# Practice for Chapter 13: Analyzing Subnet Masks

This appendix begins with ten mask conversion problems, followed by the matching answers and explanations. After that, the appendix lists ten mask analysis problems, with the matching answers to follow.

## Mask Conversion Problems

The problems in this appendix require you to convert dotted-decimal subnet masks to prefix format and vice versa. To do so, feel free to use the processes described in Chapter 13 of *Cisco CCENT/CCNA ICND1 100-101 Official Cert Guide*.

Many people use the information in Table E-1 when converting masks. The table lists the nine dotted-decimal notation (DDN) mask values, the binary equivalent, and the number of binary 1s in the binary equivalent.

**Table E-1** Nine Possible Values in One Octet of a Subnet Mask

| Binary Mask Octet | DDN Mask Octet | Number of Binary 1s |
|---|---|---|
| 00000000 | 0 | 0 |
| 10000000 | 128 | 1 |
| 11000000 | 192 | 2 |
| 11100000 | 224 | 3 |
| 11110000 | 240 | 4 |
| 11111000 | 248 | 5 |
| 11111100 | 252 | 6 |
| 11111110 | 254 | 7 |
| 11111111 | 255 | 8 |

Convert each DDN mask to prefix format and vice versa:

1. 255.240.0.0
2. 255.255.192.0
3. 255.255.255.224
4. 255.254.0.0.
5. 255.255.248.0
6. /30
7. /25
8. /11
9. /22
10. /24

# Answers to Mask Conversion Problems

## Mask Conversion Problem 1: Answer

The answer is /12.

The binary process for converting the mask from dotted-decimal format to prefix format is relatively simple. The only hard part is converting the dotted-decimal number to binary. For reference, the process is as follows: .

**Step 1.** Convert the dotted-decimal mask to binary.

**Step 2.** Count the number of binary 1s in the 32-bit binary mask; this is the value of the prefix notation mask.

For problem 1, mask 255.240.0.0 converts to

11111111 11110000 00000000 00000000

You can see from the binary number that it contains 12 binary 1s, so the prefix format of the mask will be /12.

You can find the same answer without converting decimal to binary if you have memorized the nine DDN mask values, and the corresponding number of binary 1s in each, as listed earlier in Table E-1. Follow these steps:

**Step 1.** Start with a prefix value of 0.

**Step 2.** (1st octet) Add 8 because the first mask octet of 255 includes eight binary 1s.

**Step 3.** (2nd octet) Add 4 because the second mask octet of 240 includes four binary 1s.

**Step 4.** The resulting prefix is /12.

## Mask Conversion Problem 2: Answer

The answer is /18.

For problem 2, mask 255.255.192.0 converts to the following:

11111111 11111111 11000000 00000000

You can see from the binary number that it contains 18 binary 1s, so the prefix format of the mask will be /18.

If you memorized the number of binary 1s represented by each DDN mask value, you can possibly work faster with the following logic:

**Step 1.** Start with a prefix value of 0.

**Step 2.** (1st octet) Add 8 because the first mask octet of 255 includes eight binary 1s.

**Step 3.** (2nd octet) Add 8 because the second mask octet of 255 includes eight binary 1s.

**Step 4.** (3rd octet) Add 2 because the *third* mask octet of 192 includes two binary 1s.

**Step 5.** The resulting prefix is /18.

## Mask Conversion Problem 3: Answer

The answer is /27.

For problem 3, mask 255.255.255.224 converts to the following:

11111111 11111111 11111111 11100000

You can see from the binary number that it contains 27 binary 1s, so the prefix format of the mask will be /27.

If you memorized the number of binary 1s represented by each DDN mask value, you can possibly work faster with the following logic:

**Step 1.** Start with a prefix value of 0.

**Step 2.** (1st octet) Add 8 because the first mask octet of 255 includes eight binary 1s.

**Step 3.** (2nd octet) Add 8 because the second mask octet of 255 includes eight binary 1s.

**Step 4.** (3rd octet) Add 8 because the third mask octet of 255 includes eight binary 1s.

**Step 5.** (4th octet) Add 3 because the fourth mask octet of 224 includes three binary 1s.

**Step 6.** The resulting prefix is /27.

### Mask Conversion Problem 4: Answer

The answer is /15.

For problem 4, mask 255.254.0.0 converts to the following:

11111111 11111110 00000000 00000000

You can see from the binary number that it contains 15 binary 1s, so the prefix format of the mask will be /15.

