



IP Addressing: IPv4 Addressing Configuration Guide, Cisco IOS XE Release 3S

Americas Headquarters

Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
USA
<http://www.cisco.com>
Tel: 408 526-4000
800 553-NETS (6387)
Fax: 408 527-0883

THE SPECIFICATIONS AND INFORMATION REGARDING THE PRODUCTS IN THIS MANUAL ARE SUBJECT TO CHANGE WITHOUT NOTICE. ALL STATEMENTS, INFORMATION, AND RECOMMENDATIONS IN THIS MANUAL ARE BELIEVED TO BE ACCURATE BUT ARE PRESENTED WITHOUT WARRANTY OF ANY KIND, EXPRESS OR IMPLIED. USERS MUST TAKE FULL RESPONSIBILITY FOR THEIR APPLICATION OF ANY PRODUCTS.

THE SOFTWARE LICENSE AND LIMITED WARRANTY FOR THE ACCOMPANYING PRODUCT ARE SET FORTH IN THE INFORMATION PACKET THAT SHIPPED WITH THE PRODUCT AND ARE INCORPORATED HEREIN BY THIS REFERENCE. IF YOU ARE UNABLE TO LOCATE THE SOFTWARE LICENSE OR LIMITED WARRANTY, CONTACT YOUR CISCO REPRESENTATIVE FOR A COPY.

The Cisco implementation of TCP header compression is an adaptation of a program developed by the University of California, Berkeley (UCB) as part of UCB's public domain version of the UNIX operating system. All rights reserved. Copyright © 1981, Regents of the University of California.

NOTWITHSTANDING ANY OTHER WARRANTY HEREIN, ALL DOCUMENT FILES AND SOFTWARE OF THESE SUPPLIERS ARE PROVIDED "AS IS" WITH ALL FAULTS. CISCO AND THE ABOVE-NAMED SUPPLIERS DISCLAIM ALL WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING, WITHOUT LIMITATION, THOSE OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT OR ARISING FROM A COURSE OF DEALING, USAGE, OR TRADE PRACTICE.

IN NO EVENT SHALL CISCO OR ITS SUPPLIERS BE LIABLE FOR ANY INDIRECT, SPECIAL, CONSEQUENTIAL, OR INCIDENTAL DAMAGES, INCLUDING, WITHOUT LIMITATION, LOST PROFITS OR LOSS OR DAMAGE TO DATA ARISING OUT OF THE USE OR INABILITY TO USE THIS MANUAL, EVEN IF CISCO OR ITS SUPPLIERS HAVE BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

Any Internet Protocol (IP) addresses and phone numbers used in this document are not intended to be actual addresses and phone numbers. Any examples, command display output, network topology diagrams, and other figures included in the document are shown for illustrative purposes only. Any use of actual IP addresses or phone numbers in illustrative content is unintentional and coincidental.

Cisco and the Cisco logo are trademarks or registered trademarks of Cisco and/or its affiliates in the U.S. and other countries. To view a list of Cisco trademarks, go to this URL: <http://www.cisco.com/go/trademarks>. Third-party trademarks mentioned are the property of their respective owners. The use of the word partner does not imply a partnership relationship between Cisco and any other company. (1110R)

© 2014 Cisco Systems, Inc. All rights reserved.



CONTENTS

CHAPTER 1

Configuring IPv4 Addresses 1

Finding Feature Information 1

Information About IP Addresses 2

Binary Numbering 2

IP Address Structure 4

IP Address Classes 5

IP Network Subnetting 7

IP Network Address Assignments 9

Classless Inter-Domain Routing 11

Prefixes 11

How to Configure IP Addresses 12

Establishing IP Connectivity to a Network by Assigning an IP Address to an Interface 12

Troubleshooting Tips 13

Increasing the Number of IP Hosts that Are Supported on a Network by Using Secondary IP Addresses 13

Troubleshooting Tips 14

What to Do Next 15

Maximizing the Number of Available IP Subnets by Allowing the Use of IP Subnet Zero 15

Troubleshooting Tips 16

Specifying the Format of Network Masks 16

Specifying the Format in Which Netmasks Appear for the Current Session 17

Specifying the Format in Which Netmasks Appear for an Individual Line 17

Using IP Unnumbered Interfaces on Point-to-Point WAN Interfaces to Limit Number of IP Addresses Required 18

IP Unnumbered Feature 18

Troubleshooting Tips 20

Using IP addresses with 31-Bit Prefixes on Point-to-Point WAN Interfaces to Limit Number of IP Addresses Required 20

| | |
|---|----|
| RFC 3021 | 21 |
| Troubleshooting Tips | 23 |
| Configuration Examples for IP Addresses | 23 |
| Example Establishing IP Connectivity to a Network by Assigning an IP Address to an Interface | 23 |
| Example Increasing the Number of IP Hosts that are Supported on a Network by Using Secondary IP Addresses | 24 |
| Example Using IP Unnumbered Interfaces on Point-to-Point WAN Interfaces to Limit Number of IP Addresses Required | 24 |
| Example Using IP addresses with 31-Bit Prefixes on Point-to-Point WAN Interfaces to Limit Number of IP Addresses Required | 25 |
| Example Maximizing the Number of Available IP Subnets by Allowing the Use of IP Subnet Zero | 25 |
| Where to Go Next | 25 |
| Additional References | 25 |
| Feature Information for IP Addresses | 27 |

CHAPTER 2

| | |
|--|-----------|
| IP Overlapping Address Pools | 29 |
| Finding Feature Information | 29 |
| Restrictions for IP Overlapping Address Pools | 29 |
| Information About IP Overlapping Address Pools | 30 |
| Benefits | 30 |
| How IP Address Groups Work | 30 |
| How to Configure IP Overlapping Address Pools | 30 |
| Configuring and Verifying a Local Pool Group | 30 |
| Configuration Examples for Configuring IP Overlapping Address Pools | 31 |
| Define Local Address Pooling as the Global Default Mechanism Example | 31 |
| Configure Multiple Ranges of IP Addresses into One Pool Example | 31 |
| Additional References | 32 |
| Feature Information for Configuring IP Overlapping Address Pools | 33 |
| Glossary | 34 |

CHAPTER 3

| | |
|--|-----------|
| IP Unnumbered Ethernet Polling Support | 35 |
| Finding Feature Information | 35 |
| Information About IP Unnumbered Ethernet Polling Support | 35 |

| | |
|--|----|
| IP Unnumbered Ethernet Polling Support Overview | 35 |
| How to Configure IP Unnumbered Ethernet Polling Support | 36 |
| Enabling Polling on an Ethernet Interface | 36 |
| Configuring the Queue Size and the Packet Rate for IP ARP Polling for Unnumbered Interfaces | 37 |
| Verifying IP Unnumbered Ethernet Polling Support | 38 |
| Configuration Examples for IP Unnumbered Ethernet Polling Support | 40 |
| Example: Enabling Polling on an Ethernet Interface | 40 |
| Example: Configuring the Queue Size and the Packet Rate for IP ARP Polling for Unnumbered Interfaces | 40 |
| Additional References | 40 |
| Feature Information for IP Unnumbered Ethernet Polling Support | 41 |

CHAPTER 4**Auto-IP 43**

| | |
|--|----|
| Finding Feature Information | 44 |
| Prerequisites for Auto-IP | 44 |
| Restrictions for Auto-IP | 44 |
| Information About Auto-IP | 45 |
| Auto-IP Overview | 45 |
| Seed Device | 47 |
| Auto-IP Configuration for Inserting a Device into an Auto-IP Ring | 48 |
| Device Removal from an Auto-IP Ring | 50 |
| Conflict Resolution Using the Auto-Swap Technique | 50 |
| How to Configure Auto-IP | 52 |
| Configuring a Seed Device | 52 |
| Configuring the Auto-IP Functionality on Node Interfaces (for Inclusion in an Auto-IP Ring) | 55 |
| Verifying and Troubleshooting Auto-IP | 57 |
| Configuration Examples for Auto-IP | 59 |
| Example: Configuring a Seed Device | 59 |
| Example: Configuring the Auto-IP Functionality on Node Interfaces (for Inclusion in an Auto-IP Ring) | 59 |
| Additional References for Auto-IP | 60 |
| Feature Information for Auto-IP | 61 |



CHAPTER 1

Configuring IPv4 Addresses

This chapter contains information about, and instructions for configuring IPv4 addresses on interfaces that are part of a networking device.



Note

All further references to IPv4 addresses in this document use only IP in the text, not IPv4.

- [Finding Feature Information, page 1](#)
- [Information About IP Addresses, page 2](#)
- [How to Configure IP Addresses, page 12](#)
- [Configuration Examples for IP Addresses, page 23](#)
- [Where to Go Next, page 25](#)
- [Additional References, page 25](#)
- [Feature Information for IP Addresses, page 27](#)

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see [Bug Search Tool](#) and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

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.

Information About IP Addresses

Binary Numbering

IP addresses are 32 bits long. The 32 bits are divided into four octets (8-bits). A basic understanding of binary numbering is very helpful if you are going to manage IP addresses in a network because changes in the values of the 32 bits indicate either a different IP network address or IP host address.

A value in binary is represented by the number (0 or 1) in each position multiplied by the number 2 to the power of the position of the number in sequence, starting with 0 and increasing to 7, working right to left. The figure below is an example of an 8-digit binary number.

Figure 1: Example of an 8-digit Binary Number

| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| $1 \cdot 2^7$ | $1 \cdot 2^6$ | $1 \cdot 2^5$ | $1 \cdot 2^4$ | $1 \cdot 2^3$ | $1 \cdot 2^2$ | $1 \cdot 2^1$ | $1 \cdot 2^0$ |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| |
|-------|
| 128 |
| 64 |
| 32 |
| 16 |
| 8 |
| 4 |
| 2 |
| + 1 |
| <hr/> |
| = 255 |

186186

The figure below provides binary to decimal number conversion for 0 through 134.

Figure 2: Binary to Decimal Number Conversion for 0 to 134

| | | | | |
|----------------|----------------|----------------|----------------|----------------|
| 00000000 = 000 | 00011011 = 027 | 00110110 = 054 | 01010001 = 081 | 01101100 = 108 |
| 00000001 = 001 | 00011100 = 028 | 00110111 = 055 | 01010010 = 082 | 01101101 = 109 |
| 00000010 = 002 | 00011101 = 029 | 00111000 = 056 | 01010011 = 083 | 01101110 = 110 |
| 00000011 = 003 | 00011110 = 030 | 00111001 = 057 | 01010100 = 084 | 01101111 = 111 |
| 00000100 = 004 | 00011111 = 031 | 00111010 = 058 | 01010101 = 085 | 01110000 = 112 |
| 00000101 = 005 | 00100000 = 032 | 00111011 = 059 | 01010110 = 086 | 01110001 = 113 |
| 00000110 = 006 | 00100001 = 033 | 00111100 = 060 | 01010111 = 087 | 01110010 = 114 |
| 00000111 = 007 | 00100010 = 034 | 00111101 = 061 | 01011000 = 088 | 01110011 = 115 |
| 00001000 = 008 | 00100011 = 035 | 00111110 = 062 | 01011001 = 089 | 01110100 = 116 |
| 00001001 = 009 | 00100100 = 036 | 00111111 = 063 | 01011010 = 090 | 01110101 = 117 |
| 00001010 = 010 | 00100101 = 037 | 01000000 = 064 | 01011011 = 091 | 01110110 = 118 |
| 00001011 = 011 | 00100110 = 038 | 01000001 = 065 | 01011100 = 092 | 01110111 = 119 |
| 00001100 = 012 | 00100111 = 039 | 01000010 = 066 | 01011101 = 093 | 01111000 = 120 |
| 00001101 = 013 | 00101000 = 040 | 01000011 = 067 | 01011110 = 094 | 01111001 = 121 |
| 00001110 = 014 | 00101001 = 041 | 01000100 = 068 | 01011111 = 095 | 01111010 = 122 |
| 00001111 = 015 | 00101010 = 042 | 01000101 = 069 | 01100000 = 096 | 01111011 = 123 |
| 00010000 = 016 | 00101011 = 043 | 01000110 = 070 | 01100001 = 097 | 01111100 = 124 |
| 00010001 = 017 | 00101100 = 044 | 01000111 = 071 | 01100010 = 098 | 01111101 = 125 |
| 00010010 = 018 | 00101101 = 045 | 01001000 = 072 | 01100011 = 099 | 01111110 = 126 |
| 00010011 = 019 | 00101110 = 046 | 01001001 = 073 | 01100100 = 100 | 01111111 = 127 |
| 00010100 = 020 | 00101111 = 047 | 01001010 = 074 | 01100101 = 101 | 10000000 = 128 |
| 00010101 = 021 | 00110000 = 048 | 01001011 = 075 | 01100110 = 102 | 10000001 = 129 |
| 00010110 = 022 | 00110001 = 049 | 01001100 = 076 | 01100111 = 103 | 10000010 = 130 |
| 00010111 = 023 | 00110010 = 050 | 01001101 = 077 | 01101000 = 104 | 10000011 = 131 |
| 00011000 = 024 | 00110011 = 051 | 01001110 = 078 | 01101001 = 105 | 10000100 = 132 |
| 00011001 = 025 | 00110100 = 052 | 01001111 = 079 | 01101010 = 106 | 10000101 = 133 |
| 00011010 = 026 | 00110101 = 053 | 01010000 = 080 | 01101011 = 107 | 10000110 = 134 |

The figure below provides binary to decimal number conversion for 135 through 255.

