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 2
- Information About Mapping of Address Port Using Encapsulation, on page 2
- How to Configure Mapping of Address Port Using Encapsulation, on page 5
- Configuration Examples for Mapping of Address and Port Using Encapsulation, on page 11
- Additional References for Mapping of Address and Port Using Encapsulation, on page 12

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.

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mapping of Address and Port Using Encapsulation</td>
<td>Cisco IOS XE Gibraltar 16.11.1</td>
<td>The Mapping of Address and Port Using Encapsulation (MAP-E) feature provides support for configurable rules used to define the mapping between an IPv4 prefix and an IPv4 address or between a shared IPv4 address and an IPv6 prefix/address. The following commands were introduced or modified: address-resolution-server url, api-key key, basic-mapping-rule, nat64 provisioning mode jp01default-mapping-rule, nat64 map-e, version draft-ietf-softwire-map-03port-parameters, show nat64 map-e.</td>
</tr>
</tbody>
</table>
The Mapping of Address and Port using Encapsulation (MAP-E) feature supports automatic configuring of the MAP-E rules using HTTP.

The following commands were introduced or modified: `basic-mapping-rule`, `address-resolution-server url`, `api-key key`, `basic-mapping-rule`, `default-mapping-rule`, `nat64 provisioning mode jp01`, `nat64 map-e`, `port-parameters`, `show nat64 map-e`.

MAP-E for CPE Functionality Support is an IPv6 transition mechanism for transporting IPv4 packets across an IPv6 network using IP encapsulation. With MAP-E, the IPv4 address exhaustion is resolved using the multiple CPEs sharing the same public IPv4 address.

**Note**
MAP-E CPE functionality is supported from IOS XE Amsterdam 17.1.1 release.

Use the `nat64 provisioning mode` command to enable the tunnel interface.

There were no new commands introduced or modified for this feature.

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### 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 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
destination address and a destination 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 destination 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.

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.

---

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><code>ipv6Prefix=2001:0:XXX:YYY:YY</code></td>
</tr>
<tr>
<td>5</td>
<td>Embed API key in a query parameter.</td>
<td><code>Ex) code=Abag9k2RFgerkljgsirSDEFgwada</code></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>Embed &lt;IPv6 address&gt; and &lt;prefix length&gt; allocated to CE</td>
</tr>
<tr>
<td><a href="https://rule.map.ocn.ad.jp/?ipv6Prefix=&amp;lt;address&amp;gt;&amp;amp;ipv6PrefixLength=&amp;lt;prefixLength&amp;gt;&amp;amp;code=&amp;lt;API">https://rule.map.ocn.ad.jp/?ipv6Prefix=&amp;lt;address&amp;gt;&amp;amp;ipv6PrefixLength=&amp;lt;prefixLength&amp;gt;&amp;amp;code=&amp;lt;API</a> 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=Abag9k2RFgerkJgsirSDEFgwada</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>
### Specifications

- Rule IPv4 prefix length
- EA
- bits length
- PSID offset
- BR IPv6 Address

<table>
<thead>
<tr>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>The maximum number of MAP rules that can be included in the transmitted data</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Content-length</th>
</tr>
</thead>
<tbody>
<tr>
<td>XXX (body size)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Content-type</th>
</tr>
</thead>
<tbody>
<tr>
<td>application/json; charset=utf-8</td>
</tr>
</tbody>
</table>

### Map Rule Server Response Parameters

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Type</th>
<th>Byte (max)</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>EAbit 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>pv6PrefixLength</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:**
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:
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-cabits 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  
**exit**

**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 121111030251434b2e39342c362e2349041f100259080a00745c3484e037c750b0805e8085e7020d555c0b054b0b48b1d34404b471316181c
Specifies the NAT64 rule server address.

Step 6  api-key key-id
Example:
Device(config-nat64-provisioning)# api-key api-key 7 85e57020d555c0b054b0b48b1d34404b471316181c
Specifies the NAT64 api key ID.

Step 7  address-resolution-server url
Example:
Device(config-nat64-provisioning)# address-resolution-server 7 00259080a00745c3484e037c750b0805e8085e7020d555c0b054b0b48b1d34404b471316181c
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.

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 2001:22::/128
  Basic-mapping-rule
    Ip-v6-prefix 2001:100::/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  
121111030251434B2B39342C36262349041F100259080A00745C53484E037C750B0B050E58085E7020D555C0B054B0E4B1D34404B471316181C  
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  
00259080A00745C53484E037C750B0B050E58085E7020D555C0B054B0E4B1D34404B471316181C  
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:

```
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:

```
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
  03C4F1F16556034F0B1A5F0713181F4ED9A797C78676F62615F6C21517495D1A1475951465A131357190B00090A
  api-key 7 050A070D23
  service-prefix 2400:4050::/30

end
```

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>
<td>NAT commands</td>
<td>Cisco IOS IP Addressing Services Command Reference</td>
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#### Standards and RFCs

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<th>Title</th>
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</thead>
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<td>Mapping of Address and Port (MAP)</td>
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<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>
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<tr>
<td>RFC 6145</td>
<td>IP/ICMP Translation Algorithm</td>
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</tbody>
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#### Technical Assistance

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</tr>
</thead>
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<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>