If you memorized the number of binary 1s represented by each DDN mask value, you can possibly work faster with the following logic:

**Step 1.** Start with a prefix value of 0.

**Step 2.** (1st octet) Add 8 because the first mask octet of 255 includes eight binary 1s.

**Step 3.** (2nd octet) Add 7 because the second mask octet of 254 includes seven binary 1s.

**Step 4.** The resulting prefix is /15.

### Mask Conversion Problem 5: Answer

The answer is /21.

For problem 5, mask 255.255.248.0 converts to the following:

11111111 11111111 11111000 00000000

You can see from the binary number that it contains 21 binary 1s, so the prefix format of the mask will be /21.

If you memorized the number of binary 1s represented by each DDN mask value, you can possibly work faster with the following logic:

**Step 1.** Start with a prefix value of 0.

**Step 2.** (1st octet) Add 8 because the first mask octet of 255 includes eight binary 1s.

**Step 3.** (2nd octet) Add 8 because the second mask octet of 255 includes eight binary 1s.

**Step 4.** (3rd octet) Add 5 because the third mask octet of 248 includes five binary 1s.

**Step 5.** The resulting prefix is /21.

## Mask Conversion Problem 6: Answer

The answer is 255.255.255.252.

The binary process for converting the prefix version of the mask to dotted-decimal is straightforward, but again requires some binary math. For reference, the process runs like this:

**Step 1.** Write down x binary 1s, where x is the value listed in the prefix version of the mask.

**Step 2.** Write down binary 0s after the binary 1s until the combined 1s and 0s form a 32-bit number.

**Step 3.** Convert this binary number, 8 bits at a time, to decimal, to create a dotted-decimal number; this value is the dotted-decimal version of the subnet mask. (Refer to Table E-1, which lists the binary and decimal equivalents.)

For problem 6, with a prefix of /30, you start at Step 1 by writing down 30 binary 1s, as shown here:

11111111 11111111 11111111 111111

At Step 2, you add binary 0s until you have 32 total bits, as shown next:

11111111 11111111 11111111 11111**00**

The only remaining work is to convert this 32-bit number to decimal, remembering that the conversion works with 8 bits at a time.

## Mask Conversion Problem 7: Answer

The answer is 255.255.255.128.

For problem 7, with a prefix of /25, you start at Step 1 by writing down 25 binary 1s, as shown here:

11111111 11111111 11111111 1

At Step 2, you add binary 0s until you have 32 total bits, as shown next:

11111111 11111111 11111111 **10000000**

The only remaining work is to convert this 32-bit number to decimal, remembering that the conversion works with 8 bits at a time.

### Mask Conversion Problem 8: Answer

The answer is 255.224.0.0.

For problem 8, with a prefix of /11, you start at Step 1 by writing down 11 binary 1s, as shown here:

11111111 111

At Step 2, you add binary 0s until you have 32 total bits, as shown next:

11111111 111**00000 00000000 00000000**

The only remaining work is to convert this 32-bit number to decimal, remembering that the conversion works with 8 bits at a time.

### Mask Conversion Problem 9: Answer

The answer is 255.255.252.0.

For problem 9, with a prefix of /22, you start at Step 1 by writing down 22 binary 1s, as shown here:

11111111 11111111 111111

At Step 2, you add binary 0s until you have 32 total bits, as shown next:

11111111 11111111 11111**100 00000000**

The only remaining work is to convert this 32-bit number to decimal, remembering that the conversion works with 8 bits at a time.

### Mask Conversion Problem 10: Answer

The answer is 255.255.255.0.

For problem 10, with a prefix of /24, you start at Step 1 by writing down 24 binary 1s, as shown here:

11111111 11111111 11111111

At Step 2, you add binary 0s until you have 32 total bits, as shown next:

11111111 11111111 11111111 **00000000**

The only remaining work is to convert this 32-bit number to decimal, remembering that the conversion works with 8 bits at a time.

## Mask Analysis Problems

This appendix lists problems that require you to analyze an existing IP address and mask to determine the number of network, subnet, and host bits. From that, you should calculate the number of subnets possible when using the listed mask in the class of network shown in the problem, as well as the number of possible host addresses in each subnet.

To find this information, you can use the processes explained in Chapter 13 of *Cisco CCENT/CCNA ICND1 100-101 Official Cert Guide*. When doing the problems, Table E-1, earlier in this appendix, which lists all possible DDN mask values, can be useful.