Figure 3: Binary to Decimal Number Conversion for 135 to 255

| | | | | |
|----------------|----------------|----------------|----------------|----------------|
| 10000111 = 135 | 10100010 = 162 | 10111101 = 189 | 11011000 = 216 | 11110011 = 243 |
| 10001000 = 136 | 10100011 = 163 | 10111110 = 190 | 11011001 = 217 | 11110100 = 244 |
| 10001001 = 137 | 10100100 = 164 | 10111111 = 191 | 11011010 = 218 | 11110101 = 245 |
| 10001010 = 138 | 10100101 = 165 | 11000000 = 192 | 11011011 = 219 | 11110110 = 246 |
| 10001011 = 139 | 10100110 = 166 | 11000001 = 193 | 11011100 = 220 | 11110111 = 247 |
| 10001100 = 140 | 10100111 = 167 | 11000010 = 194 | 11011101 = 221 | 11111000 = 248 |
| 10001101 = 141 | 10101000 = 168 | 11000011 = 195 | 11011110 = 222 | 11111001 = 249 |
| 10001110 = 142 | 10101001 = 169 | 11000100 = 196 | 11011111 = 223 | 11111010 = 250 |
| 10001111 = 143 | 10101010 = 170 | 11000101 = 197 | 11100000 = 224 | 11111011 = 251 |
| 10010000 = 144 | 10101011 = 171 | 11000110 = 198 | 11100001 = 225 | 11111100 = 252 |
| 10010001 = 145 | 10101100 = 172 | 11000111 = 199 | 11100010 = 226 | 11111101 = 253 |
| 10010010 = 146 | 10101101 = 173 | 11001000 = 200 | 11100011 = 227 | 11111110 = 254 |
| 10010011 = 147 | 10101110 = 174 | 11001001 = 201 | 11100100 = 228 | 11111111 = 255 |
| 10010100 = 148 | 10101111 = 175 | 11001010 = 202 | 11100101 = 229 | |
| 10010101 = 149 | 10110000 = 176 | 11001011 = 203 | 11100110 = 230 | |
| 10010110 = 150 | 10110001 = 177 | 11001100 = 204 | 11100111 = 231 | |
| 10010111 = 151 | 10110010 = 178 | 11001101 = 205 | 11101000 = 232 | |
| 10011000 = 152 | 10110011 = 179 | 11001110 = 206 | 11101001 = 233 | |
| 10011001 = 153 | 10110100 = 180 | 11001111 = 207 | 11101010 = 234 | |
| 10011010 = 154 | 10110101 = 181 | 11010000 = 208 | 11101011 = 235 | |
| 10011011 = 155 | 10110110 = 182 | 11010001 = 209 | 11101100 = 236 | |
| 10011100 = 156 | 10110111 = 183 | 11010010 = 210 | 11101101 = 237 | |
| 10011101 = 157 | 10111000 = 184 | 11010011 = 211 | 11101110 = 238 | |
| 10011110 = 158 | 10111001 = 185 | 11010100 = 212 | 11101111 = 239 | |
| 10011111 = 159 | 10111010 = 186 | 11010101 = 213 | 11110000 = 240 | |
| 10100000 = 160 | 10111011 = 187 | 11010110 = 214 | 11110001 = 241 | |
| 10100001 = 161 | 10111100 = 188 | 11010111 = 215 | 11110010 = 242 | |

IP Address Structure

An IP host address identifies a device to which IP packets can be sent. An IP network address identifies a specific network segment to which one or more hosts can be connected. The following are characteristics of IP addresses:

- IP addresses are 32 bits long
- IP addresses are divided into four sections of one byte (octet) each
- IP addresses are typically written in a format known as dotted decimal

The table below shows some examples of IP addresses.

Table 1: Examples of IP Addresses

| IP Addresses in Dotted Decimal | IP Addresses in Binary |
|--------------------------------|-------------------------------------|
| 10.34.216.75 | 00001010.00100010.11011000.01001011 |
| 172.16.89.34 | 10101100.00010000.01011001.00100010 |
| 192.168.100.4 | 11000000.10101000.01100100.00000100 |

**Note**

The IP addresses in the table above are from RFC 1918, *Address Allocation for Private Internets*. These IP addresses are not routable on the Internet. They are intended for use in private networks. For more information on RFC1918, see <http://www.ietf.org/rfc/rfc1918.txt>.

IP addresses are further subdivided into two sections known as network and host. The division is accomplished by arbitrarily ranges of IP addresses to classes. For more information see RFC 791 Internet Protocol at <http://www.ietf.org/rfc/rfc0791.txt>.

IP Address Classes

In order to provide some structure to the way IP addresses are assigned, IP addresses are grouped into classes. Each class has a range of IP addresses. The range of IP addresses in each class is determined by the number of bits allocated to the network section of the 32-bit IP address. The number of bits allocated to the network section is represented by a mask written in dotted decimal or with the abbreviation /*n* where *n* = the numbers of bits in the mask.

The table below lists ranges of IP addresses by class and the masks associated with each class. The digits in bold indicate the network section of the IP address for each class. The remaining digits are available for host IP addresses. For example, IP address 10.90.45.1 with a mask of 255.0.0.0 is broken down into a network IP address of 10.0.0.0 and a host IP address of 0.90.45.1.

Table 2: IP Address Ranges by Class with Masks

| Class | Range |
|---|---|
| A (range/mask in dotted decimal) | 0 .0.0.0 to 127.0.0.0/8 (255.0.0.0) |
| A (range in binary) | 00000000 .00000000.00000000.00000000 to 01111111 .00000000.00000000.00000000 |
| A (mask in binary) | 11111111.00000000.00000000.00000000/8 |
| B (range/mask in dotted decimal) | 128 .0.0.0 to 191.255 .0.0/16 (255.255.0.0) |
| B (range in binary) | 10000000 . 00000000 .00000000.00000000 to 10111111 . 11111111 .00000000.00000000 |
| B (mask in binary) | 11111111 . 11111111 .00000000.00000000/16 |
| C (range/mask in dotted decimal) | 192 . 0.0.0 to 223.255.255 .0/24 (255.255.255.0) |
| C (range in binary) | 11000000 . 00000000 . 00000000 .00000000 to 11011111 . 11111111 . 11111111 .00000000 |
| C (mask in binary) | 11111111.11111111.11111111.00000000/24 |
| D ¹ (range/mask in dotted decimal) | 224 . 0.0.0 to 239.255.255.255 /32 (255.255.255.255) |

| Class | Range |
|---|--|
| D (range in binary) | 11100000 .00000000.00000000.00000000 to 11101111.11111111.11111111.11111111 |
| D (mask in binary) | 11111111.11111111.11111111.11111111/32 |
| E ² (range/mask in dotted decimal) | 240 .0.0.0 to 255.255.255.255/32 (255.255.255.255) |
| E (range in binary) | 11110000 .00000000.00000000.00000000 to 11111111.11111111.11111111.11111111 |
| E (mask in binary) | 11111111.11111111.11111111.11111111/32 |

¹ Class D IP addresses are reserved for multicast applications.

² Class E IP addresses are reserved for broadcast traffic.

**Note**

Some IP addresses in these ranges are reserved for special uses. For more information refer to RFC 3330, *Special-Use IP Addresses*, at <http://www.ietf.org/rfc/rfc3330.txt>.

When a digit that falls within the network mask changes from 1 to 0 or 0 to 1 the network address is changed. For example, if you change 10101100.00010000.01011001.00100010/16 to 10101100.00110000.01011001.00100010/16 you have changed the network address from 172.16.89.34/16 to 172.48.89.34/16.

When a digit that falls outside the network mask changes from 1 to 0 or 0 to 1 the host address is changed. For example, if you change 10101100.00010000.01011001.00100010/16 to 10101100.00010000.01011001.00100011/16 you have changed the host address from 172.16.89.34/16 to 172.16.89.35/16.

Each class of IP address supports a specific range of IP network addresses and IP host addresses. The range of IP network addresses available for each class is determined with the formula 2 to the power of the number of available bits. In the case of class A addresses, the value of the first bit in the 1st octet (as shown in the table above) is fixed at 0. This leaves 7 bits for creating additional network addresses. Therefore there are 128 IP network addresses available for class A ($2^7 = 128$).

The number of IP host addresses available for an IP address class is determined by the formula 2 to the power of the number of available bits minus 2. There are 24 bits available in a class A addresses for IP host addresses. Therefore there are 16,777,214 IP hosts addresses available for class A ($(2^{24}) - 2 = 16,777,214$).

**Note**

The 2 is subtracted because there are 2 IP addresses that cannot be used for a host. The all 0's host address cannot be used because it is the same as the network address. For example, 10.0.0.0 cannot be both a IP network address and an IP host address. The all 1's address is a broadcast address that is used to reach all hosts on the network. For example, an IP datagram addressed to 10.255.255.255 will be accepted by every host on network 10.0.0.0.

The table below shows the network and host addresses available for each class of IP address.

Table 3: Network and Host Addresses Available for Each Class of IP Address

| Class | Network Addresses | Host Addresses |
|-------|------------------------|----------------|
| A | 128 | 16,777,214 |
| B | 16,384 ³ | 65534 |
| C | 2,097,152 ⁴ | 254 |

³ Only 14 bits are available for class B IP network addresses because the first 2 bits are fixed at 10 as shown in Table 2 .

⁴ Only 21 bits are available for class C IP network addresses because the first 3 bits are fixed at 110 as shown in Table 2 .

IP Network Subnetting

The arbitrary subdivision of network and host bits in IP address classes resulted in an inefficient allocation of IP space. For example, if your network has 16 separate physical segments you will need 16 IP network addresses. If you use 16 class B IP network addresses, you would be able to support 65,534 hosts on each of the physical segments. Your total number of supported host IP addresses is 1,048,544 (16 * 65,534 = 1,048,544). Very few network technologies can scale to having 65,534 hosts on a single network segment. Very few companies need 1,048,544 IP host addresses. This problem required the development of a new strategy that permitted the subdivision of IP network addresses into smaller groupings of IP subnetwork addresses. This strategy is known as subnetting.

If your network has 16 separate physical segments you will need 16 IP subnetwork addresses. This can be accomplished with one class B IP address. For example, start with the class B IP address of 172.16.0.0 you can reserve 4 bits from the third octet as subnet bits. This gives you 16 subnet IP addresses $2^4 = 16$. The table below shows the IP subnets for 172.16.0.0/20.

Table 4: Examples of IP Subnet Addresses using 172.16.0.0/20

| Number | IP Subnet Addresses in Dotted Decimal | IP Subnet Addresses in Binary |
|----------------|---------------------------------------|-------------------------------------|
| 0 ⁵ | 172.16.0.0 | 10101100.00010000.00000000.00000000 |
| 1 | 172.16.16.0 | 10101100.00010000.00010000.00000000 |
| 2 | 172.16.32.0 | 10101100.00010000.00100000.00000000 |
| 3 | 172.16.48.0 | 10101100.00010000.00110000.00000000 |
| 4 | 172.16.64.0 | 10101100.00010000.01000000.00000000 |
| 5 | 172.16.80.0 | 10101100.00010000.01010000.00000000 |
| 6 | 172.16.96.0 | 10101100.00010000.01100000.00000000 |
| 7 | 172.16.112.0 | 10101100.00010000.01110000.00000000 |

| Number | IP Subnet Addresses in Dotted Decimal | IP Subnet Addresses in Binary |
|--------|---------------------------------------|-------------------------------------|
| 8 | 172.16.128.0 | 10101100.00010000.10000000.00000000 |
| 9 | 172.16.144.0 | 10101100.00010000.10010000.00000000 |
| 10 | 172.16.160.0 | 10101100.00010000.10100000.00000000 |
| 11 | 172.16.176.0 | 10101100.00010000.10110000.00000000 |
| 12 | 172.16.192.0 | 10101100.00010000.11000000.00000000 |
| 13 | 172.16.208.0 | 10101100.00010000.11010000.00000000 |
| 14 | 172.16.224.0 | 10101100.00010000.11100000.00000000 |
| 15 | 172.16.240.0 | 10101100.00010000.11110000.00000000 |

- ⁵ The first subnet that has all of the subnet bits set to 0 is referred to as subnet 0. It is indistinguishable from the network address and must be used carefully.

