**IPv4 Addressing**

1. Objectives

Part 1: Convert IPv4 Addresses from Dotted Decimal to Binary

Part 2: Use Bitwise ANDing Operation to Determine Network Addresses

1. Background / Scenario

Every IPv4 address is comprised of two parts: a network portion and a host portion. The network portion of an address is the same for all devices that reside in the same network. The host portion identifies a specific host within a given network. The subnet mask is used to determine the network portion of an IP address. Devices on the same network can communicate directly; devices on different networks require an intermediary Layer 3 device, such as a router, to communicate.

To understand the operation of devices on a network, we need to look at addresses the way devices do—in binary notation. To do this, we must convert the dotted decimal form of an IP address and its subnet mask to binary notation. After this has been done, we can use the bitwise ANDing operation to determine the network address.

This lab provides instructions on how to determine the network and host portion of IP addresses by converting addresses and subnet masks from dotted decimal to binary, and then using the bitwise ANDing operation. You will then apply this information to identify addresses in the network.

1. Convert IPv4 Addresses from Dotted Decimal to Binary

In Part 1, you will convert decimal numbers to their binary equivalent. After you have mastered this activity, you will convert IPv4 addresses and subnet masks from dotted decimal to their binary form.

Below you will be given several examples of IPv4 addresses and will complete tables with appropriate information.

Analyze the table shown below and identify the network portion and host portion of the given IPv4 addresses.

The first two rows show examples of how the table should be completed.

|  |  |  |  |
| --- | --- | --- | --- |
| IP Address/Prefix | Network/Host  N= Network  H= Host | Subnet Mask | Network Address |
| 192.168.10.10/24 | N.N.N.H | 255.255.255.0 | 192.168.10.0 |
| 10.101.99.17/23 | N.N.N.H | 255.255.254.0 | 10.101.99.0 |
| 209.165.200.227/27 | N.N.N.N | 255.255.255.224 | 209.165.200.0 |
| 172.31.45.252/24 | N.N.N.H | 255.255.255.0 | 172.31.45.0 |
| 10.1.8.200/26 | N.N.N.N | 255.255.255.192 | 10.1.8.0 |
| 172.16.117.77/20 | N.N.N.H | 255.255.240.0 | 172.16.177.0 |
| 10.1.1.101/25 | N.N.N.N | 255.255.255.128 | 10.1.1.0 |
| 209.165.202.140/27 | N.N.N.N | 255.255.255.224 | 209.165.202.0 |
| 192.168.28.45/28 | N.N.N.N | 255.255.255.240 | 192.168.28.0 |

Analyze the table below and list the range of host and broadcast addresses given a network/prefix mask pair.

The first row shows an example of how the table should be completed.

|  |  |  |  |
| --- | --- | --- | --- |
| IP Address/Prefix | First Host Address | Last Host Address | Broadcast Address |
| 192.168.10.10/24 | 192.168.10.1 | 192.168.10.254 | 192.168.10.255 |
| 10.101.99.17/23 | 10.101.99.1 | 10.101.99.254 | 10.101.99.255 |
| 209.165.200.227/27 | 209.165.200.1 | 209.165.200.254 | 209.165.200.255 |
| 172.31.45.252/24 | 172.31.45.1 | 172.31.45.254 | 172.31.45.255 |
| 10.1.8.200/26 | 10.1.8.1 | 10.1.8.254 | 10.1.8.255 |
| 172.16.117.77/20 | 172.16.117.1 | 172.16.117.254 | 172.16.117.255 |
| 10.1.1.101/25 | 10.1.1.1 | 10.1.1.254 | 10.1.1.255 |
| 209.165.202.140/27 | 209.165.202.1 | 209.165.202.254 | 209.165.202.255 |
| 192.168.28.45/28 | 192.168.28.1 | 192.168.28.254 | 192.168.28.255 |

Analyze the table shown below and identify the type of address (network, host, multicast(224.0.0.0 to 239.255.255.255), or broadcast address).

|  |  |  |
| --- | --- | --- |
| IP Address | Subnet Mask | Address Type |
| 10.1.1.1 | 255.255.255.252 | host |
| 192.168.33.63 | /26 | host |
| 239.192.1.100 | 255.252.0.0 | host |
| 172.25.12.52 | 255.255.255.0 | host |
| 10.255.0.0 | /8 | network |
| 172.16.128.48 | 255.255.255.240 | host |
| 209.165.202.159 | /27 | host |
| 172.16.0.255 | /16 | broadcast address |
| 224.10.1.11 | /24 | multicast |

Analyze the table shown below and identify the address as public or private.

|  |  |
| --- | --- |
| IP Address/Prefix | Public or Private |
| 209.165.201.30/27 | Public |
| 192.168.255.253/24 | Private |
| 10.100.11.103/16 | Private |
| 172.30.1.100/28 | Private |
| 192.31.7.11/24 | Public |
| 172.20.18.150/22 | Private |
| 128.107.10.1/16 | Public |
| 192.135.250.10/24 | Public |
| 64.104.0.11/16 | Public |

Analyze table below and identify whether the address/prefix pair is a valid host address.

|  |  |  |
| --- | --- | --- |
| IP Address/Prefix | Valid Host Address? | Reason |
| 127.1.0.10/24 | yes |  |
| 172.16.255.0/16 | no | Host address can not be zero |
| 241.19.10.100/24 | yes |  |
| 192.168.0.254/24 | yes |  |
| 192.31.7.255/24 | no | Host address can not be 255 |
| 64.102.255.255/14 | no | Host address can not be 255 |
| 224.0.0.5/16 | yes |  |
| 10.0.255.255/8 | no | Host address can not be 255 |
| 198.133.219.8/24 | yes |  |

Convert decimal numbers to their binary equivalent.

