

Lesson 06-03: IPv4 and NAT

CS 356 Computer Networks

Mikyung Han

mhan@cs.utexas.edu

Example Protocols

Responsible for

Internet Reference Model



FTP, HTTP, SMTP

Application

application specific needs

TCP, UDP

Transport

process to process data transfer

IP

Network

host to host data transfer across different network

Ethernet, WiFi

Link

data transfer between physically adjacent nodes

802.3 PHY

Physical

bit-by-bit or symbol-by-symbol delivery

Outline

I. IPv4 Address Format

IP's **C**lassless **I**nter**D**omain **R**outing notation has 2 parts

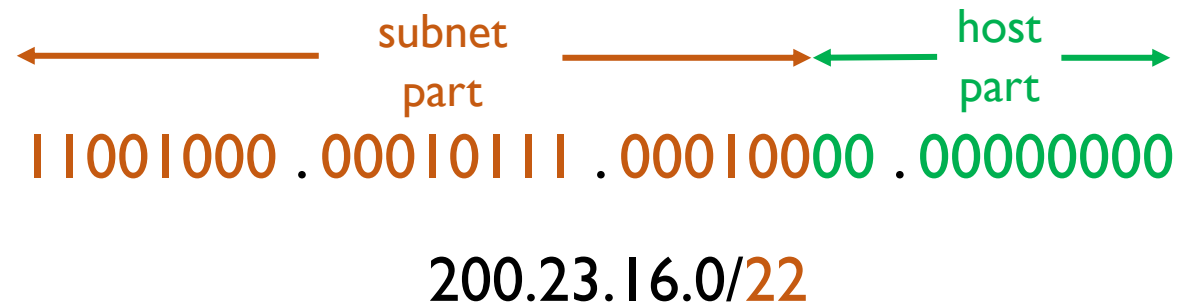
a.b.c.d/**x**

- **subnet** portion: **x** bit
- **host** portion: $32 - x$ bit
- each dot separates 8 bits



200.23.16.0/22

Subnet with 22-bit prefix example



- How many interfaces can this subnet have?
- Does 200.23.18.25 belong to this subnet?
- How about 200.23.20.25?
- What is the smallest IP address that belongs to this subnet?
- What is the largest IP address?

Outline

I. IPv4 Address Format

 2. How to obtain an IP address

How do we get an IP address?

- Q1: How to obtain subnet portion IP address?
- Q2: How to obtain host portion IP address?
 - Manual: hard-coded by sysadmin
 - Automatic: via DHCP

All 4 DHCP messages are **broadcast**

DHCP server: 223.1.2.5



DHCP discover

Broadcast: is there a DHCP server out there?

Arriving client



DHCP offer

Broadcast: I'm a DHCP server! Here's an IP address you can use

DHCP request

Broadcast: OK. I would like to use this IP address!

DHCP ACK

Broadcast: OK. You've got that IP address!

The two steps above can be skipped "if a client remembers and wishes to reuse a previously allocated network address" [RFC 2131]

What else the arriving client need?

- DNS server's IP address
- Subnet mask (ex, 23 bit 1's followed by 9 bit 0's for 23-bit subnet)
- Gateway router (first-hop router to get out of this subnet)

T/F DHCP uses TCP as underlying protocol

False! DHCP uses UDP

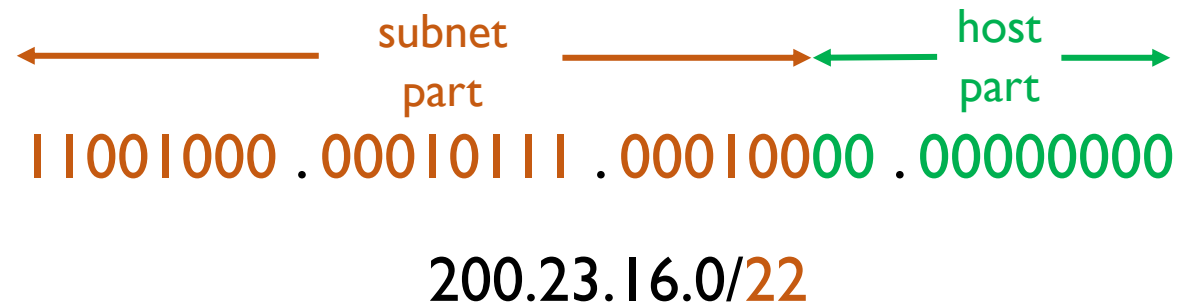
How do we get an IP address?