When a digit that falls within the subnetwork (subnet) mask changes from 1 to 0 or 0 to 1 the subnetwork address is changed. For example, if you change 10101100.00010000.01011001.00100010/20 to 10101100.00010000.01111001.00100010/20 you have changed the network address from 172.16.89.34/20 to 172.16.121.34/20.

When a digit that falls outside the subnet mask changes from 1 to 0 or 0 to 1 the host address is changed. For example, if you change 10101100.00010000.01011001.00100010/20 to 10101100.00010000.01011001.00100011/20 you have changed the host address from 172.16.89.34/20 to 172.16.89.35/20.



Timesaver

To avoid having to do manual IP network, subnetwork, and host calculations, use one of the free IP subnet calculators available on the Internet.

Some people get confused about the terms network address and subnet or subnetwork addresses and when to use them. In the most general sense the term network address means “the IP address that routers use to route traffic to a specific network segment so that the intended destination IP host on that segment can receive it”. Therefore the term network address can apply to both non-subnetted and subnetted IP network addresses. When you are troubleshooting problems with forwarding traffic from a router to a specific IP network address that is actually a subnetted network address, it can help to be more specific by referring to the destination network address as a subnet network address because some routing protocols handle advertising subnet network routes differently from network routes. For example, the default behavior for RIP v2 is to automatically summarize the subnet network addresses that it is connected to their non-subnetted network addresses (172.16.32.0/24 is advertised by RIP v2 as 172.16.0.0/16) when sending routing updates to other routers. Therefore the other routers might have knowledge of the IP network addresses in the network, but not the subnetted network addresses of the IP network addresses.



Tip

The term IP address space is sometimes used to refer to a range of IP addresses. For example, “We have to allocate a new IP network address to our network because we have used all of the available IP addresses in the current IP address space”.

IP Network Address Assignments

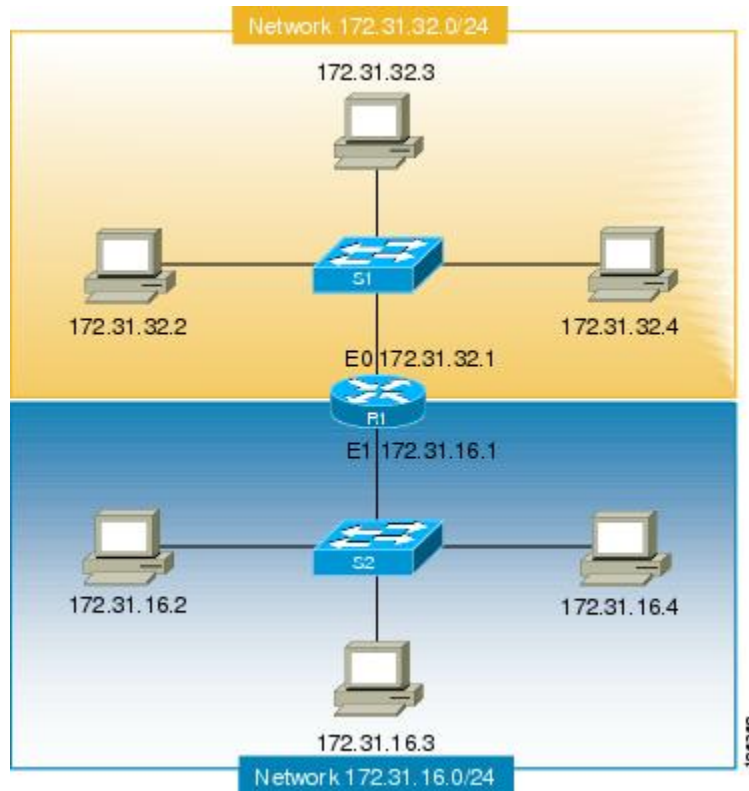
Routers keep track of IP network addresses to understand the network IP topology (layer 3 of the OSI reference model) of the network to ensure that IP traffic can be routed properly. In order for the routers to understand the network layer (IP) topology, every individual physical network segment that is separated from any other physical network segment by a router must have a unique IP network address.

The figure below shows an example of a simple network with correctly configured IP network addresses. The routing table in R1 looks like the table below.

Table 5: Routing Table for a Correctly Configured Network

| Interface Ethernet 0 | Interface Ethernet 1 |
|----------------------------|----------------------------|
| 172.31.32.0/24 (Connected) | 172.31.16.0/24 (Connected) |

Figure 4: Correctly Configured Network

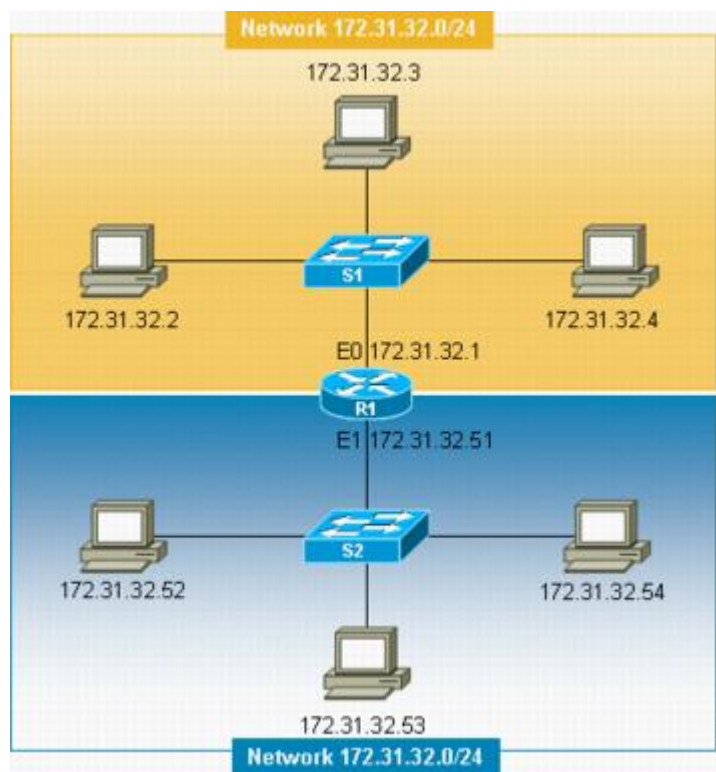


The figure below shows an example of a simple network with incorrectly configured IP network addresses. The routing table in R1 looks like the table below. If the PC with IP address 172.31.32.3 attempts to send IP traffic to the PC with IP address 172.31.32.54, router R1 cannot determine which interface that the PC with IP address 172.31.32.54 is connected to.

Table 6: Routing Table in Router R1 for an Incorrectly Configured Network (Example 1)

| Ethernet 0 | Ethernet 1 |
|----------------------------|----------------------------|
| 172.31.32.0/24 (Connected) | 172.31.32.0/24 (Connected) |

Figure 5: Incorrectly Configured Network (Example 1)



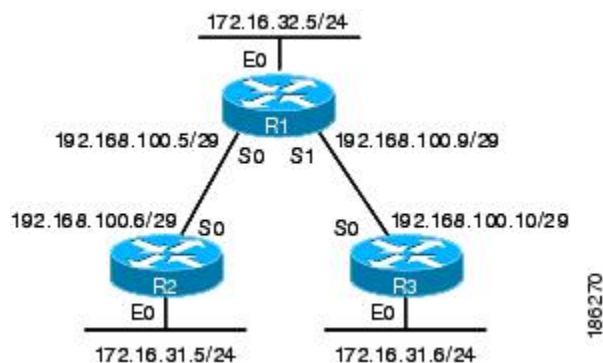
To help prevent mistakes as shown in the figure above, Cisco IOS-based networking devices will not allow you to configure the same IP network address on two or more interfaces in the router when IP routing is enabled.

The only way to prevent the mistake shown in the figure below, where 172.16.31.0/24 is used in R2 and R3, is to have very accurate network documentation that shows where you have assigned IP network addresses.

Table 7: Routing Table in Router R1 for an Incorrectly Configured Network (Example 2)

| Ethernet 0 | Serial 0 | Serial 1 |
|----------------------------|--|--|
| 172.16.32.0/24 (Connected) | 192.168.100.4/29 (Connected) 172.16.31.0/24 RIP | 192.168.100.8/29 (Connected) 172.16.31.0/24 RIP |

Figure 6: Incorrectly Configured Network (Example 2)



For a more thorough explanation of IP routing, see the "Related Documents" section for a list of documents related to IP routing.

Classless Inter-Domain Routing

Due to the continuing increase in internet use and the limitations on how IP addresses can be assigned using the class structure shown in the table above, a more flexible method for allocating IP addresses was required. The new method is documented in RFC 1519 *Classless Inter-Domain Routing (CIDR): an Address Assignment and Aggregation Strategy*. CIDR allows network administrators to apply arbitrary masks to IP addresses to create an IP addressing plan that meets the requirements of the networks that they administrate.

For more information on CIDR, refer to RFC 1519 at <http://www.ietf.org/rfc/rfc1519.txt>.

Prefixes

The term prefix is often used to refer to the number of bits of an IP network address that are of importance for building routing tables. If you are using only classful (strict adherence to A, B, and C network address boundaries) IP addresses, the prefixes are the same as the masks for the classes of addresses. For example, using classful IP addressing, a class C IP network address such as 192.168.10.0 uses a 24-bit mask (/24 or 255.255.255.0) and can also be said to have a 24-bit prefix.

If you are using CIDR, the prefixes are arbitrarily assigned to IP network addresses based on how you want to populate the routing tables in your network. For example, a group of class C IP addresses such as 192.168.10.0, 192.168.11.0, 192.168.12.0, 192.168.13.0 can be advertised as a single route to 192.168.0.0 with a 16-bit prefix (192.168.0.0/16). This results in a 4:1 reduction in the number of routes that the routers in your network need to manage.

How to Configure IP Addresses

Establishing IP Connectivity to a Network by Assigning an IP Address to an Interface

Perform this task to configure an IP address on an interface.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **no shutdown**
5. **ip address** *ip-address mask*
6. **end**

DETAILED STEPS

| | Command or Action | Purpose |
|--------|--|--|
| Step 1 | enable Example: Router> enable | Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted. |
| Step 2 | configure terminal Example: Router# configure terminal | Enters global configuration mode. |
| Step 3 | interface <i>type number</i> Example: Router(config)# interface fastethernet 0/0 | Specifies an interface and enters interface configuration mode. |
| Step 4 | no shutdown Example: Router(config-if)# no shutdown | Enables the interface. |

| | Command or Action | Purpose |
|---------------|---|---|
| Step 5 | ip address <i>ip-address mask</i> Example: <pre>Router(config-if)# ip address 172.16.16.1 255.255.240.0</pre> | Configures the IP address on the interface. |
| Step 6 | end Example: <pre>Router(config-if)# end</pre> | Exits the current configuration mode and returns to privileged EXEC mode. |

Troubleshooting Tips

The following commands can help troubleshoot IP addressing:

- **show ip interface** --Displays the IP parameters for the interface.
- **show ip route connected** --Displays the IP networks the networking device is connected to.

Increasing the Number of IP Hosts that Are Supported on a Network by Using Secondary IP Addresses

If you have a situation in which you need to connect more IP hosts to a network segment and you have used all of the available IP host addresses for the subnet to which you have assigned the segment, you can avoid having to readdress all of the hosts with a different subnet by adding a second IP network address to the network segment.

Perform this task to configure a secondary IP address on an interface.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **no shutdown**
5. **ip address** *ip-address mask*
6. **ip address** *ip-address mask secondary*
7. **end**

DETAILED STEPS

| | 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 | interface <i>type number</i> Example: Router(config)# interface fastethernet 0/0 | Specifies an interface and enters interface configuration mode. |
| Step 4 | no shutdown Example: Router(config-if)# no shutdown | Enables the interface. |
| Step 5 | ip address <i>ip-address mask</i> Example: Router(config-if)# ip address 172.16.16.1 255.255.240.0 | Configures the IP address on the interface. |
| Step 6 | ip address <i>ip-address mask secondary</i> Example: Router(config-if)# ip address 172.16.32.1 255.255.240.0 secondary | Configures the secondary IP address on the interface. |
| Step 7 | end Example: Router(config-if)# end | Exits the current configuration mode and returns to privileged EXEC mode. |

Troubleshooting Tips

The following commands can help troubleshoot IP addressing:

- **show ip interface** --Displays the IP parameters for the interface.
- **show ip route connected** --Displays the IP networks the networking device is connected to.

What to Do Next

If your network has two or more routers and you have already configured a routing protocol, make certain that the other routers can reach the new IP network that you assigned. You might need to modify the configuration for the routing protocol on the router so that it advertises the new network. Consult the *Cisco IOS IP Routing: Protocol-Independent Configuration Guide* for information on configuring routing protocols.

Maximizing the Number of Available IP Subnets by Allowing the Use of IP Subnet Zero

If you using subnetting in your network and you are running out of network addresses, you can configure your networking device to allow the configuration of subnet zero. This adds one more usable network address for every subnet in your IP addressing scheme. The table above shows the IP subnets (including subnet 0) for 172.16.0.0/20.