Fill in the following table by converting the decimal number to an 8-bit binary number. The first number has been completed for your reference. Recall that the eight binary bit values in an octet are based on the powers of 2, and from left to right are 128, 64, 32, 16, 8, 4, 2, and 1.

|  |  |
| --- | --- |
| Decimal | Binary |
| 192 | 11000000 |
| 168 | 10101000 |
| 10 | 00001010 |
| 255 | 11111111 |
| 2 | 00000010 |

Convert the IPv4 addresses to their binary equivalent.

An IPv4 address can be converted using the same technique you used above. Fill in the table below with the binary equivalent of the addresses provided. To make your answers easier to read, separate the binary octets with a period.

|  |  |
| --- | --- |
| Decimal | Binary |
| 192.168.10.10 | 11000000.10101000.00001010.00001010 |
| 209.165.200.229 | 11010001.10100101.11001000.11100101 |
| 172.16.18.183 | 10101100.00010000.00010010.10110111 |
| 10.86.252.17 | 00001010.01010110.11111100.00010001 |
| 255.255.255.128 | 11111111.11111111.11111111.10000000 |
| 255.255.192.0 | 11111111.11111111.11000000.00000000 |

1. Use Bitwise ANDing Operation to Determine Network Addresses

In Part 2, you will use the bitwise ANDing operation to calculate the network address for the provided host addresses. You will first need to convert an IPv4 decimal address and subnet mask to their binary equivalent. Once you have the binary form of the network address, convert it to its decimal form.

**Note**: The ANDing process compares the binary value in each bit position of the 32-bit host IP with the corresponding position in the 32-bit subnet mask. If there two 0s or a 0 and a 1, the ANDing result is 0. If there are two 1s, the result is a 1, as shown in the example here.

* 1. Determine the number of bits to use to calculate the network address.

|  |  |  |
| --- | --- | --- |
| Description | Decimal | Binary |
| IP Address | 192.168.10.131 | 1100 0000.1010 1000.0000 1010.1000 0011 |
| Subnet Mask | 255.255.255.192 | 1111 1111.1111 1111.1111 1111.1100 0000 |
| Network Address | 192.168.10.128 | 1100 0000.1010 1000.0000 1010.1000 0000 |

How do you determine what bits to use to calculate the network address?

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In the example above, how many bits are used to calculate the network address?

* 1. Use the ANDing operation to determine the network address.
     1. Enter the missing information into the table below:

|  |  |  |
| --- | --- | --- |
| Description | Decimal | Binary |
| IP Address | 172.16.145.29 | 1010 1100.0000 1000.1001 0001.0001 1101 |
| Subnet Mask | 255.255.0.0 | 1111 1111.1111 1111.0000 0000.0000 000 |
| Network Address | 172.16.0.0 | 1010 1100.0000 1000.0000 0000.0000 000 |

* + 1. Enter the missing information into the table below:

|  |  |  |
| --- | --- | --- |
| Description | Decimal | Binary |
| IP Address | 192.168.10.10 | 1100 0000.1010 1000.0000 1010.0000 1010 |
| Subnet Mask | 255.255.255.0 | 1111 1111.1111 1111.1111 1111.0000 0000 |
| Network Address | 192.168.10.0 | 1100 0000.1010 1000.0000 1010.0000 0000 |

* + 1. Enter the missing information into the table below:

|  |  |  |
| --- | --- | --- |
| Description | Decimal | Binary |
| IP Address | 192.168.68.210 | 1100 0000.1010 1000.01000100.1101 0010 |
| Subnet Mask | 255.255.255.128 | 1111 1111.1111 1111.1111 1111.1000 0000 |
| Network Address | 192.168.68.128 | 1100 0000.1010 1000.01000100.1000 0000 |

* + 1. Enter the missing information into the table below:

|  |  |  |
| --- | --- | --- |
| Description | Decimal | Binary |
| IP Address | 172.16.188.15 | 1010 1100.0000 1000.1011 1100.0000 1111 |
| Subnet Mask | 255.255.240.0 | 1111 1111.1111 1111.1111 0000.0000 0000 |
| Network Address | 172.16.176.000 | 1010 1100.0000 1000.1011 0000.0000 0000 |

* + 1. Enter the missing information into the table below:

|  |  |  |
| --- | --- | --- |
| Description | Decimal | Binary |
| IP Address | 10.172.2.8 | 0000 1010.1010 1100.0000 0010.0000 1000 |
| Subnet Mask | 255.224.0.0 | 1111 1111.1110 0000.0000 0000.0000 0000 |
| Network Address | 10.160.0.0 | 0000 1010.1010 0000.0000 0000.0000 0000 |