Lesson 06-03: IPv4 Recap

CS 356 Computer Networks

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Internet Reference Model

Example Protocols		Responsible for
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

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Outline

1. IPv4 Address Format

IP's Classless InterDomain Routing Notation

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

200.23.16.0/22

- 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?

In-class Exercise!

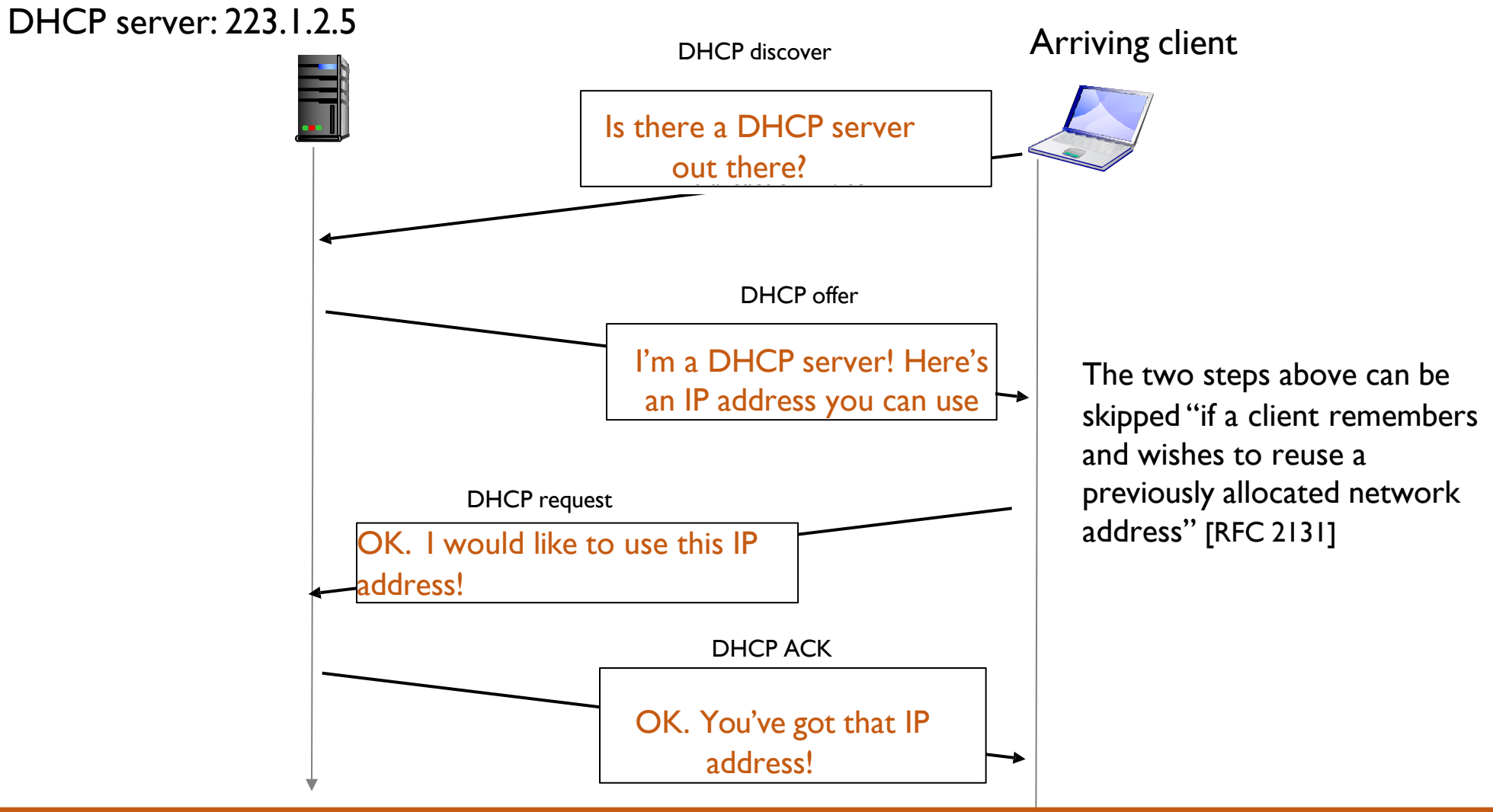
Outline

1. 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 Dynamic Host Config Protocol (DHCP)

