rule server address.

Step 6  api-key key-id
Example:
Device(config-nat64-provisioning)# api-key api-key 7 85E57020D555C0B054B0E4B1D34404B471316181C
Specifies the NAT64 api key ID.

Step 7  address-resolution-server url
Example:
Device(config-nat64-provisioning)# address-resolution-server 7 00259080A00745C5348E037C750B8050E5808E57020D555C0B054B0E4B1D34404B471316181C
Specifies URL of the address resolution server.

Step 8  exit
Example:
Device(config-nat64-provisioning)# exit

Exits the NAT64 provisioning and returns to MAP-E configuration mode.

**Step 9**

**Example:**

Device(config)# end

Exits MAP-E configuration mode and returns to privileged EXEC mode.

---

**Verifying Manual Mapping of Address and Port Using Encapsulation Configuration**

**Step 1**

*enable*

**Example:**

Device> enable

Enables privileged EXEC mode.

- Enter your password if prompted.

**Step 2**

*show nat64 MAP-E [domain number]*

**Example:**

Device# show nat64 MAP-E domain 1

MAP-E Domain 1  
Mode MAP-E 
Default-mapping-rule 
Ip-v6-prefix 2001::/128  
Basic-mapping-rule 
Ip-v6-prefix 2001::/64  
Ip-v4-prefix 10.1.1.0/24  
Port-parameters 
  Share-ratio 2  Contiguous-ports 1024  Start-port 1024  
  Share-ratio-bits 1  Contiguous-ports-bits 10  Port-offset-bits 5

Displays MAP-E configuration.

---

**Automatic Configuration of Address and Port Using Encapsulation**

**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  nat64 provisioning mode mode id

Example:
Device(config)# nat64 provisioning mode jp01
Specifies the nat64 MAP-E domain and enters the MAP-E configuration mode.

Step 4  version draft-ietf-softwire-map-03

Example:
Device(config-nat-provisioning)# version draft-ietf-softwire-map-03
Specifies the MAP version.

Step 5  rule-server url

Example:
Device(config-nat64-provisioning)# rule server rule-server 7
121111030251434B2B39342C36262349041F100259080A00745C53484E037C750B8050B58085E57020D555C0B054B0E4B1D34404B471316181C
Specifies the NAT64 rule server address.

Step 6  api-key key-id

Example:
Device(config-nat64-provisioning)# api-key api-key 7
85E57020D555C0B054B0E4B1D34404B471316181C
Specifies the NAT64 api key ID.

Step 7  address-resolution-server url

Example:
Device(config-nat64-provisioning)# address-resolution-server 7
00259080A00745C53484E037C750B8050B58085E57020D555C0B054B0E4B1D34404B471316181C
Specifies URL of the address resolution server.

Step 8  exit

Example:
Device(config-nat64-provisioning)# exit
Exits the NAT64 provisioning and returns to MAP-E configuration mode.

Step 9  end

Example:
Device(config)# end
Exits MAP-E configuration mode and returns to privileged EXEC mode.
Configuration Examples for Mapping of Address and Port Using Encapsulation

Example: Manual Mapping of Address and Port Using Encapsulation Configuration

The following example shows how to configure MAP-E:

```bash
enable
configure terminal
nat64 map-e domain 1
  basic-mapping-rule
    ipv6-prefix 4001:DB8::/40
    ipv4-prefix 50.50.50.0/24
    port-parameters share-ratio 1 start-port 1
    default-mapping-rule 3001:1::C0A8:105/128
end
```

The following example shows shared IPv4 configurations:

```bash
enable
configure terminal
  nat64 route 0.0.0.0/0 GigabitEthernet0/0/0
  nat64 provisioning mode jp01
  version draft-ietf-softwire-map-03
  rule-server 7
    030C4F1F16556E034F0B1A5F0713181F4E0A797C78676F06315F4C215106080209055F4C1517495D1A1475951465A131357190E00090A
    api-key 7 050A070D23
    service-prefix 2400:4050::/30
end
```

```bash
enable
configure terminal
  nat64 map-e domain 1
  basic-mapping-rule
    ipv6-prefix 4001:DB8::/40
    ipv4-prefix 50.50.50.0/24
    port-parameters share-ratio 1 start-port 1
    default-mapping-rule 3001:1::C0A8:105/128
end
```
# Additional References for Mapping of Address and Port Using Encapsulation

## Related Documents

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<tr>
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<th>Document Title</th>
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<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
<tr>
<td>NAT commands</td>
<td>Cisco IOS IP Addressing Services Command Reference</td>
</tr>
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## Standards and RFCs

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<th>Title</th>
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<td>MAP</td>
<td>Mapping of Address and Port (MAP)</td>
</tr>
<tr>
<td>MAP Encapsulation</td>
<td>MAP Encapsulation (MAP-E) - specification</td>
</tr>
<tr>
<td>RFC 6052</td>
<td>IPv6 Addressing of IPv4/IPv6 Translators</td>
</tr>
<tr>
<td>RFC 6144</td>
<td>Framework for IPv4/IPv6 Translation</td>
</tr>
<tr>
<td>RFC 6145</td>
<td>IP/ICMP Translation Algorithm</td>
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## Technical Assistance

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<tbody>
<tr>
<td>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>
Additional References for Mapping of Address and Port Using Encapsulation