Perform this task to enable the use of IP subnet zero on your networking device.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip subnet-zero**
4. **interface** *type number*
5. **no shutdown**
6. **ip address** *ip-address mask*
7. **end**

DETAILED STEPS

| | Command or Action | Purpose |
|--------|--|--|
| Step 1 | enable Example: Router> enable | Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted. |
| Step 2 | configure terminal Example: Router# configure terminal | Enters global configuration mode. |

| | Command or Action | Purpose |
|---------------|---|---|
| Step 3 | ip subnet-zero Example: Router(config)# ip subnet-zero | Enables the use of IP subnet zero. |
| Step 4 | interface type number Example: Router(config)# interface fastethernet 0/0 | Specifies an interface and enters interface configuration mode. |
| Step 5 | no shutdown Example: Router(config-if)# no shutdown | Enables the interface. |
| Step 6 | ip address ip-address mask Example: Router(config-if)# ip address 172.16.0.1 255.255.240.0 | Configures the subnet zero IP address on the interface. |
| Step 7 | end Example: Router(config-if)# end | Exits the current configuration mode and returns to privileged EXEC mode. |

Troubleshooting Tips

The following commands can help troubleshoot IP addressing:

- **show ip interface** --Displays the IP parameters for the interface.
- **show ip route connected** --Displays the IP networks the networking device is connected to.

Specifying the Format of Network Masks

By default, **show** commands display an IP address and then its netmask in dotted decimal notation. For example, a subnet would be displayed as 131.108.11.55 255.255.255.0.

You might find it more convenient to display the network mask in hexadecimal format or bit count format instead. The hexadecimal format is commonly used on UNIX systems. The previous example would be displayed as 131.108.11.55 0XFFFFFF00.

The bit count format for displaying network masks is to append a slash (/) and the total number of bits in the netmask to the address itself. The previous example would be displayed as 131.108.11.55/24.

Specifying the Format in Which Netmasks Appear for the Current Session

Perform this task to specify the format in which netmasks appear for the current session.

SUMMARY STEPS

1. **enable**
2. **term ip netmask-format {bitcount | decimal | hexadecimal}**

DETAILED STEPS

| | Command or Action | Purpose |
|--------|---|--|
| Step 1 | enable Example: Router> enable | Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted. |
| Step 2 | term ip netmask-format {bitcount decimal hexadecimal} Example: Router# term ip netmask-format hexadecimal | Specifies the format the router uses to display network masks. |

Specifying the Format in Which Netmasks Appear for an Individual Line

Perform this task to specify the format in which netmasks appear for an individual line.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **line vty first last**
4. **term ip netmask-format {bitcount | decimal | hexadecimal}**
5. **end**

DETAILED STEPS

| | Command or Action | Purpose |
|--------|-------------------|-------------------------------|
| Step 1 | enable | Enables privileged EXEC mode. |

| | Command or Action | Purpose |
|---------------|---|--|
| | Example: Router> enable | <ul style="list-style-type: none"> • Enter your password if prompted. |
| Step 2 | configure terminal Example: Router# configure terminal | Enters global configuration mode. |
| Step 3 | line vty <i>first last</i> Example: Router(config)# line vty 0 4 | Enters line configuration mode for the range of lines specified by the <i>first</i> and <i>last</i> arguments. |
| Step 4 | term ip netmask-format {bitcount decimal hexadecimal} Example: Router(config-line)# ip netmask-format hexadecimal | Specifies the format the router uses to display the network mask for an individual line. |
| Step 5 | end Example: Router(config-if)# end | Exits the current configuration mode and returns to privileged EXEC mode. |

Using IP Unnumbered Interfaces on Point-to-Point WAN Interfaces to Limit Number of IP Addresses Required

If you have a limited number of IP network or subnet addresses and you have point-to-point WANs in your network, you can use the IP Unnumbered Interfaces feature to enable IP connectivity on the point-to-point WAN interfaces without actually assigning an IP address to them.

Perform this task to configure the IP Unnumbered Interfaces feature on a point-to-point WAN interface.

IP Unnumbered Feature

The IP Unnumbered Interfaces feature enables IP processing on a point-to-point WAN interface without assigning it an explicit IP address. The IP unnumbered point-to-point WAN interface uses the IP address of another interface to enable IP connectivity, which conserves network addresses.

**Note**

The following restrictions apply to the IP Unnumbered Interfaces feature:

- The IP Unnumbered Interfaces feature is only supported on point-to-point (non-multiaccess) WAN interfaces
- You cannot netboot a Cisco IOS image over an interface that is using the IP Unnumbered Interfaces feature

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **no shutdown**
5. **ip address** *ip-address mask*
6. **interface** *type number*
7. **no shutdown**
8. **ip unnumbered** *type number*
9. **end**

DETAILED STEPS

| | 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 | interface <i>type number</i> Example: Router(config)# interface fastethernet 0/0 | Specifies an interface and enters interface configuration mode. |
| Step 4 | no shutdown Example: Router(config-if)# no shutdown | Enables the interface. |

| | Command or Action | Purpose |
|---------------|---|--|
| Step 5 | ip address <i>ip-address mask</i> Example: <pre>Router(config-if)# ip address 172.16.16.1 255.255.240.0</pre> | Configures the IP address on the interface. |
| Step 6 | interface <i>type number</i> Example: <pre>Router(config-if)# interface serial 0/0</pre> | Specifies a point-to-point WAN interface and enters interface configuration mode. |
| Step 7 | no shutdown Example: <pre>Router(config-if)# no shutdown</pre> | Enables the point-to-point WAN interface. |
| Step 8 | ip unnumbered <i>type number</i> Example: <pre>Router(config-if)# ip unnumbered fastethernet 0/0</pre> | Enables the IP unnumbered feature on the point-to-point WAN interface. In this example the point-to-point WAN interface uses IP address 172.16.16.1 from Fast Ethernet 0/0. |
| Step 9 | end Example: <pre>Router(config-if)# end</pre> | Exits the current configuration mode and returns to privileged EXEC mode. |

Troubleshooting Tips

The following commands can help troubleshoot IP addressing:

- **show ip interface** --Displays the IP parameters for the interface.
- **show ip route connected** --Displays the IP networks the networking device is connected to.

Using IP addresses with 31-Bit Prefixes on Point-to-Point WAN Interfaces to Limit Number of IP Addresses Required

You can reduce the number of IP subnets used by networking devices to establish IP connectivity to point-to-point WANs that they are connected to by using IP Addresses with 31-bit Prefixes as defined in RFC 3021.

Perform this task to configure an IP address with a 31-bit prefix on a point-to-point WAN interface.

RFC 3021

Prior to RFC 3021, *Using 31-bit Prefixes on IPv4 Point-to-Point Links*, many network administrators assigned IP address with a 30-bit subnet mask (255.255.255.252) to point-to-point interfaces to conserve IP address space. Although this practice does conserve IP address space compared to assigning IP addresses with shorter subnet masks such as 255.255.255.240, IP addresses with a 30-bit subnet mask still require four addresses per link: two host addresses (one for each host interface on the link), one all-zeros network address, and one all-ones broadcast network address.

The table below shows an example of the four IP addresses that are created when a 30-bit (otherwise known as 255.255.255.252 or /30) subnet mask is applied to the IP address 192.168.100.4. The bits that are used to specify the host IP addresses in bold.

Table 8: Four IP Addresses Created When a 30-Bit Subnet Mask (/30) Is Used

| Address | Description | Binary |
|------------------|----------------------------|---|
| 192.168.100.4/30 | All-zeros IP address | 11000000.10101000.01100100.00000 100 |
| 192.168.100.5/30 | First host addresses | 11000000.10101000.01100100.00000 101 |
| 192.168.100.6/30 | Second host address | 11000000.10101000.01100100.00000 110 |
| 192.168.100.7/30 | All-ones broadcast address | 11000000.10101000.01100100.00000 111 |

Point-to-point links only have two endpoints (hosts) and do not require broadcast support because any packet that is transmitted by one host is always received by the other host. Therefore the all-ones broadcast IP address is not required for a point-to-point interface.

The simplest way to explain RFC 3021 is to say that the use of a 31-bit prefix (created by applying a 31-bit subnet mask to an IP address) allows the all-zeros and all-ones IP addresses to be assigned as host addresses on point-to-point networks. Prior to RFC 3021 the longest prefix in common use on point-to-point links was 30-bits, which meant that the all-zeros and all-ones IP addresses were wasted.

The table below shows an example of the two IP addresses that are created when a 31-bit (otherwise known as 255.255.255.254 or /31) subnet mask is applied to the IP address 192.168.100.4. The bit that is used to specify the host IP addresses in bold

Table 9: Two IP Addresses Created When a 31-Bit Subnet Mask (/31) Is Used

| Address | Description | Binary |
|------------------|---------------------|--|
| 192.168.100.4/31 | First host address | 11000000.10101000.01100100.00000 10 |
| 192.168.100.5/31 | Second host address | 11000000.10101000.01100100.00000 01 |

The complete text for RFC 3021 is available at <http://www.ietf.org/rfc/rfc3021.txt>.

Before You Begin

You must have classless IP addressing configured on your networking device before you configure an IP address with a 31-bit prefix on a point-to-point interface. Classless IP addressing is enabled by default in many versions of Cisco IOS software. If you are not certain that your networking device has IP classless addressing configured, enter the **ip classless** command in global configuration mode to enable it.



Note This task can only be performed on point-to-point (nonmultiaccess) WAN interfaces.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip classless**
4. **interface** *type number*
5. **no shutdown**
6. **ip address** *ip-address mask*
7. **end**

DETAILED STEPS

| | Command or Action | Purpose |
|---------------|--|--|
| Step 1 | enable Example: Router> enable | Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted. |
| Step 2 | configure terminal Example: Router# configure terminal | Enters global configuration mode. |
| Step 3 | ip classless Example: Router(config)# ip classless | (Optional) Enables IP classless (CIDR). Note This command is enabled by default in many versions of Cisco IOS. If you are not certain if it is enabled by default in the version of Cisco IOS that your networking device is running, enter the ip classless command as shown. When you are done with this task view the configuration. If the ip classless command does not appear in your configuration, it is enabled by default. |

| | Command or Action | Purpose |
|---------------|---|---|
| Step 4 | interface <i>type number</i> Example: Router(config)# interface serial 0/0 | Specifies a point-to-point WAN interface and enters interface configuration mode. |
| Step 5 | no shutdown Example: Router(config-if)# no shutdown | Enables the interface. |
| Step 6 | ip address <i>ip-address mask</i> Example: Router(config-if)# ip address 192.168.100.4 255.255.255.254 | Configures the 31bit prefix IP address on the point-to-point WAN interface. |
| Step 7 | end Example: Router(config-if)# end | Exits the current configuration mode and returns to privileged EXEC mode. |

Troubleshooting Tips

The following commands can help troubleshoot IP addressing:

- **show ip interface** --Displays the IP parameters for the interface.
- **show ip route connected** --Displays the IP networks the networking device is connected to.

Configuration Examples for IP Addresses

Example Establishing IP Connectivity to a Network by Assigning an IP Address to an Interface

The following example configures an IP address on three interfaces:

```
!
interface FastEthernet0/0
  no shutdown
  ip address 172.16.16.1 255.255.240.0
!
interface FastEthernet0/1
```

```

no shutdown
ip address 172.16.32.1 255.255.240.0
!
interface FastEthernet0/2
no shutdown
ip address 172.16.48.1 255.255.240.0
!

```

Example Increasing the Number of IP Hosts that are Supported on a Network by Using Secondary IP Addresses

The following example configures secondary IP addresses on three interfaces:

```

!
interface FastEthernet0/0
no shutdown
ip address 172.16.16.1 255.255.240.0
ip address 172.16.32.1 255.255.240.0 secondary
!
!
interface FastEthernet0/1
no shutdown
ip address 172.17.16.1 255.255.240.0
ip address 172.17.32.1 255.255.240.0 secondary
!
!
interface FastEthernet0/2
no shutdown
ip address 172.18.16.1 255.255.240.0
ip address 172.18.32.1 255.255.240.0 secondary
!

```

Example Using IP Unnumbered Interfaces on Point-to-Point WAN Interfaces to Limit Number of IP Addresses Required

The following example configures the unnumbered IP feature on three interfaces:

```

!
interface FastEthernet0/0
no shutdown
ip address 172.16.16.1 255.255.240.0
!
interface serial0/0
no shutdown
ip unnumbered fastethernet0/0
!
interface serial0/1
no shutdown
ip unnumbered fastethernet0/0
!
interface serial0/2
no shutdown
ip unnumbered fastethernet0/0
!