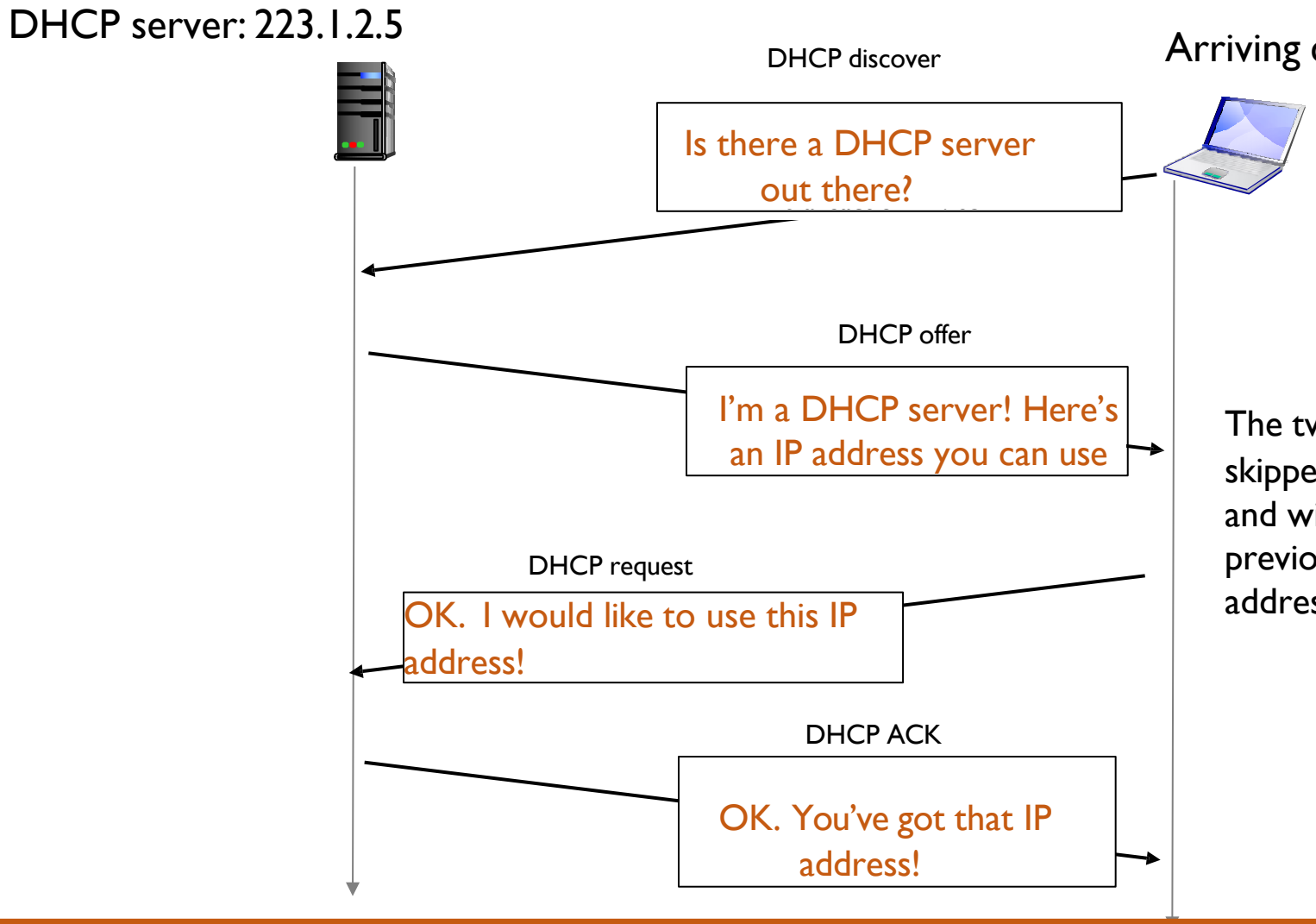
How DHCP messages work



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

False! Why?