Each row of Table E-2 lists an IP address and mask. For each row, complete the table. Note that for the purposes of this exercise, you can assume that the two special subnets in each network, the zero subnet and broadcast subnet, are allowed to be used.

**Table E-2** Mask Analysis Problems

| Problem Number | Problem | Network Bits | Subnet Bits | Host Bits | Number of Subnets in Network | Number of Hosts per Subnet |
|---|---|---|---|---|---|---|
| 1 | 10.66.5.99, 255.255.254.0 | | | | | |
| 2 | 172.16.203.42, 255.255.252.0 | | | | | |
| 3 | 192.168.55.55, 255.255.255.224 | | | | | |
| 4 | 10.22.55.87/30 | | | | | |
| 5 | 172.30.40.166/26 | | | | | |
| 6 | 192.168.203.18/29 | | | | | |
| 7 | 200.11.88.211, 255.255.255.240 | | | | | |
| 8 | 128.1.211.33, 255.255.255.128 | | | | | |
| 9 | 9.211.45.65/21 | | | | | |
| 10 | 223.224.225.226/25 | | | | | |

# Answers to Mask Analysis Problems

Table E-3 includes the answers to problems 1–10. The paragraphs following the table provide the explanations of each answer.

**Table E-3** Answers to Problems in This Appendix

| Problem Number | Problem | Network Bits | Subnet Bits | Host Bits | Number of Subnets in Network | Number of Hosts per Subnet |
|---|---|---|---|---|---|---|
| 1 | 10.66.5.99, 255.255.254.0 | 8 | 15 | 9 | $2^{15} = 32,768$ | $2^9 - 2 = 510$ |
| 2 | 172.16.203.42, 255.255.252.0 | 16 | 6 | 10 | $2^6 = 64$ | $2^{10} - 2 = 1022$ |
| 3 | 192.168.55.55, 255.255.255.224 | 24 | 3 | 5 | $2^3 = 8$ | $2^5 - 2 = 30$ |
| 4 | 10.22.55.87/30 | 8 | 22 | 2 | $2^{22} = 4,194,304$ | $2^2 - 2 = 2$ |
| 5 | 172.30.40.166/26 | 16 | 10 | 6 | $2^{10} = 1024$ | $2^6 - 2 = 62$ |
| 6 | 192.168.203.18/29 | 24 | 5 | 3 | $2^5 = 32$ | $2^3 - 2 = 6$ |
| 7 | 200.11.88.211, 255.255.255.240 | 24 | 4 | 4 | $2^4 = 16$ | $2^4 - 2 = 14$ |
| 8 | 128.1.211.33, 255.255.255.128 | 16 | 9 | 7 | $2^9 = 512$ | $2^7 - 2 = 126$ |
| 9 | 9.211.45.65/21 | 8 | 13 | 11 | $2^{13} = 8192$ | $2^{11} - 2 = 2046$ |
| 10 | 223.224.225.226/25 | 24 | 1 | 7 | $2^1 = 2$ | $2^7 - 2 = 126$ |

## Mask Analysis Problem 1: Answer

Address 10.66.5.99 is in Class A network 10.0.0.0, meaning that 8 network bits exist. Mask 255.255.254.0 converts to prefix /23, because the first two octets of value 255 represent 8 binary 1s, and the 254 in the third octet represents 7 binary 1s, for a total of 23 binary 1s. Therefore, the number of host bits is 32 – 23 = 9, leaving 15 subnet bits (32 – 8 network bits – 9 host bits = 15 subnet bits). The number of subnets in this Class A network, using mask 255.255.254.0, is $2^{15} = 32,768$. The number of hosts per subnet is $2^9 - 2 = 510$.

## Mask Analysis Problem 2: Answer

Address 172.16.203.42, mask 255.255.252.0, is in Class B network 172.16.0.0, meaning that 16 network bits exist. Mask 255.255.252.0 converts to prefix /22, because the first two octets of value 255 represent 8 binary 1s, and the 252 in the third octet represents 6 binary 1s, for a total of 22 binary 1s. Therefore, the number of host bits is 32 – 22 = 10, leaving 6 subnet bits (32 – 16 network bits – 10 host bits = 6 subnet bits). The number of subnets in this Class B network, using mask 255.255.252.0, is $2^6 = 64$. The number of hosts per subnet is $2^{10} - 2 = 1022$.