```

Example Using IP addresses with 31-Bit Prefixes on Point-to-Point WAN Interfaces to Limit Number of IP Addresses Required

The following example configures 31-bit prefixes on two interfaces:

```
!
ip classless
!
interface serial0/0
 no shutdown
 ip address 192.168.100.2 255.255.255.254
!
!
interface serial0/1
 no shutdown
 ip address 192.168.100.4 255.255.255.254
```

Example Maximizing the Number of Available IP Subnets by Allowing the Use of IP Subnet Zero

The following example enables subnet zero:

```
!
interface FastEthernet0/0
 no shutdown
 ip address 172.16.16.1 255.255.240.0
!
ip subnet-zero
!
```

Where to Go Next

If your network has two or more routers and you have not already configured a routing protocol, consult the *Cisco IOS IP Routing Protocols Configuration Guide*, Release 12.4T, for information on configuring routing protocols.

Additional References

Related Documents

| Related Topic | Document Title |
|--|--|
| Cisco IOS commands | Cisco IOS Master Commands List, All Releases |
| IP addressing commands: complete command syntax, command mode, command history, defaults, usage guidelines, and examples | <i>Cisco IOS IP Addressing Services Command Reference</i> |

| Related Topic | Document Title |
|--|--|
| Fundamental principles of IP addressing and IP routing | <i>IP Routing Primer ISBN 1578701082</i> |

Standards

| Standard | Title |
|--|-------|
| No new or modified standards are supported, and support for existing standards has not been modified | -- |

MIBs

| MIB | MIBs Link |
|--|---|
| No new or modified MIBs are supported, and support for existing MIBs has not been modified | To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs |

RFCs

| RFC ⁶ | Title |
|------------------|--|
| RFC 791 | <i>Internet Protocol</i> http://www.ietf.org/rfc/rfc0791.txt |
| RFC 1338 | <i>Classless Inter-Domain Routing (CIDR): an Address Assignment and Aggregation Strategy</i> http://www.ietf.org/rfc/rfc1519.txt |
| RFC 1466 | <i>Guidelines for Management of IP Address Space</i> http://www.ietf.org/rfc/rfc1466.txt |
| RFC 1716 | <i>Towards Requirements for IP Routers</i> http://www.ietf.org/rfc/rfc1716.txt |
| RFC 1918 | <i>Address Allocation for Private Internets</i> http://www.ietf.org/rfc/rfc1918.txt |
| RFC 3330 | <i>Special-Use IP Addresses</i> http://www.ietf.org/rfc/rfc3330.txt |

- ⁶ These references are only a sample of the many RFCs available on subjects related to IP addressing and IP routing. Refer to the IETF RFC site at <http://www.ietf.org/rfc.html> for a full list of RFCs.

Technical Assistance

| Description | Link |
|---|---|
| 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. | http://www.cisco.com/cisco/web/support/index.html |

Feature Information for IP Addresses

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 10: Feature Information for IP Addresses

| Feature Name | Releases | Feature Information |
|--------------------------------|----------|--|
| Classless Inter-Domain Routing | 10.0 | CIDR is a new way of looking at IP addresses that eliminates the concept of classes (class A, class B, and so on). For example, network 192.213.0.0, which is an illegal class C network number, is a legal supernet when it is represented in CIDR notation as 192.213.0.0/16. The /16 indicates that the subnet mask consists of 16 bits (counting from the left). Therefore, 192.213.0.0/16 is similar to 192.213.0.0 255.255.0.0. The following command was introduced or modified: ip classless . |

| Feature Name | Releases | Feature Information |
|--|--------------------|--|
| IP Subnet Zero | 10.0 | <p>In order to conserve IP address space IP Subnet Zero allows the use of the all-zeros subnet as an IP address on an interface, such as configuring 172.16.0.1/24 on Fast Ethernet 0/0.</p> <p>The following command was introduced or modified: ip subnet-zero.</p> |
| IP Unnumbered Interfaces | 10.0 | <p>In order to conserve IP address space, IP unnumbered interfaces use the IP address of another interface to enable IP connectivity.</p> <p>The following command was introduced or modified: ip unnumbered.</p> |
| Using 31-bit Prefixes on IP Point-to-Point Links | 12.0(14)S 12.2(4)T | <p>In order to conserve IP address space on the Internet, a 31-bit prefix length allows the use of only two IP addresses on a point-to-point link. Previously, customers had to use four IP addresses or unnumbered interfaces for point-to-point links.</p> |



CHAPTER 2

IP Overlapping Address Pools

The IP Overlapping Address Pools feature improves flexibility in assigning IP addresses dynamically. This feature allows you to configure overlapping IP address pool groups to create different address spaces and concurrently use the same IP addresses in different address spaces.

- [Finding Feature Information, page 29](#)
- [Restrictions for IP Overlapping Address Pools, page 29](#)
- [Information About IP Overlapping Address Pools, page 30](#)
- [How to Configure IP Overlapping Address Pools, page 30](#)
- [Configuration Examples for Configuring IP Overlapping Address Pools, page 31](#)
- [Additional References, page 32](#)
- [Feature Information for Configuring IP Overlapping Address Pools, page 33](#)
- [Glossary, page 34](#)

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see [Bug Search Tool](#) and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

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 IP Overlapping Address Pools

The Cisco IOS XE software checks for duplicate addresses on a per-group basis. The check for duplicate addresses means that you can configure pools in multiple groups that could have possible duplicate addresses. The IP Overlapping Address Pools feature should be used only in cases where overlapping IP address pools make sense, such as Multiprotocol Label Switching (MPLS) Virtual Private Network (VPN) environments where multiple IP address spaces are supported.

Information About IP Overlapping Address Pools

Benefits

The IP Overlapping Address Pools gives greater flexibility in assigning IP addresses dynamically. It allows you to configure overlapping IP address pool groups to create different address spaces and concurrently use the same IP addresses in different address spaces.

How IP Address Groups Work

IP Control Protocol (IPCP) IP pool processing implements all IP addresses as belonging to a single IP address space, and a given IP address should not be assigned multiple times. IP developments such as virtual private dialup network (VPDN) and Network Address Translation (NAT) implement the concept of multiple IP address spaces where it can be meaningful to reuse IP addresses, although such usage must ensure that these duplicate address are not placed in the same IP address space. An IP address group to support multiple IP address spaces and still allow the verification of nonoverlapping IP address pools within a pool group. Pool names must be unique within the router. The pool name carries an implicit group identifier because that pool name can be associated only with one group. Pools without an explicit group name are considered members of the base system group and are processed in the same manner as the original IP pool implementation.

Existing configurations are not affected by the new pool feature. The “group” concept is an extension of the existing **ip local pool** command. Processing of pools that are not specified as a member of a group is unchanged from the existing implementation.

How to Configure IP Overlapping Address Pools

Configuring and Verifying a Local Pool Group

Perform this task to configure a local pool group and verify that it exists.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip local pool** {**default** | *poolname*} {*low-ip-address* [*high-ip-address*] [**group** *group-name*] [**cache-size** *size*]}
4. **show ip local pool** [*poolname* | [**group** *group-name*]]

DETAILED STEPS

| | Command or Action | Purpose |
|--------|-------------------|-------------------------------|
| Step 1 | enable | Enables privileged EXEC mode. |

| | Command or Action | Purpose |
|---------------|--|--|
| | Example: Router> enable | <ul style="list-style-type: none"> • Enter your password if prompted. |
| Step 2 | configure terminal Example: Router# configure terminal | Enters global configuration mode. |
| Step 3 | ip local pool {default poolname} {low-ip-address [high-ip-address] [group group-name] [cache-size size]} Example: Router(config)# ip local pool testpool 10.2.2.1 10.2.2.10 group testgroup cache-size 10000 | Configures a group of local IP address pools, gives this group a name, and specifies a cache size. |
| Step 4 | show ip local pool [poolname [group group-name]] Example: Router(config)# show ip local pool group testgroup testpool | Displays statistics for any defined IP address pools. |

Configuration Examples for Configuring IP Overlapping Address Pools

Define Local Address Pooling as the Global Default Mechanism Example

The following example shows how to configure local pooling as the global default mechanism:

```
ip address-pool local
ip local pool default 192.168.15.15 192.168.15.16
```

Configure Multiple Ranges of IP Addresses into One Pool Example

The following example shows how to configure two ranges of IP addresses for one IP address pool:

```
ip local pool default 192.169.10.10 192.169.10.20
ip local pool default 192.168.50.25 192.168.50.50
```

Additional References

The following sections provide references related to configuring IP Overlapping Address Pools.

Related Documents

| Related Topic | Document Title |
|---|---|
| Dial commands: complete command syntax, command mode, command history, defaults, usage guidelines, and examples | <i>Cisco IOS Dial Services Command Reference</i> |
| IP address pooling | “Configuring Media-Independent PPP and Multilink PPP” chapter of the Cisco IOS XE Dial Technologies Configuration Guide |

Standards

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

MIBs

| MIBs | MIBs Link |
|---|---|
| No new or modified MIBs are supported by this feature, and support for existing MIBs has not been modified by this feature. | To locate and download MIBs for selected platforms, Cisco IOS XE releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs |

RFCs

| RFCs | Title |
|----------|---|
| RFC 826 | <i>Address Resolution Protocol</i> |
| RFC 903 | <i>Reverse Address Resolution Protocol</i> |
| RFC 1027 | <i>Proxy Address Resolution Protocol</i> |
| RFC 1042 | <i>Standard for the Transmission of IP Datagrams over IEEE 802 Networks</i> |

Technical Assistance

| Description | Link |
|---|--|
| <p>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies.</p> <p>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.</p> <p>Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</p> | <p>http://www.cisco.com/techsupport</p> |

Feature Information for Configuring IP Overlapping Address Pools

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 11: Feature Information for Configuring IP Overlapping Address Pools

| Feature Name | Releases | Feature Information |
|------------------------------|--------------------------|---|
| IP Overlapping Address Pools | Cisco IOS XE Release 2.1 | <p>The IP Overlapping Address Pools feature improves flexibility in assigning IP addresses dynamically. This feature allows you to configure overlapping IP address pool groups to create different address spaces and concurrently use the same IP addresses in different address spaces.</p> <p>The following commands were modified by this feature: ip local pool and show ip local pool.</p> |

Glossary

IPCP --IP Control Protocol. Protocol that establishes and configures IP over PPP.

MPLS --Multiprotocol Label Switching. Switching method that forwards IP traffic using a label. This label instructs the routers and the switches in the network where to forward the packets based on preestablished IP routing information.

NAT --Network Address Translation. Mechanism for reducing the need for globally unique IP addresses. NAT allows an organization with addresses that are not globally unique to connect to the Internet by translating those addresses into globally routable address space. Also known as Network Address Translator.

VPDN --virtual private dialup network. Also known as virtual private dial network. A VPDN is a network that extends remote access to a private network using a shared infrastructure. VPDNs use Layer 2 tunnel technologies (L2F, L2TP, and PPTP) to extend the Layer 2 and higher parts of the network connection from a remote user across an ISP network to a private network. VPDNs are a cost-effective method of establishing a long distance, point-to-point connection between remote dial users and a private network. See also VPN.

VPN --Virtual Private Network. Enables IP traffic to travel securely over a public TCP/IP network by encrypting all traffic from one network to another. A VPN uses “tunneling” to encrypt all information at the IP level.

VRF --A VPN routing and forwarding instance. A VRF consists of an IP routing table, a derived forwarding table, a set of interfaces that use the forwarding table, and a set of rules and routing protocols that determine what goes into the forwarding table. In general, a VRF includes the routing information that defines a customer VPN site that is attached to a PE router.



IP Unnumbered Ethernet Polling Support

The IP Unnumbered Ethernet Polling Support feature provides IP unnumbered support for Ethernet physical interfaces. This support already exists for serial interfaces.

- [Finding Feature Information, page 35](#)
- [Information About IP Unnumbered Ethernet Polling Support, page 35](#)
- [How to Configure IP Unnumbered Ethernet Polling Support, page 36](#)
- [Configuration Examples for IP Unnumbered Ethernet Polling Support, page 40](#)
- [Additional References, page 40](#)
- [Feature Information for IP Unnumbered Ethernet Polling Support, page 41](#)

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see [Bug Search Tool](#) and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

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.

Information About IP Unnumbered Ethernet Polling Support

IP Unnumbered Ethernet Polling Support Overview

IP unnumbered support for serial interfaces is extended to Ethernet physical interfaces. Unnumbered Ethernet physical interfaces are used in the same manner as unnumbered serial interfaces. On a device, if a loopback interface is configured and an IP address is assigned to it, using the polling option more than one Ethernet physical interface can be unnumbered to the loopback.

The polling option enables the dynamic discovery of hosts (connected though the unnumbered interfaces) based on the Address Resolution Protocol (ARP) protocol.

