Subnetting

Practical 4

UCD School of Computer Science

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IPv4 address space

- The 32-bit IP address is grouped 8 bits $\rightarrow$ each group of 8 bits is an octet. Each of the four octets is separated by a dot, and represented in decimal format, this is known as dotted decimal notation.
  - For example: `10.0.2.10`
- The total number of addresses: $2^{32} = 4,294,967,296$ IPv4 addresses $\rightarrow$ still lower than Earth's population (≈ 7 billions)

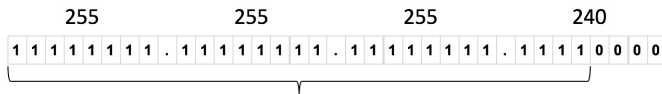# History - Class-based-subnet (Used before 1993 and is now deprecated
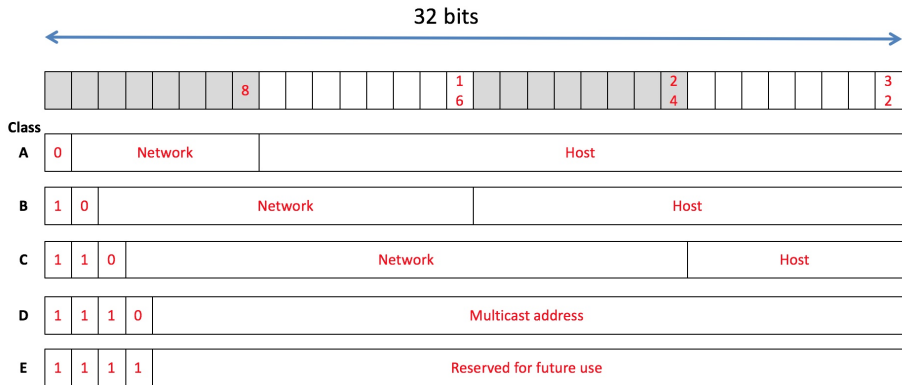
Subnetting

- Divide a network into sub-networks. For example, UCD has one network but many sub-networks for different schools.
- The netmask splits the IP address into:
    - Network-prefix (Network ID)
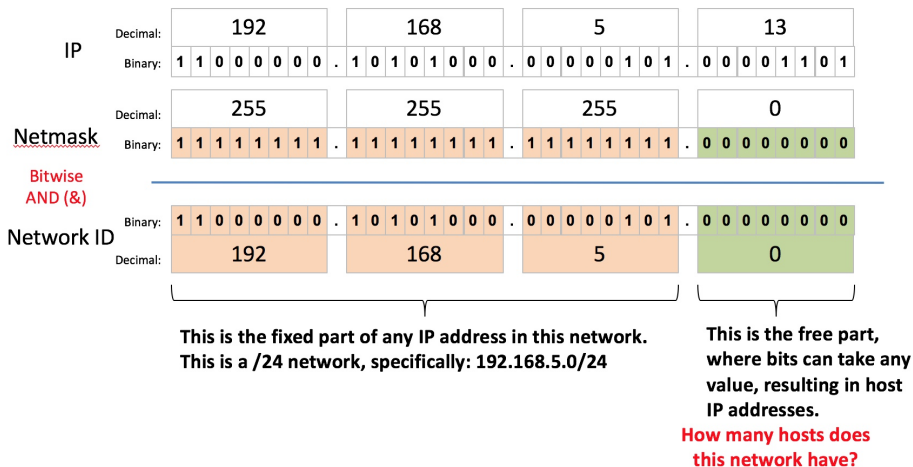   - Host-number (Host ID)

CIDR - Classless Inter-Domain Routing

- Why it exists:
  - The 8-bit address boundary had lack of vision
  - E.g. Class B networks are too big, i.e., 65535 hosts
  - In CIDR, the address space can be allocated to Internet Providers and end-users on any address bit boundary using netmasks.
- Netmask (Network mask):
  - 32 bit long
  - Used to specify
    - How many bits from IP address define the network ID / How many bits from IP address are used for Host IDs?
- For example

255	255	255	240
1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1	1 1 1 1 0 0 0 0

In this example, there are 28 bits of "1" and 4 bits of "0". So, it is said that this is a /28 network.

This is the fixed part of any IP address in this network.
This is a /24 network, specifically: 192.168.5.0/24

This is the free part, where bits can take any value, resulting in host IP addresses.

How many hosts does this network have?

Example: 192.168.5.0/24

In network 192.168.5.0/24,
there are 254 hosts:
$2^{(32-24)} - 2 = 2^8 - 2 = 256 - 2 = 254$ hosts,
And the broadcast address is 192.168.5.255

Network ID
Binary: 1 1 0 0 0 0 0 0 . 1 0 1 0 1 0 0 0 . 0 0 0 0 0 1 0 1 . 0 0 0 0 0 0 0 0
Decimal: 192 . 168 . 5 . 0

First host's address
Binary: 1 1 0 0 0 0 0 0 . 1 0 1 0 1 0 0 0 . 0 0 0 0 0 1 0 1 . 0 0 0 0 0 0 0 1
Decimal: 192 . 168 . 5 . 1

Other hosts
Binary: 1 1 0 0 0 0 0 0 . 1 0 1 0 1 0 0 0 . 0 0 0 0 0 1 0 1 . x x x x x x x x
Decimal: 192 . 168 . 5 . 2 to 253

Last host's address
Binary: 1 1 0 0 0 0 0 0 . 1 0 1 0 1 0 0 0 . 0 0 0 0 0 1 0 1 . 1 1 1 1 1 1 1 0
Decimal: 192 . 168 . 5 . 254

Subnetting: Number of hosts

- If your network has a `/n` (with `n < 31`), then:
  - There are $2^{32-n} - 2$ hosts (or usable IP addresses).
  - Why n should be less than 31 ?
  - What if n = 32 ?

Reversed range

- The following IP Address ranges are not used over the Internet, but valid in local network
  - `10.0.0.0 - 10.255.255.255`
  - `172.16.0.0 - 172.31.255.255`
  - `192.168.0.0 - 192.168.255.255`
  - `127.0.0.0 - 127.255.255.255`

IPv6

- Solution to the scarce IPv4 address domain
- Addresses are on 128 bits
- Total number of IPv6 addresses:
    - $2^{128} = 340, 282, 366, 920, 938, 463, 463, 374, 607, 431, 768, 211, 456$
    - More than enough for anybody on the Earth to own multiple IP addresses.
    - Internet of Things (IoT) will use a lot of these IPv6 addresses.

There are 21 of "1"s in this netmask!

IP
&
Netmask

| Decimal: | 192 | 168 | 153 | 33 |

Binary:

Network ID

Hosts
(range)

Exercises - Try it on your own

- This exercise for your free time you don't have to submit it. Please determine:
  - Network ID
  - Host Range (First hosts address to Last hosts address)
  - The number of maximum usable address
  - Broadcast address

1. 10.234.171.0/27
2. 10.79.63.0/29
3. 172.22.173.118/20
4. 10.63.113.33/17
5. 172.22.29.40/17
6. 192.168.56.192/28

- For more exercise, please check:
  https://www.subnetting.net/Subnetting.aspx?mode=practice

ENJOY !!!