- Q1: How to obtain subnet portion IP address?
- Q2: How to obtain host portion IP address?

ICANN: Internet Corporation for Assigned Names and Numbers

- ICANN allocates to 5 regional registries
- Regional registries allocate to local registries
- Eventually comes down to each ISP with an allocated subnet address
- ISP can further divide its subnet to multiple smaller subnets and sell to smaller organizations

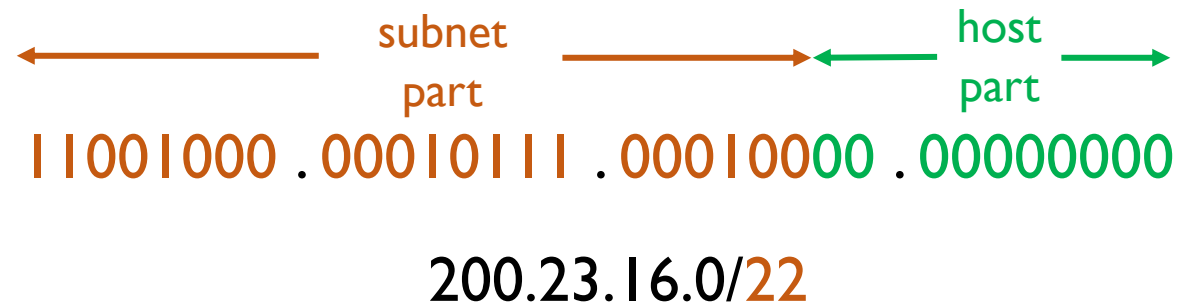
Sub-dividing a subnet with 22-bit prefix example



3 organization with below needs

- Org 1: minimum host of 300
- Org 2: minimum host of 200
- Org 3: minimum host of 60

Sub-dividing a subnet with 22-bit prefix example



Find the nearest power of 2 that is greater than the minimum

- Org 1: ~~minimum host of 300 512~~
- Org 2: ~~minimum host of 200 256~~
- Org 3: ~~minimum host of 60 64~~

Sub-dividing a subnet with 22-bit prefix example

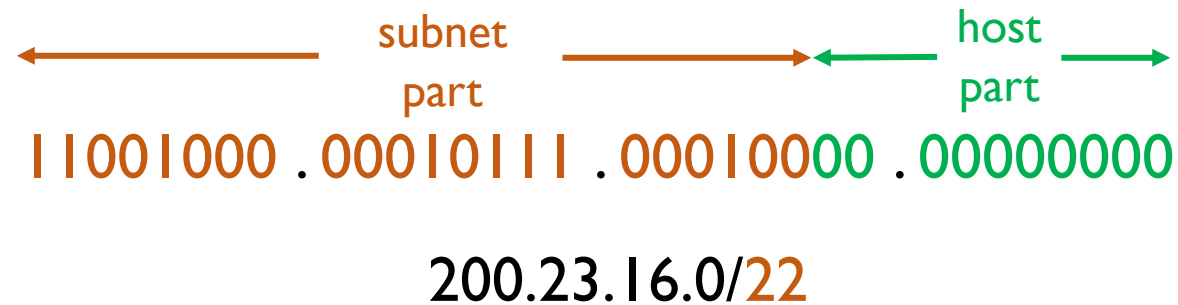


Figure out the num bit needed for the new subnet

- Org 1: $512 \rightarrow 2^9 \rightarrow 32-9 = 23$ -bit prefix subnet
- Org 2: $256 \rightarrow 2^8 \rightarrow 32-8 = 24$ -bit
- Org 3: $64 \rightarrow 2^6 \rightarrow 32-6 = 26$ -bit

