


Computer Networks

CMSC 417 : Spring 2024

COMPUTER SCIENCE
UNIVERSITY OF MARYLAND

Topic: Internetworking: CIDR, DHCP, NAT, ARP (Textbook chapter 3)

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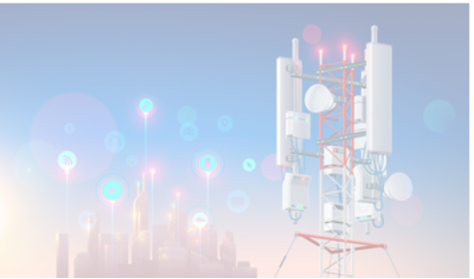
Tu-Th 2:00-3:15pm
CSI 2117

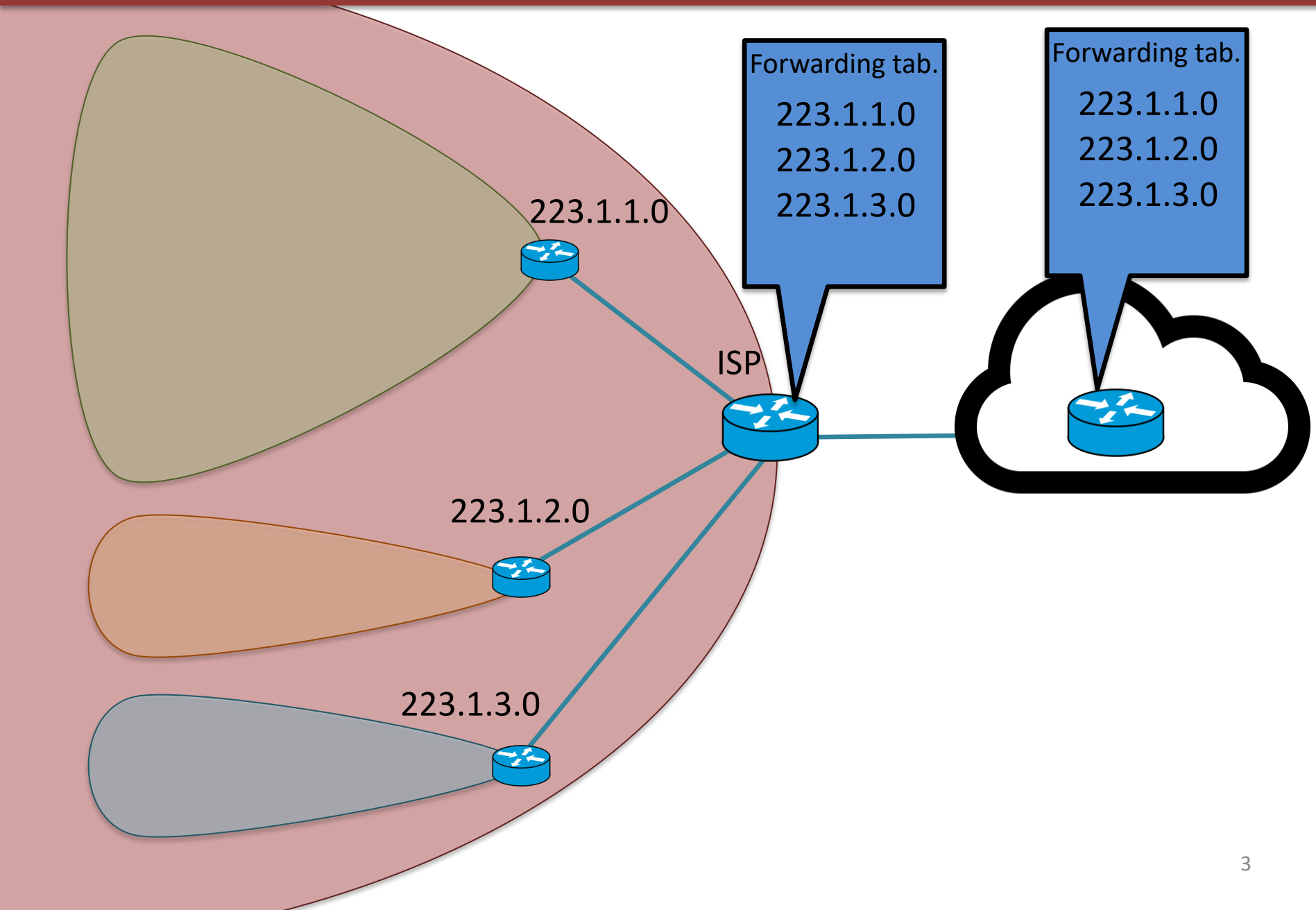
Feb 27th, 2024




Class-less Interdomain Routing (CIDR)

