

Exploration: IP CIDR Addressing and Subnets

Introduction



This lecture will focus on internet addressing and configuration. Recall from our last exploration that IP addresses contain both a network address and a host number. Where do they come from?

In a typical scenario, an ISP will get a “block” of addresses from ICANN, for example: 200.23.16.0/20. The ISP's block can be shown as follows:

11001000 00010111 00010000 00000000

The /20 means that the first 20 bits specify the network address (underlined). Therefore the remaining 12 bits can be used for host numbers. These 12 bits would allow for 2^{12} (4096) IP addresses that can be used as host addresses, ranging from 0 to 4095 [0000 00000000 ... 1111 11111111]. Recall that a host address (IP address) is a network address combined with a host number. Note that 2 addresses are always reserved. In our example, 200.23.16.0 is the network address, and 200.23.31.255 is reserved as a “broadcast” address. Neither of these can be assigned to a host. With these restrictions, our host addresses for the example range from 200.23.16.1 to 200.23.31.254:

from 11001000 00010111 00010000 00000001

to 11001000 00010111 00011111 11111110

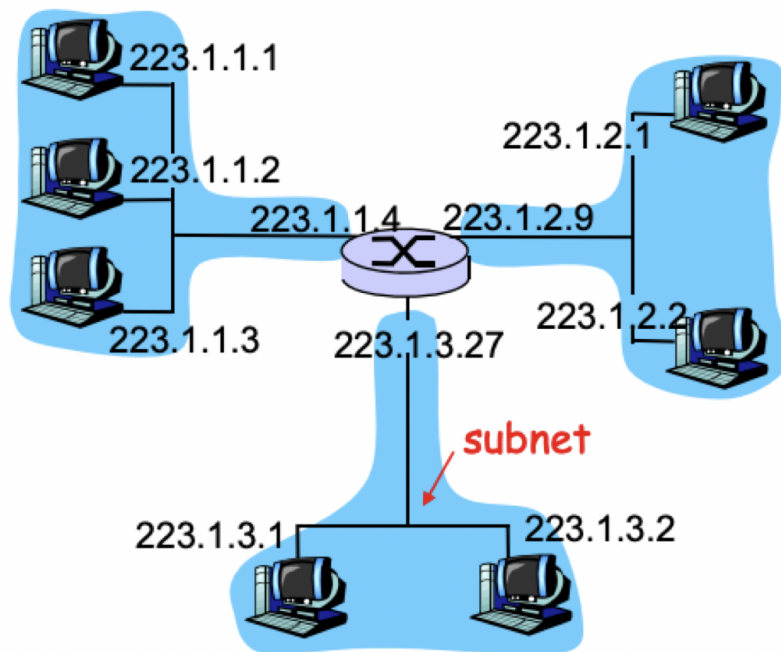
Subnets

An ISP can also create subnets with their block of addresses. But what is a subnet?

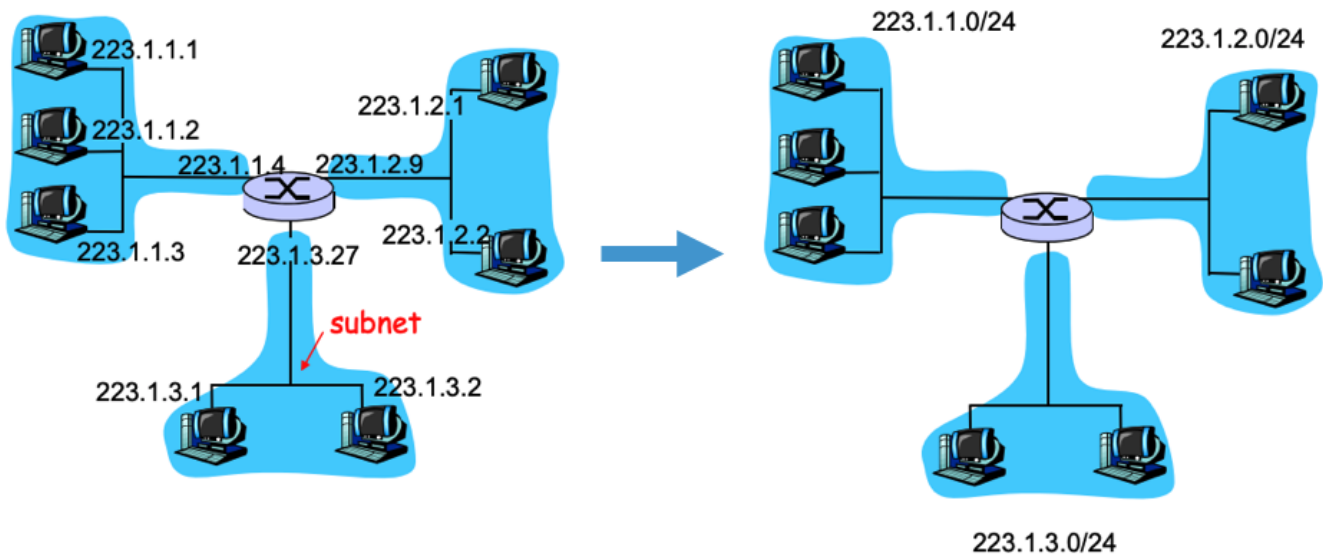
Definition

A subnet is a network where *all interfaces have the same IP address prefix* and can communicate with each other *without using a router*.