Org 1: 23-bit prefix subnet

original 200.23.16.0/22 11001000 . 00010111 . 00010000 . 00000000

org1 200.23.16.0/23 11001000 . 00010111 . 00010000 . 00000000

Find out min and max IP address based on prefix

In-class Exercise

Org 1	200.23.16.0/22	11001000 . 00010111 . 00010000 . 00000000 11001000 . 00010111 . 00010011 . 11111111
Org 2	200.23.20.0/22	11001000 . 00010111 . 00010100 . 00000000 11001000 . 00010111 . 00010111 . 11111111
Org 3	200.23.24.0/22	11001000 . 00010111 . 00011000 . 00000000 11001000 . 00010111 . 00011011 . 11111111
Org 3	200.23.28.0/22	11001000 . 00010111 . 00011100 . 00000000 11001000 . 00010111 . 00011111 . 11111111

In-class Exercise

200.23.16.0/20 11001000 . 00010111 . 00010000 . 00000000
 11001000 . 00010111 . 00011111 . 11111111

Org 1: 23-bit prefix subnet

original	200.23.16.0/22	11001000 . 00010111 . 00010000 . 00000000
org1	200.23.16.0/23	11001000 . 00010111 . 00010000 . 00000000
	200.23.17.255/23	11001000 . 00010111 . 00010001 . 11111111

Find out min and max IP address based on prefix

- Org 1: 23-bit subnet from 200.23.16.0/23 ~ 200.23.17.255/23

Org 2: 24-bit prefix subnet

original	200.23.16.0/22	11001000 . 00010111 . 00010000 . 00000000
org1	200.23.16.0/23	11001000 . 00010111 . 00010000 . 00000000
	200.23.17.255/23	11001000 . 00010111 . 00010001 . 11111111
org2	200.23.18.0/24	11001000 . 00010111 . 00010010 . 00000000
	200.23.18.255/24	11001000 . 00010111 . 00010010 . 11111111

Find out min and max IP address based on prefix

- Org 1: 23-bit subnet from 200.23.16.0/23 ~ 200.23.17.255/23
- Org 2: 24-bit subnet from 200.23.18.0/24 ~ 200.23.18.255/24

Org 3: 26-bit prefix subnet

original	200.23.16.0/22	11001000 . 00010111 . 00010000 . 00000000
org1	200.23.16.0/23	11001000 . 00010111 . 00010000 . 00000000
	200.23.17.255/23	11001000 . 00010111 . 00010001 . 11111111
org2	200.23.18.0/24	11001000 . 00010111 . 00010010 . 00000000
	200.23.18.255/24	11001000 . 00010111 . 00010010 . 11111111
org3	200.23.19.0/26	11001000 . 00010111 . 00010011 . 00000000
	200.23.19.63/26	11001000 . 00010111 . 00010011 . 00111111

Find out min and max IP address based on prefix

- Org 1: 23-bit subnet from 200.23.16.0/23 ~ 200.23.17.255/23
- Org 2: 24-bit subnet from 200.23.18.0/24 ~ 200.23.18.255/24
- Org 3: 26-bit subnet from 200.23.19.0/26 ~ 200.23.19.63/26

Acknowledgements

Slides are adopted from Kurose' Computer Networking Slides

Sub-dividing a subnet with 18-bit prefix example

original	192.168.64.0/18	11000000 . 10101000 . 01000000 . 00000000
org1	192.168.64.0/24	11000000 . 10101000 . 01000000 . 00000000
	192.168.64.255/24	11000000 . 10101000 . 01000000 . 11111111
org2	192.168.65.0/25	11000000 . 10101000 . 01000001 . 00000000
	192.168.65.127/25	11000000 . 10101000 . 01000001 . 01111111
org3	192.168.65.128/27	11000000 . 10101000 . 01000001 . 10000000
	192.168.65.159/27	11000000 . 10101000 . 01000001 . 10011111

3 organization with below needs

- Org 1: min 200 → 256 (24-bit subnet)
- Org 2: min 100 → 128 (25-bit subnet)
- Org 3: min 30 → 32 (27-bit subnet)