Generalizes the ideas of subnetting

Lessons learned from subnetting



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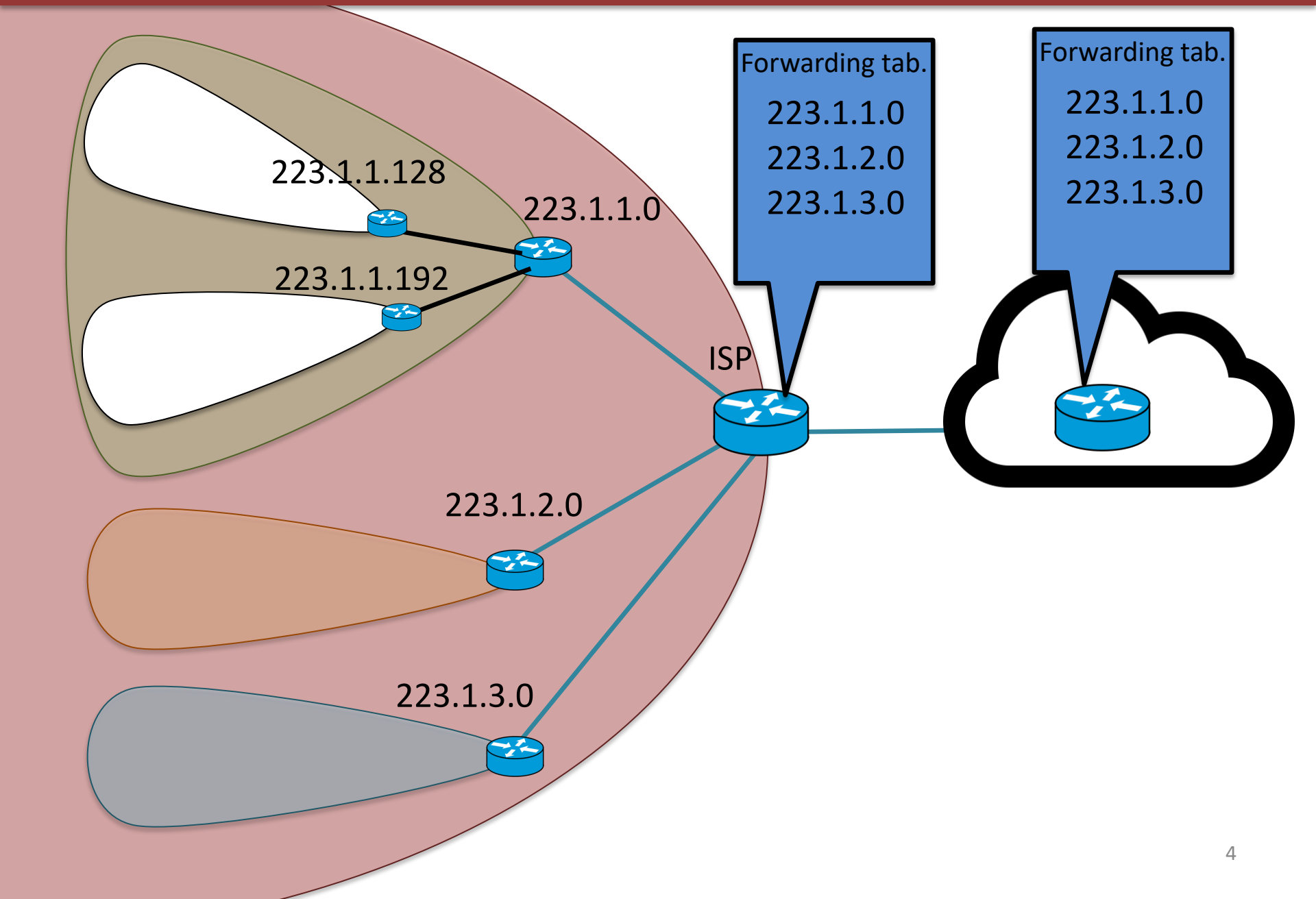