In the following diagram, there are subnets. See if you can apply the definition to say how many?



If you said 3 subnets, you are correct! The subnets are shown on the right along with the /x prefix.



How does an ISP create subnets?

First the ISP will get a “block” of addresses from ICANN

ISP's block 11001000 00010111 00010000 00000000
 200.23.16.0/20

From this, the ISP can create subnets. In this example, each subnet gets 256 IP addresses

Organization 0 11001000 00010111 00010000 00000000
 200.23.16.0/24
 IP addresses from 200.23.16.1 to 200.23.16.254

```

Organization 1 11001000 00010111 00010010 00000000
200.23.18.0/24
  IP addresses from 200.23.18.1 to 200.23.18.254
Organization 2 11001000 00010111 00010100 00000000
200.23.20.0/24
  IP addresses from 200.23.20.1 to 200.23.20.254
...
Organization 7 11001000 00010111 00011110 00000000
200.23.30.0/24
  IP addresses from 200.23.30.1 to 200.23.30.254

```

How many /24 subnets are possible in this example?

- 4 bits of freedom: [0000 ... 1111] (16 combinations)
- 16 possible subnets, each controls 254 host addresses
- Extracting the network address from an IP address

Extracting the network address from an IP address

Routers need network addresses for forwarding. The first /x bits of any IP address is often called the *prefix*. A *netmask* is all 1's in the first x bits, and all zeros in the rest of the 32 bits. When the IP address is bit-wise AND'd with the netmask, we obtain the network address:

```

Example: 200.23.21.170/20
  address in binary: 11001000 00010111 00010101 10101010
  netmask:          11111111 11111111 11110000 00000000
  bit-wise AND:     11001000 00010111 00010000 00000000
  network address:  200.23.16.0
  netmask:          255.255.240.0

```

Routers can then use network address for longest prefix match in their routing table.

Extracting the host number from an IP address

The local network admin needs the host number for an IP address with /x prefix. The last (32 – x) bits of any IP address is often called the *suffix*. The hostmask is all zeros in the first x bits, and all 1's in the rest of the bits.

```

Example: 200.23.21.170/20
  address in binary: 11001000 00010111 00010101 10101010
  hostmask:          00000000 00000000 00001111 11111111
  bit-wise AND:     00000000 00000000 00000101 10101010
  host number:      1450

```

Routers can then use network address for longest prefix match in their routing table.

CIDR (Classless Inter-Domain Routing)

CIDR routing takes advantage of all the previous methods of extracting info from an IP address. A CIDR address includes the /x specification for the number of bits to use for the netmask.

Example: host address 128.193.47.25/22

10000000 11000001 00101111 00011001

What is the netmask?

255.255.252.0

11111111 11111111 11111100 00000000

What is the network address?

Host address: 10000000 11000001 00101111 00011001

Bit-wise AND w/netmask: 11111111 11111111 11111100 00000000

Network address: 10000000 11000001 00101100 00000000

Network address: 128.193.44.0

What is the hostmask?

0.0.3.255 00000000 00000000 00000011 11111111

What is the host number?

Host address: 10000000 11000001 00101111 00011001

Bit-wise AND w/hostmask: 00000000 00000000 00000011 11111111

Host number: 00000000 00000000 00000011 00011001

Host number: 793 (decimal)

For more on subnets and CIDR, be sure to watch the video lecture, and then test your knowledge with the Self-Check exercises below.

Video Lecture

Internet Addressing



CS 372 Lecture
The Internet Protocol

- Classless addressing
- Subnetting
- Classless Inter-Domain Routing (CIDR)

Note: Many of the lecture slides are based on presentations that accompany *Computer Networking: A Top Down Approach*, 6th edition, by Jim Kurose & Keith Ross, Addison-Wesley, 2013.

Oregon State University

0:00 / 11:47

([PDF \(https://oregonstate.instructure.com/courses/1798856/files/83165057/download?wrap=1\)](https://oregonstate.instructure.com/courses/1798856/files/83165057/download?wrap=1) )

(<https://oregonstate.instructure.com/courses/1798856/files/83165057/download?wrap=1>) **PPT**

(<https://oregonstate.instructure.com/courses/1798856/files/83165093/download?wrap=1>) 

(<https://oregonstate.instructure.com/courses/1798856/files/83165093/download?wrap=1>)

Self-Check Exercises

What is a subnet?

 Turn

Card 1 of 6




Given the network address “block” **128.193.0.0 /16**. Suppose that we want to split all of
the addresses into 4 equal-sized subnets.

What are the network addresses of each subnet?

 Turn

Card 1 of 3



 Reuse  Embed



Resources

- **Wikipedia: Classless Inter-Domain Routing** [_\(https://en.wikipedia.org/wiki/Classless_Inter-Domain_Routing\)_](https://en.wikipedia.org/wiki/Classless_Inter-Domain_Routing)
“Classless Inter-Domain Routing.” In Wikipedia, March 1, 2020. https://en.wikipedia.org/w/index.php?title=Classless_Inter-