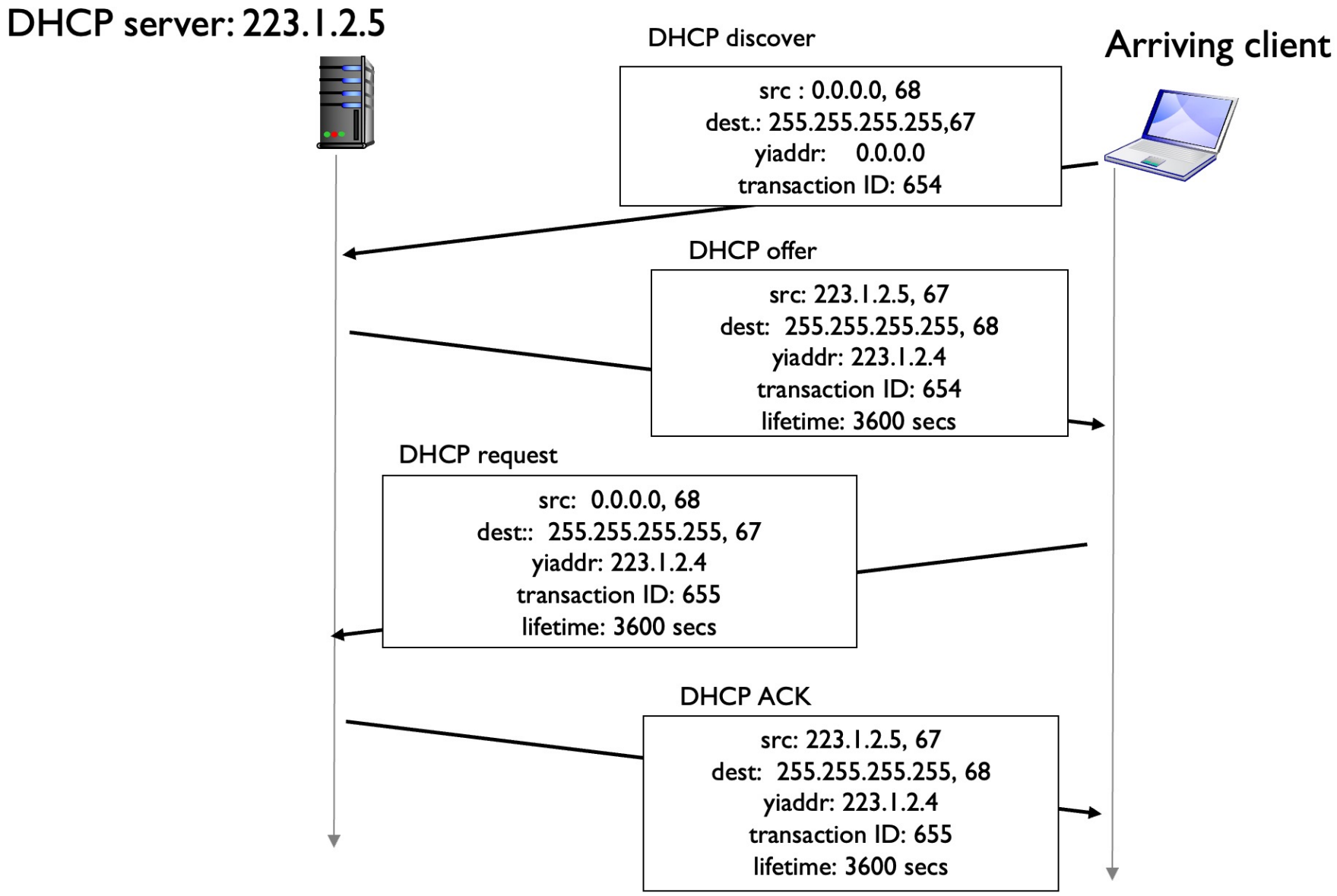
Which DHCP messages MUST be a broadcast?



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

Why the last two are also broadcast?

What actual DHCP messages would look like



What else the arriving client need?

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

T/F DHCP uses TCP as underlying protocol

False! DHCP uses UDP

Why?

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

In-class Exercise!

How to divide the original subnet into 4 equal-size smaller subnets?

Original 200.23.16.0/20 11001000 . 00010111 . 00010000 . 00000000

How many additional bits needed to distinguish 4 new subnets?

The new smaller subnets needs 22 bits for subnet!

Original	200.23.16.0/20	11001000 . 00010111 . 00010000 . 00000000
Org 1	200.23.16.0/22	11001000 . 00010111 . 00010000 . 00000000
Org 2	200.23.20.0/22	11001000 . 00010111 . 00010100 . 00000000
Org 3	200.23.24.0/22	11001000 . 00010111 . 00011000 . 00000000
Org 4	200.23.28.0/22	11001000 . 00010111 . 00011100 . 00000000

Each org has 2^10 hosts addresses

How about sub-dividing existing subnet into different size smaller subnets?

Sub-dividing a subnet with 22-bit prefix example

200.23.16.0/22

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 → 2^9 → 32-9 = 23-bit prefix subnet
- Org 2: 256 → 2^8 → 32-8 = 24-bit
- Org 3: 64 → 2^6 → 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

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: min100 → 128 (25-bit subnet)
- Org 3: min 30 → 32 (27-bit subnet)