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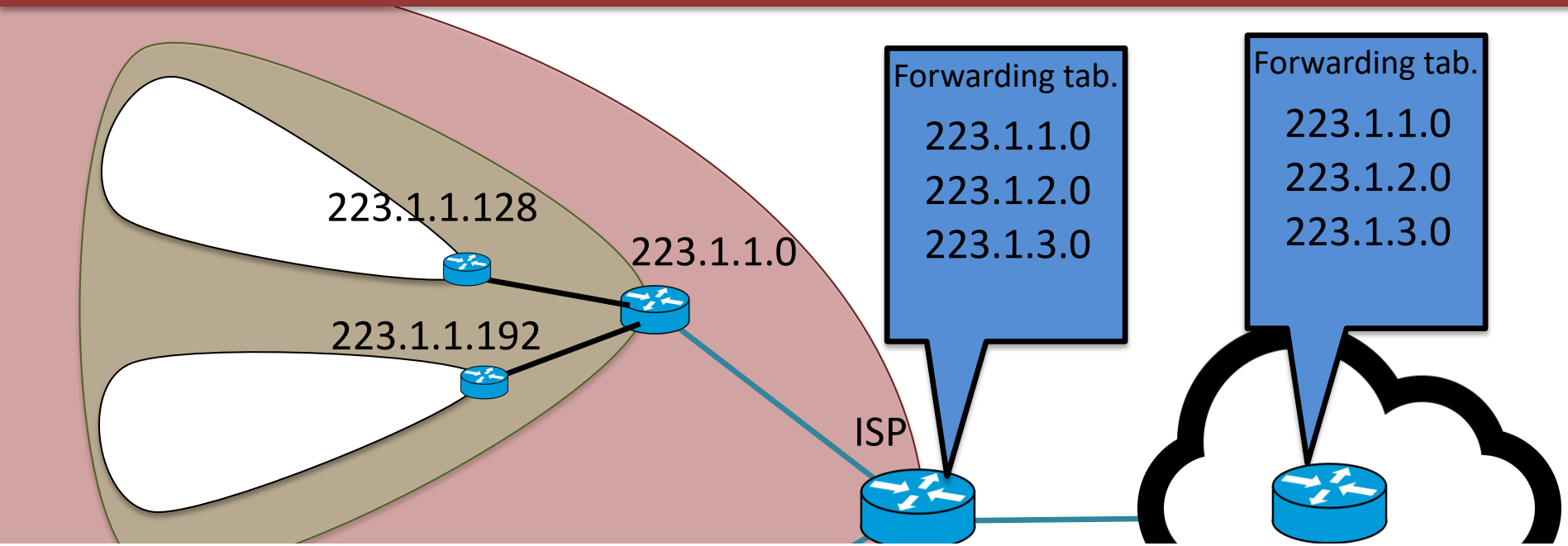


Lesson 1:

Address classes are not needed. Mask can define the number of bits for the network part.

Lesson 2:

Network hierarchies can be hidden from the outside world.

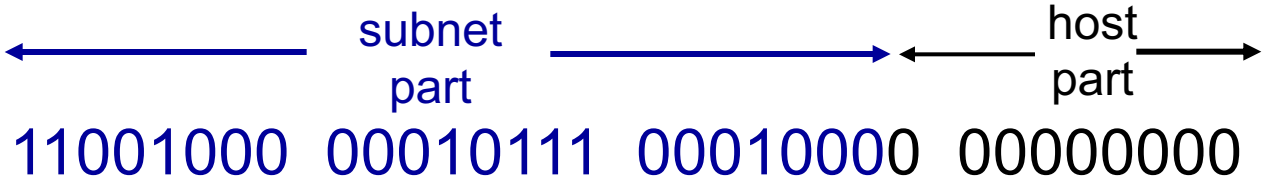
Network addresses can be aggregated/summarized/combined

CIDR: Classless address

IP addressing: CIDR

CIDR: Classless InterDomain Routing

- Network portion of address of arbitrary length
- address format: a.b.c.d/x, where x is # bits in subnet portion of address



