

Assignment: Subnet Calculations

Objective: This assignment aims to deepen your understanding of IP addressing and subnetting. This will help you start seeing how it is used in routing, which are fundamental concepts in networking and covered in your Kurose readings. By calculating subnets, you'll learn how to divide a network into smaller, more manageable parts, improving network performance and security.

This task will also give you practical experience with binary math, often used in subnet calculations. You'll become familiar with Classless Inter-Domain Routing (CIDR) notation, a compact way of representing IP addresses and their associated routing prefixes.

Ultimately, this hands-on experience will prepare you for real-world networking tasks common for network administrators. Yes, administrators still perform these calculations today!

Part 1: Introduction to subnets (very light refresher)

Subnet: A subnet, or subnetwork, is a smaller network within a more extensive network. It's like dividing a large piece of land into smaller plots. Each device (like your computer or phone) on the same subnet shares a common IP address prefix. Subnets help manage network traffic and enhance security by isolating groups of hosts.

Why Subnets Exist: Subnets exist for several reasons. They improve network performance by reducing congestion, as traffic can be confined to a smaller area. They enhance security by isolating sensitive devices or data on separate subnets. They also make IP address management more efficient, as addresses can be allocated to subnets based on need rather than on a flat, organization-wide basis.

CIDR Notation: Classless Inter-Domain Routing (CIDR) notation is a way to represent IP addresses and their associated network prefix. An IP address in CIDR notation looks like this: 192.168.1.0/24. The /24 is the subnet mask in CIDR notation, indicating that the first 24 bits are used for the network prefix, and the remaining 8 bits are used for host addresses within the network.

Read up on the RFC here: [RFC 4632 - Classless Inter-domain Routing \(CIDR\): The Internet Address Assignment and Aggregation Plan \(ietf.org\)](https://www.rfc-editor.org/rfc/rfc4632)

Part 2: The Steps

1. Identify the IP address and the subnet mask: An IP address in CIDR notation looks something like this: 192.168.1.0/24. The /24 at the end is the subnet mask.

Convert to Binary: Convert each octet of the IP address into binary. For example, 192 in binary is 11000000.

2. Calculate the number of host addresses: The number after the slash in the CIDR IP address is the number of bits used for the network address. Subtract this number from 32 (the total number of bits in an IPv4 address). Raise 2 to the power of the result to get the total number of host addresses in the subnet. For example, with 192.168.1.0/24, we subtract 24 from 32 to get 8, and 2^8 equals 256, so there are 256 host addresses in this subnet.

So, the subnet mask in binary would be:

11111111.11111111.11111111.00000000

3. Identify the Network Address: This is the first IP address in your range (where all host bits are set to zero).

The network address is the first address in your subnet. To calculate it, take your IP address and "AND" it with the subnet mask. "AND" in binary means if both corresponding bits are 1, the result is 1; otherwise, it's 0.

For example, with an IP address of 192.168.1.0 and a subnet mask of 255.255.255.0 (or /24 in CIDR notation), the network address is 192.168.1.0

```
IP:    11000000.10101000.00000001.00000000
Mask:  11111111.11111111.11111111.00000000
----- bitwise AND
      11000000.10101000.00000001.00000000
```

For more details on logic and discrete mathematics, see: [Discrete Mathematics and Its Applications, 8th ed.](#), by Kenneth H. Rosen, 2019

4. Identify Broadcast Address: This is the last IP address in your range (where all host bits are set to one).

To calculate it, take your network address and replace all host bits with 1s. For our example, this would be 192.168.1.255.

5. Find the range of host addresses: The range of host addresses in your subnet can be found by changing the host bits (the remaining bits after the network bits) all to 0 for the network address and all to 1 for the broadcast address (this is usually the last address in your subnet). The addresses in between these two are usable for hosts.

Calculate the First Usable Address: This is typically the network address plus one. For our example, this would be 192.168.1.1.

Calculate the Last Usable Address: This is typically the broadcast address minus one. This would be 192.168.1.254

So for our given IP address 192.168.1.0/24:

- The network address is 192.168.1.0
- The first usable address is 192.168.1.1
- The last usable address is 192.168.1.254
- The broadcast address is 192.168.1.255.

Remember that in a real-world scenario, the first and last addresses in a subnet (network and broadcast addresses) are typically not used for hosts.

Part 3: Run one more example. This time just the math

Let's use 208.88.227.94/25

1. Convert IP and Subnet Mask to Binary:

- IP: 208.88.227.94 in binary is 11010000.01011000.11100011.01011110.
- Subnet Mask: /25 means the first 25 bits are used for the network address, so the subnet mask in binary is 11111111.11111111.11111111.10000000 (or 255.255.255.128 in decimal).

2. Calculate Network Address:

- Perform a bitwise AND operation between the binary IP and the binary Subnet Mask.

```

IP:    11010000.01011000.11100011.01011110
Mask:  11111111.11111111.11111111.10000000
----- bitwise AND
      11010000.01011000.11100011.00000000
  
```

- Result: 11010000.01011000.11100011.00000000 (or 208.88.227.0 in decimal).

3. Calculate Broadcast Address:

- Replace all host bits of the network address with 1s.

Network Bits
Host Bits

IP: [11010000.01011000.11100011.0][0000000]

Set host bits to 1s:

[11010000.01011000.11100011.0][1111111]

- Result: 11010000.01011000.11100011.01111111 (or 208.88.227.127 in decimal).

4. Calculate First Usable Address:

- Add one to the host part of the network address.
- Result: 11010000.01011000.11100011.00000001 (or 208.88.227.1 in decimal).

5. Calculate Last Usable Address:

- Subtract one from the host part of the broadcast address.
- Result: 11010000.01011000.11100011.01111110 (or 208.88.227.126 in decimal).

For our given IP address 208.88.227.94/25:

- The network address is 208.88.227.0
- The first usable address is 208.88.227.1
- The last usable address is 208.88.227.126
- The broadcast address is 208.88.227.127

Part 4: Your Turn!

Click the Google Form link within the assignment on BrightSpace. Consent for us to send you an e-mail, and you will receive your set of subnet problems to solve.

You will be given a target IP (an address within the subnet) in CIDR notation.

Download the Python file (do not change the name) and fill in the answers for each of your problems. Once done, go to Gradescope and submit your answer under the "Lab: Network Subnets".