How to Configure IP Unnumbered Ethernet Polling Support

Enabling Polling on an Ethernet Interface

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ip address** *ip-address mask*
5. **exit**
6. **interface** *type number*
7. **ip unnumbered** *type number poll*
8. **end**

DETAILED STEPS

| | Command or Action | Purpose |
|---------------|---|---|
| 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 | interface <i>type number</i> Example: Device(config)# interface loopback 0 | Specifies an interface and enters interface configuration mode. |
| Step 4 | ip address <i>ip-address mask</i> Example: Device(config-if)# ip address 209.165.200.229 255.255.240.224 | Configures the IP address on the interface. |

| | Command or Action | Purpose |
|---------------|---|--|
| Step 5 | exit Example: Device(config-if)# exit | Exits interface configuration mode and returns to global configuration mode. |
| Step 6 | interface <i>type number</i> Example: Device(config)# interface ethernet 0/0 | Specifies an interface and enters interface configuration mode. |
| Step 7 | ip unnumbered <i>type number poll</i> Example: Device(config-if)# ip unnumbered loopback 0 poll | Enables IP-connected host polling on the specified interface. |
| Step 8 | end Example: Device(config-if)# end | Returns to privileged EXEC mode. |

Configuring the Queue Size and the Packet Rate for IP ARP Polling for Unnumbered Interfaces

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip arp poll queue** *queue-size*
4. **ip arp poll rate** *packet-rate*
5. **end**

DETAILED STEPS

| | Command or Action | Purpose |
|---------------|--|--|
| Step 1 | enable Example: Device> enable | Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted. |

| | Command or Action | Purpose |
|--------|---|---|
| Step 2 | configure terminal Example: Device# configure terminal | Enters global configuration mode. |
| Step 3 | ip arp poll queue <i>queue-size</i> Example: Device(config)# ip arp poll queue 1000 | Configures the IP ARP polling queue size. |
| Step 4 | ip arp poll rate <i>packet-rate</i> Example: Device(config)# ip arp poll rate 1000 | Configures the IP ARP polling packet rate, in packets per second. |
| Step 5 | end Example: Device(config-if)# end | Returns to privileged EXEC mode. |

Verifying IP Unnumbered Ethernet Polling Support

Perform this task to verify IP unnumbered Ethernet polling support.



Note The **show** commands are not in any specific order.

SUMMARY STEPS

1. **enable**
2. **show ip arp poll**
3. **show ip interface *type number* unnumbered**
4. **show ip interface *type number* unnumbered detail**

DETAILED STEPS

- Step 1** **enable**
Enables privileged EXEC mode.

Example:

```
Device> enable
```

Step 2 **show ip arp poll**

Displays the IP ARP host polling status.

Example:

```
Device# show ip arp poll
```

```
Number of IP addresses processed for polling: 438
Number of entries in the queue: 100 (high water mark: 154, max: 1000)
Number of request dropped:
  Queue was full: 1288
  Request was throttled by incomplete ARP: 10
  Duplicate entry found in queue: 1431
```

Step 3 **show ip interface *type number* unnumbered**

Displays the status of unnumbered interface support on interfaces configured for IP.

Example:

```
Device# show ip interface loopback 0 unnumbered
```

```
Number of unnumbered interfaces with polling: 10
Number of IP addresses processed for polling: 15
Number of IP addresses in queue for polling: 4
```

Step 4 **show ip interface *type number* unnumbered detail**

Displays the detailed status of unnumbered interface support on interfaces configured for IP.

Example:

```
Device# show ip interface loopback 0 unnumbered detail
```

```
Number of unnumbered interfaces with polling: 10
Number of IP addresses processed for polling: 15
Last 10 IP addresses processed for polling:
  209.165.201.2
  209.165.201.3
  209.165.201.4
  209.165.201.5
  209.165.201.6
  209.165.201.7
  209.165.201.8
  209.165.201.9
  209.165.201.10
  209.165.201.11
Number of IP addresses in queue for polling: 4 (high water mark: 5)
  209.165.201.12
  209.165.201.13
  209.165.201.14
  209.165.201.15
```

Configuration Examples for IP Unnumbered Ethernet Polling Support

Example: Enabling Polling on an Ethernet Interface

```
Device> enable
Device# configure terminal
Device(config)# interface loopback 0
Device(config-if)# ip address 209.165.200.229 255.255.240.224
Device(config-if)# exit
Device(config)# interface ethernet 0/0
Device(config-if)# ip unnumbered loopback 0 poll
Device(config-if)# end
```

Example: Configuring the Queue Size and the Packet Rate for IP ARP Polling for Unnumbered Interfaces

```
Device> enable
Device# configure terminal
Device(config)# ip arp poll queue 1000
Device(config)# ip arp poll rate 1000
Device(config)# end
```

Additional References

Related Documents

| Related Topic | Document Title |
|---|--|
| Cisco IOS commands | Cisco IOS Master Command List, All Releases |
| IPv4 Addressing commands | Cisco IOS IP Addressing Services Command Reference |
| Conceptual information about IPv4 addresses | “Configuring IPv4 Addresses” module in the <i>IP Addressing: IPv4 Addressing Configuration Guide</i> |

Technical Assistance

| Description | Link |
|---|---|
| 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. | http://www.cisco.com/cisco/web/support/index.html |

Feature Information for IP Unnumbered Ethernet Polling Support

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 12: Feature Information for IP Unnumbered Ethernet Polling Support

| Feature Name | Releases | Feature Information |
|--|---------------------------|---|
| IP Unnumbered Ethernet Polling Support | Cisco IOS XE Release 3.8S | The IP Unnumbered Ethernet Polling Support feature provides IP unnumbered support for Ethernet physical interfaces. The following commands were introduced or modified: clear ip arp poll statistics , clear ip interface , ip arp poll , ip unnumbered poll , show ip arp poll , and show ip interface unnumbered . |



Auto-IP

The auto-IP feature automatically provides IP addresses to the nodes inserted into a ring. In ring topology, when a device is inserted into the ring, the neighboring node interfaces require manual reconfiguration. The auto-IP feature addresses the problem of manually reconfiguring nodes during insertion, deletion, and movement of nodes within the ring. The auto-IP feature is supported on the following:

- Ethernet interfaces and sub interfaces.
- Virtual routing and forwarding instance (VRF) interfaces.
- Switch Virtual Interfaces (SVIs).
- EtherChannels.



Attention

To know the release versions that support the auto-IP feature on VRF interfaces, SVIs, and EtherChannels, refer [Feature Information for Auto-IP](#).



Note

When a device is inserted into a ring, it is called a node.

- [Finding Feature Information](#), page 44
- [Prerequisites for Auto-IP](#), page 44
- [Restrictions for Auto-IP](#), page 44
- [Information About Auto-IP](#), page 45
- [How to Configure Auto-IP](#), page 52
- [Configuration Examples for Auto-IP](#), page 59
- [Additional References for Auto-IP](#), page 60
- [Feature Information for Auto-IP](#), page 61

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see [Bug Search Tool](#) and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

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.

Prerequisites for Auto-IP

- Link Layer Discovery Protocol (LLDP) must be enabled on the device before the auto-IP functionality is enabled on the node interface.

Auto-IP on an EtherChannel

- When you configure auto-IP on an EtherChannel, ensure that LLDP is enabled on the member interfaces of the EtherChannel.
- Auto-IP configuration on an interface must be removed before moving an interface into an EtherChannel.

Auto-IP on VRF interfaces

- If you intend to configure auto-IP on an interface for a specific virtual routing and forwarding instance (VRF), then ensure that the interface is presently within the VRF. If you enable auto-IP on an interface and then associate the interface to a VRF, the auto-IP settings on the interface will be cleared, and you will have to enable the auto-IP feature on the VRF interface again.

Restrictions for Auto-IP

- Auto-IP addresses must not contain an even number in the last octet (such as 10.1.1.2, where the number in the last octet is 2).

Auto-IP on VRF interfaces

- Auto-IP configuration on an interface is not retained when the interface is moved from one virtual routing and forwarding instance (VRF) to another, including the global VRF.
- Interface nodes in different VRFs cannot be configured for the same ring. Ensure that the nodes you select belong to the same VRF.
- If a VRF address family is IPv6, you cannot configure auto-IP on the interfaces within the VRF. You can configure auto-IP on a VRF interface if the VRF address family is IPv4.

Auto-IP on SVI interfaces

- Auto-IP configuration is not possible on a Switch Virtual Interface (SVI) with more than one physical interface. The SVI physical interface must be an access port or trunk port with only one associated VLAN or a bridge domain interface (BDI).

Auto-IP on EtherChannel interfaces

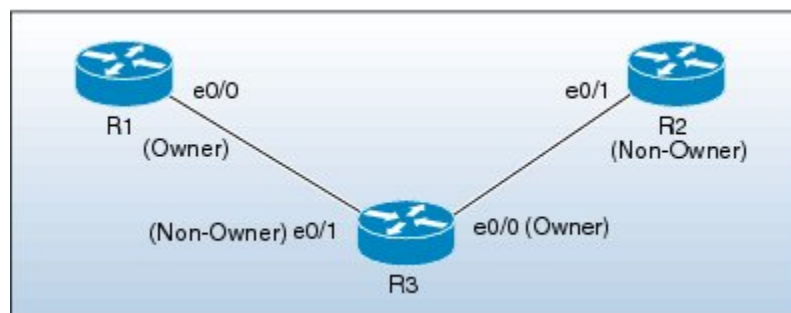
- Auto-IP configuration can be done on an EtherChannel interface, but not on a member interface of the EtherChannel.

Information About Auto-IP

Auto-IP Overview

The auto-IP feature is an enhancement of Link Layer Discovery Protocol (LLDP). LLDP uses a set of attributes to discover neighbor devices. This attribute set is called Type Length Value (TLV) as it contains type, length, and value descriptions.

In a ring topology, two network-to-network interfaces (NNIs or node interfaces) of a device are used to be part of the ring. For a ring to function as an auto-IP ring, you must configure the auto-IP feature on all the node interfaces within the ring. One node interface of a device is designated as the owner-interface and the other interface as the non-owner-interface. In an auto-IP ring, the owner-interface of a device is connected to a non-owner-interface of the neighbor device. A sample topology is given below:



When a new device is inserted into an auto-IP ring, owner and non-owner-interfaces of the inserted device are identified. The node interface of the inserted device that is connected to an owner-interface is designated as the non-owner-interface, and it automatically receives an IP address from the connected neighbor device. The IP address is automatically configured on the interface. Since the non-owner-interface is identified, the other node interface of the inserted device is designated as the owner-interface, and the device assigns a pre configured auto-IP address to its designated owner-interface.

An auto-IP address is a preconfigured address configured on a node interface to make the interface capable of automatically assigning an IP address to a new neighbor interface that is detected in the auto-IP ring. The configured auto-IP address is used for allocation purposes.

You must configure the same auto-IP address on the two node interfaces that are designated to be part of an auto-IP ring, and the auto-IP address must contain an odd number in the last octet. The auto-IP address is assigned to the owner-interface when the device is introduced into an auto-IP ring. Since each auto-IP address contains an odd number in the last octet, the IP address derived by subtracting 1 from the last octet is an even number, and is not used for designating auto-IP addresses. This IP address is allocated to a newly detected neighbor, non-owner-interface.

For example, if we assume that the device R3 is inserted between the devices R1 and R2 in the above topology, and the auto-IP address 10.1.1.3 is configured on e0/1 and e0/0, the two node interfaces on device R3, then R1 assigns an IP address to the non-owner-interface of R3, e0/1. The IP address 10.1.1.3 is assigned to the

owner-interface of R3, e0/0. The IP address derived by subtracting 1 from the last octet of the auto-IP address is 10.1.1.2. 10.1.1.2 is assigned to the neighbor non-owner-interface of the connected neighbor device R2.

Auto-IP TLV exchange

Before insertion, the node interfaces are not designated as owner and non-owner. After insertion, the auto-IP TLV is exchanged between the neighbor devices. During this initial negotiation with the adjacent device interfaces, owner and non-owner-interfaces are determined automatically.

After a device is inserted into a ring, the auto-IP address configured for the device (such as 10.1.1.3) is assigned to the owner-interface for the /31 subnet. An owner-interface has a priority 2 in the auto-IP TLV, and a non-owner-interface has priority 0 in the auto-IP TLV. If there is no assigned IP address on the node interface (before the node is inserted into a ring), then the ring interface has priority 1 in the auto-IP TLV.

The IP address negotiation is based on priority; the higher value of priority wins the negotiation. If the priority is equal, then IP negotiation fails. This scenario usually occurs when there is an incorrect configuration or wiring. In such a scenario, you must ensure that the configuration and wiring is proper.

