Lab – Converting IPv4 Addresses to Binary

1. Objectives

Part 1: Convert IPv4 Addresses from Dotted Decimal to Binary

Part 2: Use Bitwise ANDing Operation to Determine Network Addresses

Part 3: Apply Network Address Calculations

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.

* 1. 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 |  |
| 10 |  |
| 255 |  |
| 2 |  |

* 1. 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 |  |
| 172.16.18.183 |  |
| 10.86.252.17 |  |
| 255.255.255.128 |  |
| 255.255.192.0 |  |

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 | 11000000.10101000.00001010.10000011 |
| Subnet Mask | 255.255.255.192 | 11111111.11111111.11111111.11000000 |
| Network Address | 192.168.10.128 | 11000000.10101000.00001010.10000000 |

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 |  |
| Subnet Mask | 255.255.0.0 |  |
| Network Address |  |  |

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

|  |  |  |
| --- | --- | --- |
| Description | Decimal | Binary |
| IP Address | 192.168.10.10 |  |
| Subnet Mask | 255.255.255.0 |  |
| Network Address |  |  |

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

|  |  |  |
| --- | --- | --- |
| Description | Decimal | Binary |
| IP Address | 192.168.68.210 |  |
| Subnet Mask | 255.255.255.128 |  |
| Network Address |  |  |

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

|  |  |  |
| --- | --- | --- |
| Description | Decimal | Binary |
| IP Address | 172.16.188.15 |  |
| Subnet Mask | 255.255.240.0 |  |
| Network Address |  |  |

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

|  |  |  |
| --- | --- | --- |
| Description | Decimal | Binary |
| IP Address | 10.172.2.8 |  |
| Subnet Mask | 255.224.0.0 |  |
| Network Address |  |  |

1. Apply Network Address Calculations

In Part 3, you must calculate the network address for the given IP addresses and subnet masks. After you have the network address, you should be able to determine the responses needed to complete the lab.

* 1. Determine whether IP addresses are on same network.
     1. You are configuring two PCs for your network. PC-A is given an IP address of 192.168.1.18, and PC-B is given an IP address of 192.168.1.33. Both PCs receive a subnet mask of 255.255.255.240.

What is the network address for PC-A? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What is the network address for PC-B? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Will these PCs be able to communicate directly with each other? \_\_\_\_\_\_\_

What is the highest address that can be given to PC-B that allows it to be on the same network as PC-A?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* + 1. You are configuring two PCs for your network. PC-A is given an IP address of 10.0.0.16, and PC-B is given an IP address of 10.1.14.68. Both PCs receive a subnet mask of 255.254.0.0.

What is the network address for PC-A? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What is the network address for PC-B? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Will these PCs be able to communicate directly with each other? \_\_\_\_\_\_

What is the lowest address that can be given to PC-B that allows it to be on the same network as PC-A?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* 1. Identify the default gateway address.
     1. Your company has a policy to use the first IP address in a network as the default gateway address. A host on the local-area network (LAN) has an IP address of 172.16.140.24 and a subnet mask of 255.255.192.0.

What is the network address for this network?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What is the default gateway address for this host?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* + 1. Your company has a policy to use the first IP address in a network as the default gateway address. You have been instructed to configure a new server with an IP address of 192.168.184.227 and a subnet mask of 255.255.255.248.

What is the network address for this network?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What is the default gateway for this server?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Reflection

Why is the subnet mask important in determining the network address?

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\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_



**Packet Tracer – Subnet an IPv4 Network**

# Addressing Table

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Device** | **Interface** | **IP Address** | **Subnet Mask** | **Default Gateway** |
| CustomerRouter  *CustomerRouter*  *CustomerRouter* | G0/0 | *blank* | *blank* | N/A  *N/A*  *N/A* |
| G0/1 | *blank* | *blank* |
| S0/1/0 | 209.165.201.2 | 255.255.255.252 |
| LAN-A Switch | VLAN1 | *blank* | *blank* | *blank* |
| LAN-B Switch | VLAN1 | *blank* | *blank* | *blank* |
| PC-A | NIC | *blank* | *blank* | *blank* |
| PC-B | NIC | *blank* | *blank* | *blank* |
| ISPRouter  *ISPRouter* | G0/0 | 209.165.200.225 | 255.255.255.224 | N/A *N/A* |
| S0/1/0 | 209.165.201.1 | 255.255.255.252 |
| ISPSwitch | VLAN1 | 209.165.200.226 | 255.255.255.224 | 209.165.200.225 |
| ISP Workstation | NIC | 209.165.200.235 | 255.255.255.224 | 209.165.200.225 |
| ISP Server | NIC | 209.165.200.240 | 255.255.255.224 | 209.165.200.225 |

# Objectives

**Part 1: Design an IPv4 Network Subnetting Scheme**

**Part 2: Configure the Devices**

**Part 3: Test and Troubleshoot the Network**

# Background / Scenario

In this activity, you will subnet the Customer network into multiple subnets. The subnet scheme should be based on the number of host computers required in each subnet, as well as other network considerations, like future network host expansion.

After you have created a subnetting scheme and completed the table by filling in the missing host and interface IP addresses, you will configure the host PCs, switches and router interfaces.

After the network devices and host PCs have been configured, you will use the **ping** command to test for network connectivity.

# Instructions Part 1: Subnet the Assigned Network

**Step 1: Create a subnetting scheme that meets the required number of subnets and required number of host addresses.**

In this scenario, you are a network technician assigned to install a new network for a customer. You must create multiple subnets out of the 192.168.0.0/24 network address space to meet the following requirements: a. The first subnet is the LAN-A network. You need a minimum of 50 host IP addresses.