### Mask Analysis Problem 3: Answer

Address 192.168.55.55 is in Class C network 192.168.55.0, meaning that 24 network bits exist. Mask 255.255.255.224 converts to prefix /27, because the first three octets of value 255 represent 8 binary 1s, and the 224 in the fourth octet represents 3 binary 1s, for a total of 27 binary 1s. Therefore, the number of host bits is 32 – 27 = 5, leaving 3 subnet bits (32 – 24 network bits – 5 host bits = 3 subnet bits). The number of subnets in this Class C network, using mask 255.255.255.224, is $2^3 = 8$. The number of hosts per subnet is $2^5 – 2 = 30$.

### Mask Analysis Problem 4: Answer

Address 10.22.55.87 is in Class A network 10.0.0.0, meaning that 8 network bits exist. The prefix format mask of /30 lets you calculate the number of host bits as 32 – prefix length (in this case, 32 – 30 = 2). This leaves 22 subnet bits (32 – 8 network bits – 2 host bits = 22 subnet bits). The number of subnets in this Class A network, using mask 255.255.255.252, is $2^{22} = 4{,}194{,}304$. The number of hosts per subnet is $2^2 – 2 = 2$. (Note that this mask is popularly used on serial links, which need only two IP addresses in a subnet.)

### Mask Analysis Problem 5: Answer

Address 172.30.40.166 is in Class B network 172.30.0.0, meaning that 16 network bits exist. The prefix format mask of /26 lets you calculate the number of host bits as 32 – prefix length (in this case, 32 – 26 = 6). This leaves 10 subnet bits (32 – 16 network bits – 6 host bits = 10 subnet bits). The number of subnets in this Class B network, using mask /26, is $2^{10} = 1024$. The number of hosts per subnet is $2^6 – 2 = 62$.

### Mask Analysis Problem 6: Answer

Address 192.168.203.18 is in Class C network 192.168.203.0, meaning that 24 network bits exist. The prefix format mask of /29 lets you calculate the number of host bits as 32 – prefix length (in this case, 32 – 29 = 3). This leaves 5 subnet bits, because 32 – 24 network bits – 3 host bits = 5 subnet bits. The number of subnets in this Class C network, using mask /29, is $2^5 = 32$. The number of hosts per subnet is $2^3 – 2 = 6$.



### Mask Analysis Problem 7: Answer

Address 200.11.88.211 is in Class C network 200.11.88.0, meaning that 24 network bits exist. Mask 255.255.255.240 converts to prefix /28, because the first three octets of value 255 represent 8 binary 1s, and the 240 in the fourth octet represents 4 binary 1s, for a total of 28 binary 1s. This leaves 4 subnet bits (32 – 24 network bits – 4 host bits = 4 subnet bits). The number of subnets in this Class C network, using mask /28, is $2^4 = 16$. The number of hosts per subnet is $2^4 – 2 = 14$.

### Mask Analysis Problem 8: Answer

Address 128.1.211.33, mask 255.255.255.128, is in Class B network 128.1.0.0, meaning that 16 network bits exist. Mask 255.255.255.128 converts to prefix /25, because the first three octets of value 255 represent 8 binary 1s, and the 128 in the fourth octet represents 1 binary 1, for a total of 25 binary 1s. Therefore, the number of host bits is 32 – 25 = 7, leaving 9 subnet bits (32 – 16 network bits – 7 host bits = 9 subnet bits). The number of subnets in this Class B network, using mask 255.255.255.128, is $2^9$ = 512. The number of hosts per subnet is $2^7$ – 2 = 126.

### Mask Analysis Problem 9: Answer

Address 9.211.45.65 is in Class A network 10.0.0.0, meaning that 8 network bits exist. The prefix format mask of /21 lets you calculate the number of host bits as 32 – prefix length (in this case, 32 – 21 = 11). This leaves 13 subnet bits (32 – 8 network bits – 11 host bits = 13 subnet bits). The number of subnets in this Class A network, using mask /21, is $2^{13}$ = 8192. The number of hosts per subnet is $2^{11}$ – 2 = 2046.

### Mask Analysis Problem 10: Answer

Address 223.224.225.226 is in Class C network 223.224.225.0, meaning that 24 network bits exist. The prefix format mask of /25 lets you calculate the number of host bits as 32 – prefix length (in this case, 32 – 25 = 7). This leaves 1 subnet bit (32 – 24 network bits – 7 host bits = 1 subnet bit). The number of subnets in this Class C network, using mask /25, is $2^1$ = 2. The number of hosts per subnet is $2^7$ – 2 = 126.