Auto-IP on VRF interfaces

Some points on auto-IP configuration on virtual routing and forwarding instance (VRF) interfaces are noted below:

- Auto-IP configuration on an interface is removed when the interface is moved from one VRF to another, including the global VRF. So, assign the interface to a VRF and then configure the auto-IP feature on the interface.
- You can configure auto-IP on a VRF interface only if the address family of the VRF is IPv4. If the IPv4 address family configuration is removed from a VRF, the auto-IP configuration is removed from all the interfaces within the VRF.
- If a VRF address family is IPv6, you cannot configure auto-IP on the interfaces within the VRF. However, if a VRF address family is IPv4 and IPv6, you can configure auto-IP on the interfaces within the VRF.
- If the IPv6 address family configuration is removed from a VRF with both IPv4 and IPv6 address-family configuration, the auto-IP configuration on the interfaces within the VRF remain intact.
- If a VRF is deleted, then the auto-IP configuration on all the interfaces assigned to the VRF are removed.
- A specific ring has two interface nodes. Ensure that the two nodes you select belong to the same VRF. Nodes in different VRFs cannot be configured for the same ring.
- Within a VRF, the same auto-IP address cannot be used for different ring IDs.

Auto-IP on EtherChannel interfaces

Some points on auto-IP configuration for an EtherChannel interface are noted below:

- You can configure auto-IP on an EtherChannel interface. If you configure the auto-IP feature on an EtherChannel and then add member interfaces to the EtherChannel, then auto-IP TLV information is carried to all the member interfaces. If you add member interfaces to the EtherChannel and then configure auto-IP on the EtherChannel, auto-IP TLV information is carried to all the member interfaces.



Attention

LLDP must be enabled on the member interfaces.

- The list of EtherChannel member interfaces are maintained in ring interfaces corresponding to the EtherChannel. Auto-IP information is transmitted on all the EtherChannel member interfaces.
- If you remove a member interface from an EtherChannel, auto-IP TLV information is not carried to the removed interface.

Auto-IP on SVI interfaces

Some points on auto-IP configuration on a Switch Virtual Interface (SVI) are noted below:

- Auto-IP configuration on an SVI is possible only if a single physical interface is associated with an SVI.
- The SVI physical interface must be an access port or trunk port with only one associated VLAN or a bridge domain interface (BDI).
- If the SVI is mapped to more than one physical port, then the auto-IP configuration on the SVI will be removed.

Seed Device

Seed devices are the devices used to initiate network discovery. To initiate auto-IP capability in a ring, at least one device must be configured as a seed device in the ring. To configure a device as a seed device in an auto-IP ring, you must manually configure the IP address configured on one of its node interfaces with the auto-IP address of the interface, with the mask /31 (or 255.255.255.254).

A sample topology is given below. In this scenario, device R1 is being configured as the seed device.



The e0/0 interface on device R1 is configured with the auto-IP address 10.1.1.1 and the e0/1 interface on device R2 is configured with the auto-IP address 10.1.1.3.

To configure R1 as the seed device, 10.1.1.1 must be configured as the IP address of the interface e0/0. By configuring the IP address of e0/0 interface of R1 to its auto-IP address, R1 is configured as the seed device and the interface e0/0 becomes the owner of the subnet.

The process of configuring the device R1 as the seed device is given below:

After a connection is established between the devices R1 and R2, R1 sends a Link Layer Discovery Protocol (LLDP) packet which contains an auto-IP Type Length Value (TLV) with priority 2.

The auto-IP information for the e0/0 interface on R1 is given below:

| Interface IP address | Auto-IP address | Priority |
|----------------------|-----------------|----------|
| 10.1.1.1 | 10.1.1.1 | 2 |

On receiving the auto-IP TLV from R1, R2 derives the IP address for the interface e0/1 (by subtracting 1 from the last octet of R1's auto-IP address), and assigns the IP address 10.1.1.0/31 to R2's e0/1 interface. The interface e0/1 on R2 becomes the non-owner interface on this subnet.

The IP address allocation is displayed in the illustration given below:



The device and node interface details for the subnet are given below:

| Device | Interface | IP address | Designation |
|--------|-----------|-------------|-------------|
| R1 | e0/0 | 10.1.1.1/31 | Owner |
| R2 | e0/1 | 10.1.1.0/31 | Non-owner |



Note

Since the auto-IP address configured on the e0/1 interface on R2 is 10.1.1.3, the other node interface of R2 is designated as the owner interface and 10.1.1.3 is automatically configured as the interface IP address of the other node interface.

Auto-IP Configuration for Inserting a Device into an Auto-IP Ring

To insert a device into an existing auto-IP ring, the node interfaces of the device must be configured with the auto-IP address.



Note

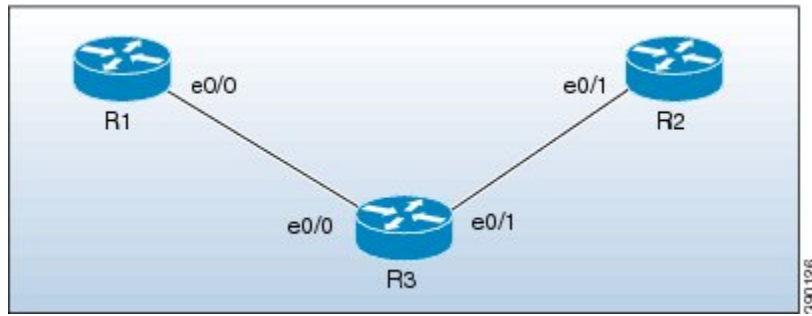
You can also configure the auto-IP feature on node interfaces that are part of an existing, but non-auto-IP ring.

The topology in the illustration below shows a sample scenario.



Device R1 is configured as the seed device. Interface e0/0 on R1 is configured with the IP address 10.1.1.1/31, and is the owner of the subnet connecting R1 and R2. Interface e0/1 on device R2 has the IP address 10.1.1.0/31, and is the non-owner interface of the subnet.

Device R3 is inserted between R1 and R2. The two designated node interfaces e0/0 and e0/1 of R3 are configured with the auto-IP address 10.1.1.5. After insertion of the device, the ring topology appears as shown in the illustration below:



Auto-IP TLV exchange between the devices R1 and R3 is given below:

- 1 R1 sends an auto-IP Type Length Value (TLV) with priority 2 to the e0/0 interface of R3.
- 2 After receiving the auto-IP TLV from R1, R3 sends an auto-IP TLV with priority 0 to the e0/0 interface of R1.
- 3 R1 wins the election process and the interface e0/0 of R1 is designated as the owner interface on the subnet connecting R1 and R3.
- 4 The e0/0 interface on R3 becomes the non-owner interface and the IP address 10.1.1.0 is assigned to it.
- 5 The other node interface on R3 is designated as an owner interface and its auto-IP address (10.1.1.5) is assigned as the IP address of the interface.

Auto-IP TLV exchange between the devices R3 and R2 is given below:

- 1 R3 sends an auto-IP TLV with priority 2 to the e0/1 interface of R2.
- 2 After receiving the auto-IP TLV from R3, R2 sends an auto-IP TLV with priority 0 to the e0/1 interface of R3.
- 3 R3 wins the election process and its interface e0/1 is designated as the owner interface on the subnet connecting R3 and R2.
- 4 The e0/1 interface on R2 is designated as the non-owner interface, and the IP address 10.1.1.4 is assigned to it.
- 5 The other node interface on R2 is designated as the owner interface and its auto-IP address is assigned as the IP address.

The IP addresses that are configured for the owner and non-owner interfaces on the devices R1, R2, and R3 are given below:

| Device | Interface | IP Address | Designation |
|--------|-----------|-------------|-------------|
| R1 | e0/0 | 10.1.1.1/31 | Owner |
| R3 | e0/0 | 10.1.1.0/31 | Non-owner |
| R3 | e0/1 | 10.1.1.5/31 | Owner |
| R2 | e0/1 | 10.1.1.4/31 | Non-owner |

Device Removal from an Auto-IP Ring

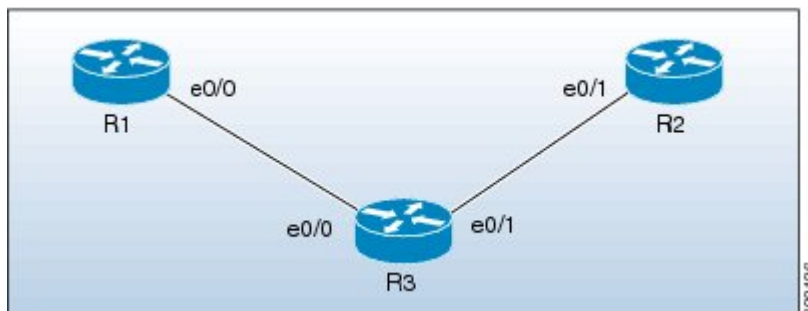
You can manually remove a device from an existing auto-IP ring.



Note

No configuration is required if you remove a device from an auto-IP ring and connect its neighbor devices.

The topology in the illustration below shows a sample scenario:



In the topology, device R3 is removed from the auto-IP ring and device R1 is connected to R2. As a result, auto-IP Type Length Value (TLVs) are exchanged between R1 and R2. Since the e0/0 interface of R1 sends an auto-IP TLV with priority 2 and the e0/1 interface of R2 sends an auto-IP TLV with priority 0 to the e0/0 interface on R1, the e0/0 interface of R1 is designated as the owner interface on the subnet connecting R1 and R2. R1 assigns the IP address to the e0/1 interface on R2, and it becomes the non-owner interface on this subnet.

After the removal of R3 from the auto-IP ring, the ring topology looks like this:



The IP address of the owner and non-owner interfaces on the subnet are given below:

| Device | Interface | Designation |
|--------|-----------|-------------|
| R1 | e0/0 | Owner |
| R2 | e0/1 | Non-owner |

Conflict Resolution Using the Auto-Swap Technique

The auto-swap technique automatically resolves conflicts due to incorrect insertion of a device into an auto-IP ring.

If you remove a device from an auto-IP ring, the owner and non-owner auto-IP configuration on the node interfaces is retained. You can insert the device back into an auto-IP ring.

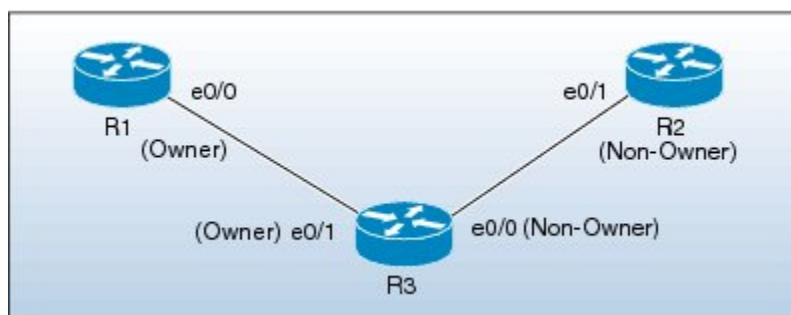
If you incorrectly insert a device into a ring with its interfaces swapped (due to which two owner interfaces and two non-owner interfaces are connected to each other, rather than a connection between an owner and a non-owner interface), then identical priority values are exchanged between interfaces during the auto-IP Type Length Value (TLV) transmission. This leads to a tie in the priority value that is exchanged between the node interfaces of the inserted device, and a conflict is detected.

The auto-swap technique resolves conflicts on both the node interfaces of the inserted device and allows allocation of IP addresses for the interfaces.


Note

No configuration is required to enable the auto-swap technique; it is enabled automatically. The auto-swap technique is used only when conflict is detected on both the node interfaces of the device.

The topology in the illustration below shows a sample scenario:



In this topology, device R3 is incorrectly inserted between the devices R1 and R2, with its interfaces swapped. The conflict arises due to incorrect insertion, as given below:

- An owner interface is connected to another owner interface; the e0/0 interface of R1 is connected to the e0/1 interface of R3.
- A non-owner interface is connected to another non-owner interface; the e0/1 interface of R2 is connected to the e0/0 interface of R3.

The auto-IP TLV exchange details between R1 and R3 are given below:

- The e0/0 interface on R1 sends an auto-IP TLV with priority 2 to the e0/1 interface on R3.
- The e0/1 interface on R3 sends an auto-IP TLV with priority 2 to the e0/0 interface on R1.

Since the same priority value of 2 is sent in both instances, there is a tie during the election process, leading to a conflict.

Similarly, the same priority value of 0 is exchanged between the e0/0 interface of R3 and the e0/1 interface of R2 since they are non-owner interfaces, leading to a conflict.

Auto Swap

The auto-IP feature uses the auto-swap technique to resolve conflicts on both the node interfaces of the inserted device.

The priority and the interface IP address of the e0/1 interface on R3 is swapped with the priority and the interface IP address of the e0/0 interface on R3, respectively.

After swapping, the following auto-IP TLV information is exchanged between R1 and R3:

- The e0/0 interface on R1 sends an auto-IP TLV with priority 2 to the e0/1 interface on R3.
- The e0/1 interface on R3 sends an auto-IP TLV with priority 0 to the e0/0 interface on R1.