1. The second subnet is the LAN-B network. You need a minimum of 40 host IP addresses.
2. You also need at least two additional unused subnets for future network expansion.

**Note**: Variable length subnet masks will not be used. All of the device subnet masks should be the same length.

1. Answer the following questions to help create a subnetting scheme that meets the stated network requirements:

Questions:

How many host addresses are needed in the largest required subnet?

***Type your answers here.***

What is the minimum number of subnets required?

***Type your answers here.***

The network that you are tasked to subnet is 192.168.0.0/24. What is the /24 subnet mask in binary?

***Type your answers here.***

1. The subnet mask is made up of two portions, the network portion, and the host portion. This is represented in the binary by the ones and the zeros in the subnet mask.

Questions:

In the network mask, what do the ones represent?

***Type your answers here.***

In the network mask, what do the zeros represent?

***Type your answers here.***

1. To subnet a network, bits from the host portion of the original network mask are changed into subnet bits.

The number of subnet bits defines the number of subnets.

Questions:

Given each of the possible subnet masks depicted in the following binary format, how many subnets and how many hosts are created in each example?

**Hint**: Remember that the number of host bits (to the power of 2) defines the number of hosts per subnet

(minus 2), and the number of subnet bits (to the power of two) defines the number of subnets. The subnet bits (shown in bold) are the bits that have been borrowed beyond the original network mask of /24. The /24 is the prefix notation and corresponds to a dotted decimal mask of 255.255.255.0.

* 1. (/25) 11111111.11111111.11111111.**1**0000000 Dotted decimal subnet mask equivalent:

***Type your answers here.***

Number of subnets? Number of hosts?

***Type your answers here.***

* 1. (/26) 11111111.11111111.11111111.**11**000000 Dotted decimal subnet mask equivalent:

***Type your answers here.***

Number of subnets? Number of hosts?

***Type your answers here.***

* 1. (/27) 11111111.11111111.11111111.**111**00000 Dotted decimal subnet mask equivalent:

***Type yor answers here.***

Number of subnets? Number of hosts?

***Type your answers here.***

* 1. (/28) 11111111.11111111.11111111.**1111**0000 Dotted decimal subnet mask equivalent:

***Type your answers here.***

Number of subnets? Number of hosts?

***Type your answers here.***

* 1. (/29) 11111111.11111111.11111111.**11111**000 Dotted decimal subnet mask equivalent:

***Type your answers here.***

Number of subnets? Number of hosts?

***Type your answers here.***

* 1. (/30) 11111111.11111111.11111111.**111111**00 Dotted decimal subnet mask equivalent:

***Type your answers here.***

Number of subnets? Number of hosts?

***Type your answers here.***

Considering your answers above, which subnet masks meet the required number of minimum host addresses?

***Type your answers here.***

Considering your answers above, which subnet masks meets the minimum number of subnets required?

***Type your answers here.***

Considering your answers above, which subnet mask meets both the required minimum number of hosts and the minimum number of subnets required?

***Type your answers here.***

When you have determined which subnet mask meets all of the stated network requirements, derive each of the subnets. List the subnets from first to last in the table. Remember that the first subnet is 192.168.0.0 with the chosen subnet mask.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Subnet Address** |  | **Prefix** |  | **Subnet Mask** |
| ***blank*** | ***blank*** |  | ***blank*** |  |
| ***blank*** | ***blank*** |  | ***blank*** |  |
| ***blank*** | ***blank*** |  | ***blank*** |  |
| ***blank*** | ***blank*** |  | ***blank*** |  |

**Step 2: Fill in the missing IP addresses in the Addressing Table**

Assign IP addresses based on the following criteria: Use the ISP Network settings as an example. a. Assign the first subnet to LAN-A.

1. Use the first host address for the CustomerRouter interface connected to LAN-A switch.
2. Use the second host address for the LAN-A switch. Make sure to assign a default gateway address for the switch.
3. Use the last host address for PC-A. Make sure to assign a default gateway address for the PC. b. Assign the second subnet to LAN-B.
4. Use the first host address for the CustomerRouter interface connected to LAN-B switch.
5. Use the second host address for the LAN-B switch. Make sure to assign a default gateway address for the switch.
6. Use the last host address for PC-B. Make sure to assign a default gateway address for the PC.

# Part 2: Configure the Devices

Configure basic settings on the PCs, switches, and router. Refer to the Addressing Table for device names and address information.

**Step 1: Configure CustomerRouter.**

1. Set the enable secret password on CustomerRouter to **Class123**
2. Set the console login password to **Cisco123**.
3. Configure **CustomerRouter** as the hostname for the router.
4. Configure the G0/0 and G0/1 interfaces with IP addresses and subnet masks, and then enable them.
5. Save the running configuration to the startup configuration file.

**Step 2: Configure the two customer LAN switches.**

Configure the IP addresses on interface VLAN 1 on the two customer LAN switches. Make sure to configure the correct default gateway on each switch.

**Step 3: Configure the PC interfaces.**

Configure the IP address, subnet mask, and default gateway settings on **PC-A** and **PC-B**.

# Part 3: Test and Troubleshoot the Network

In Part 3, you will use the **ping** command to test network connectivity.

1. Determine if PC-A can communicate with its default gateway. Do you get a reply?

***Type your answers here.***

1. Determine if PC-B can communicate with its default gateway. Do you get a reply?

***Type your answers here.***

1. Determine if PC-A can communicate with PC-B. Do you get a reply?

***Type your answers here.***

If you answered “no” to any of the preceding questions, then you should go back and check your IP address and subnet mask configurations, and ensure that the default gateways have been correctly configured on PCA and PC-B.

*End of Document*