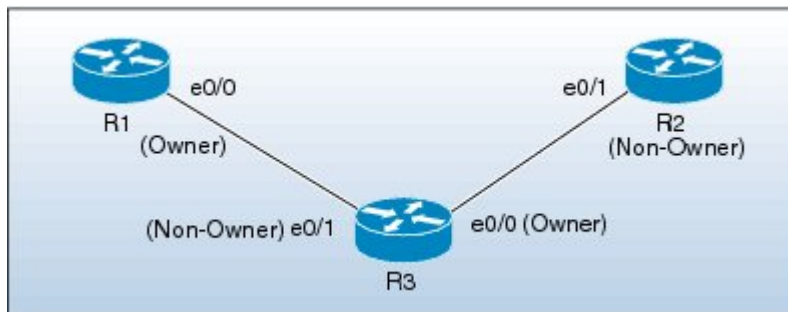
Since the priority sent by R1 to R3 is higher than the priority sent by the interface e0/1 on R3, R3 derives the IP address 10.1.1.0 for the e0/1 interface from the auto-IP address of R1 (10.1.1.1).

The following auto-IP TLV information is exchanged between R3 and R2:

- The e0/0 interface on R3 sends an auto-IP TLV with priority 2 to the e0/1 interface on R2.
- The e0/1 interface on R2 sends an auto-IP TLV with priority 0 to the e0/1 interface on R3.

R2 detects the priority sent by R3 to be higher than the priority sent by its interface e0/1 and derives the IP address 10.1.1.4 from the auto-IP address of R3 (10.1.1.5).

After conflict resolution, the topology looks like this:



The e0/1 interface on R3 is designated as a non-owner interface and the e0/0 interface on R3 is designated as the owner interface.

How to Configure Auto-IP

Configuring a Seed Device

You must configure at least one seed device in an auto-IP ring. To configure a seed device, you must configure the auto-IP address on the two node interfaces of the device (for a specific ring), and use the same IP address to configure the IP address on one of the two node interfaces.

**Attention**

Understand these concepts before configuring auto-IP on virtual routing and forwarding instance (VRF) interfaces, Switch Virtual Interfaces (SVIs), and EtherChannels:

- VRF—If you intend to enable auto-IP on a VRF interface, ensure that the node interface is presently within the VRF. If the interface is not within a VRF presently, assign the interface to the VRF and then configure auto-IP on the VRF interface. Ensure that both node interfaces for the ring are assigned to the same VRF.
- SVI—Auto-IP configuration on an SVI is possible only if a single physical interface is associated with an SVI and the physical interface is an access port.
- EtherChannels—You can configure auto-IP on an EtherChannel interface, but not on a member interface of the EtherChannel.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **lldp run**
4. **interface** *type number*
5. **auto-ip-ring** *ring-id* **ipv4-address** *auto-ip-address*
6. **exit**
7. **interface** *type number*
8. **auto-ip-ring** *ring-id* **ipv4-address** *auto-ip-address*
9. **ip address** *interface-ip-address* *subnet-mask*
10. **end**
11. **show auto-ip-ring** [*ring-id*][**detail**]

DETAILED STEPS

| | Command or Action | Purpose |
|---------------|--|--|
| Step 1 | enable Example: Device> enable | Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted. |
| Step 2 | configure terminal Example: Device# configure terminal | Enters global configuration mode. |

| | Command or Action | Purpose |
|----------------|--|---|
| Step 3 | lldp run Example: Device(config)# lldp run | Enables Link Layer Discovery Protocol (LLDP) for the device. |
| Step 4 | interface type number Example: Device(config)# interface ethernet 0/0 | Specifies an interface type and number, and enters interface configuration mode. |
| Step 5 | auto-ip-ring ring-id ipv4-address auto-ip-address Example: Device(config-if)# auto-ip-ring 4 ipv4-address 10.1.1.1 | Configures the auto-IP address on the specified interface. |
| Step 6 | exit Example: Device(config-if)# exit | Exits interface configuration mode and enters global configuration mode. |
| Step 7 | interface type number Example: Device(config)# interface ethernet 0/1 | Specifies an interface type and number, and enters interface configuration mode. |
| Step 8 | auto-ip-ring ring-id ipv4-address auto-ip-address Example: Device(config-if)# auto-ip-ring 4 ipv4-address 10.1.1.1 | Configures the auto-IP address on the specified interface. |
| Step 9 | ip address interface-ip-address subnet-mask Example: Device(config-if)# ip address 10.1.1.1 255.255.255.254 | Configures the IP address on the specified interface. Note The specified interface is designated as the owner interface of the seed device. |
| Step 10 | end Example: Device(config-if)# end | Returns to privileged EXEC mode. |

| | Command or Action | Purpose |
|---------|---|-------------------------------|
| Step 11 | show auto-ip-ring [<i>ring-id</i>][detail] Example: Device# show auto-ip-ring 4 detail | Displays auto-IP information. |

Configuring the Auto-IP Functionality on Node Interfaces (for Inclusion in an Auto-IP Ring)

To insert a device into an auto-IP ring or to enable node interfaces in an existing ring, you must configure the auto-IP address on the 2 designated node interfaces of the device.



Attention

Understand these concepts before configuring auto-IP on virtual routing and forwarding instance (VRF) interfaces, Switch Virtual Interfaces (SVIs), and EtherChannels:

- **VRF**—If you intend to enable auto-IP on a VRF interface, ensure that the node interface is presently within the VRF. If the interface is not within a VRF presently and you want the interface to be within a VRF, move the interface within the VRF and then configure auto-IP on the VRF interface. Ensure that both node interfaces are within the same VRF.
- **SVI**—Auto-IP configuration on an SVI is possible only if a single physical interface is associated with an SVI and the physical interface is an access port.
- **EtherChannels**—You can configure auto-IP on an EtherChannel interface, but not on a member interface of the EtherChannel.

This task is applicable for a non-seed device in an auto-IP ring. Ensure that a seed device is configured for the auto-IP ring before performing this task.

Perform the steps given below to configure the auto-IP functionality on the two node interfaces of a device:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **lldp run**
4. **interface** *type number*
5. **auto-ip-ring** *ring-id* **ipv4-address** *auto-ip-address*
6. **exit**
7. **interface** *type number*
8. **auto-ip-ring** *ring-id* **ipv4-address** *auto-ip-address*
9. **end**
10. **show auto-ip-ring** [*ring-id*][**detail**]

DETAILED STEPS

| | Command or Action | Purpose |
|---------------|---|---|
| Step 1 | enable Example: Device> enable | Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted. |
| Step 2 | configure terminal Example: Device# configure terminal | Enters global configuration mode. |
| Step 3 | lldp run Example: Device(config)# lldp run | Enables Link Layer Discovery Protocol (LLDP) for the device. |
| Step 4 | interface <i>type number</i> Example: Device(config)# interface ethernet 0/1 | Specifies an interface type and number, and enters interface configuration mode. |
| Step 5 | auto-ip-ring <i>ring-id</i> ipv4-address <i>auto-ip-address</i> Example: Device(config-if)# auto-ip-ring 4 ipv4-address 10.1.1.3 | Configures the auto-IP address on the specified interface. |

| | Command or Action | Purpose |
|----------------|---|--|
| Step 6 | exit Example: Device(config-if)# exit | Exits interface configuration mode and enters global configuration mode. |
| Step 7 | interface <i>type number</i> Example: Device(config)# interface ethernet 1/1 | Specifies an interface type and number, and enters interface configuration mode. |
| Step 8 | auto-ip-ring <i>ring-id</i> ipv4-address <i>auto-ip-address</i> Example: Device(config-if)# auto-ip-ring 4 ipv4-address 10.1.1.3 | Configures the auto-IP address on the specified interface. |
| Step 9 | end Example: Device(config-if)# end | Returns to privileged EXEC mode. |
| Step 10 | show auto-ip-ring [<i>ring-id</i>][detail] Example: Device# show auto-ip-ring 4 detail | Displays auto-IP information. |

Verifying and Troubleshooting Auto-IP

Perform this task to verify auto-IP functions.



Note

The commands are not in any specific order. The **show auto-ip-ring** command is presented twice. One of the examples displays auto-IP ring information for virtual routing and forwarding instance (VRF) interfaces, and the other example displays auto-IP ring information for non-VRF interfaces.

SUMMARY STEPS

1. **enable**
2. **show auto-ip-ring** [*ring-id*][**detail**]
3. **show auto-ip-ring** [*ring-id*][**detail**]
4. **debug auto-ip-ring** {*ring-id* {**errors** | **events**} | **errors** | **events**}

DETAILED STEPS

Step 1 **enable**
Enables privileged EXEC mode.

Example:

```
Device> enable
```

Step 2 **show auto-ip-ring [*ring-id*][*detail*]**
This command displays auto-IP ring information for a specific device or auto-IP ring.

Example:

```
Device# show auto-ip-ring

Auto-IP ring 1
Auto-IP Address      : 10.1.1.5

Ring Port0          : Ethernet0/0
My Current-IP       : 0.0.0.0
My Priority          : 1

Auto-IP ring 3
Auto-IP Address      : 10.1.1.3

Ring Port0          : Ethernet0/1
My Current-IP       : 0.0.0.0
My Priority          : 1
```

Step 3 **show auto-ip-ring [*ring-id*][*detail*]**
This command displays auto-IP ring information for VRF interfaces.

Example:

```
Device# show auto-ip-ring detail

Auto-IP ring 7
Auto-IP Address      : 10.1.1.11

VRF Name            : 3
Ring Port1          : Ethernet1/1
My Current-IP       : 10.1.1.11
My Priority          : 2

Rx Auto-IP Address  : 10.1.1.13
Rx Current-IP       : 10.1.1.10
Rx Priority          : 0

VRF Name            : 3
Ring Port0          : Ethernet1/0
My Current-IP       : 10.1.1.8
My Priority          : 0

Rx Auto-IP Address  : 10.1.1.9
Rx Current-IP       : 10.1.1.9
Rx Priority          : 2
```

- Step 4** `debug auto-ip-ring {ring-id {errors | events} |errors | events}`
This command debugs errors and events for the specified auto-IP ring.

Example:

```
Device# debug auto-ip-ring 1 errors
```

```
Auto IP Ring errors debugging is on for the ring id : 1
*Jul 26 11:30:40.541: (Ethernet0/0) priority (value:1) conflict detected, need admin intervention
```

Note A conflict is detected in the above debug example because the priority in the auto-IP Type Length Value (TLV) that is sent from the interface and the priority that is received from the neighbor interface is the same.

Configuration Examples for Auto-IP

Example: Configuring a Seed Device

```
Device> enable
Device# configure terminal
Device(config)# lldp run
Device(config)# interface ethernet 0/0
Device(config-if)# auto-ip-ring 4 ipv4-address 10.1.1.1
Device(config-if)# exit
Device(config)# interface ethernet 1/0
Device(config-if)# auto-ip-ring 4 ipv4-address 10.1.1.1
Device(config-if)# ip address 10.1.1.1 255.255.255.254
Device(config-if)# end
```

Example: Configuring the Auto-IP Functionality on Node Interfaces (for Inclusion in an Auto-IP Ring)

```
Device> enable
Device# configure terminal
Device(config)# lldp run
Device(config)# interface ethernet 0/1
Device(config-if)# auto-ip-ring 4 ipv4-address 10.1.1.3
Device(config-if)# exit
Device(config)# interface ethernet 1/1
Device(config-if)# auto-ip-ring 4 ipv4-address 10.1.1.3
Device(config-if)# end
```

Additional References for Auto-IP

Related Documents

| Related Topic | Document Title |
|---|--|
| Configuring IPv4 Addresses | IP Addressing: IPv4 Addressing Configuration Guide |
| Using Link Layer Discovery Protocol in Multivendor Networks | Carrier Ethernet Configuration Guide |
| IPv4 Addressing commands | Cisco IOS IP Addressing Services Command Reference |
| Cisco IOS commands | Cisco IOS Master Command List, All Releases |

Technical Assistance

| Description | Link |
|---|---|
| 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. | http://www.cisco.com/cisco/web/support/index.html |

Feature Information for Auto-IP

Table 13: Feature Information for Auto-IP

| Feature Name | Releases | Feature Information |
|--------------|------------------------------|---|
| Auto-IP | Cisco IOS XE Release 3.10(S) | <p>The auto-IP feature addresses the problem of manually reconfiguring nodes during insertion, deletion, and movement of nodes within an auto-IP ring. The auto-IP feature automatically provides IP addresses to the node interfaces inserted into an auto-IP ring.</p> <p>In Cisco IOS XE Release 3.10(S), it is not possible to configure the auto-IP feature on virtual routing and forwarding instance (VRF) interfaces, SVIs, and EtherChannels.</p> <p>The following commands were introduced or modified: auto-ip-ring, debug auto-ip-ring, show auto-ip-ring.</p> |
| | Cisco IOS XE Release 3.12(S) | <p>In Cisco IOS XE Release 3.12(S), the auto-IP feature is enhanced to support auto-IP configuration on virtual routing and forwarding instance (VRF) interfaces, SVIs, and EtherChannels.</p> <p>The following commands were introduced or modified: show auto-ip-ring.</p> |