200.23.16.0/23

200.23.16.0–200.23.17.255

This X bit network part is often called Prefix or Network-prefix

IP addressing: CIDR

CIDR: Classless InterDomain Routing

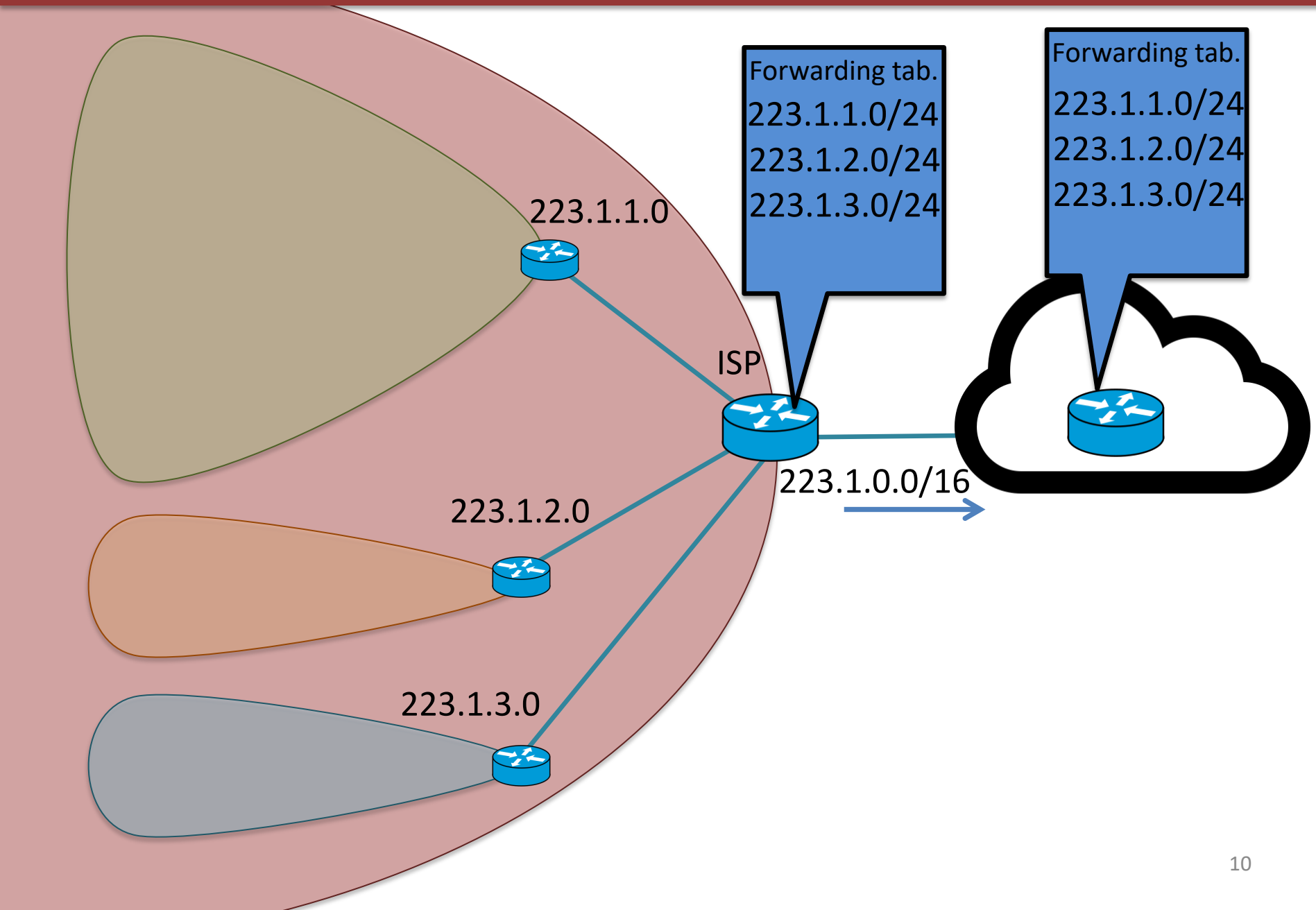
- subnet portion of address of arbitrary length
- address format: a.b.c.d/x, where x is # bits in subnet portion of address

forwarding table

4.0.0.0/8
4.83.128.0/17
201.10.0.0/21
201.10.6.0/23
126.255.103.0/24

CIDR: Super-netting/ Route aggregation

Lessons learned from subnetting



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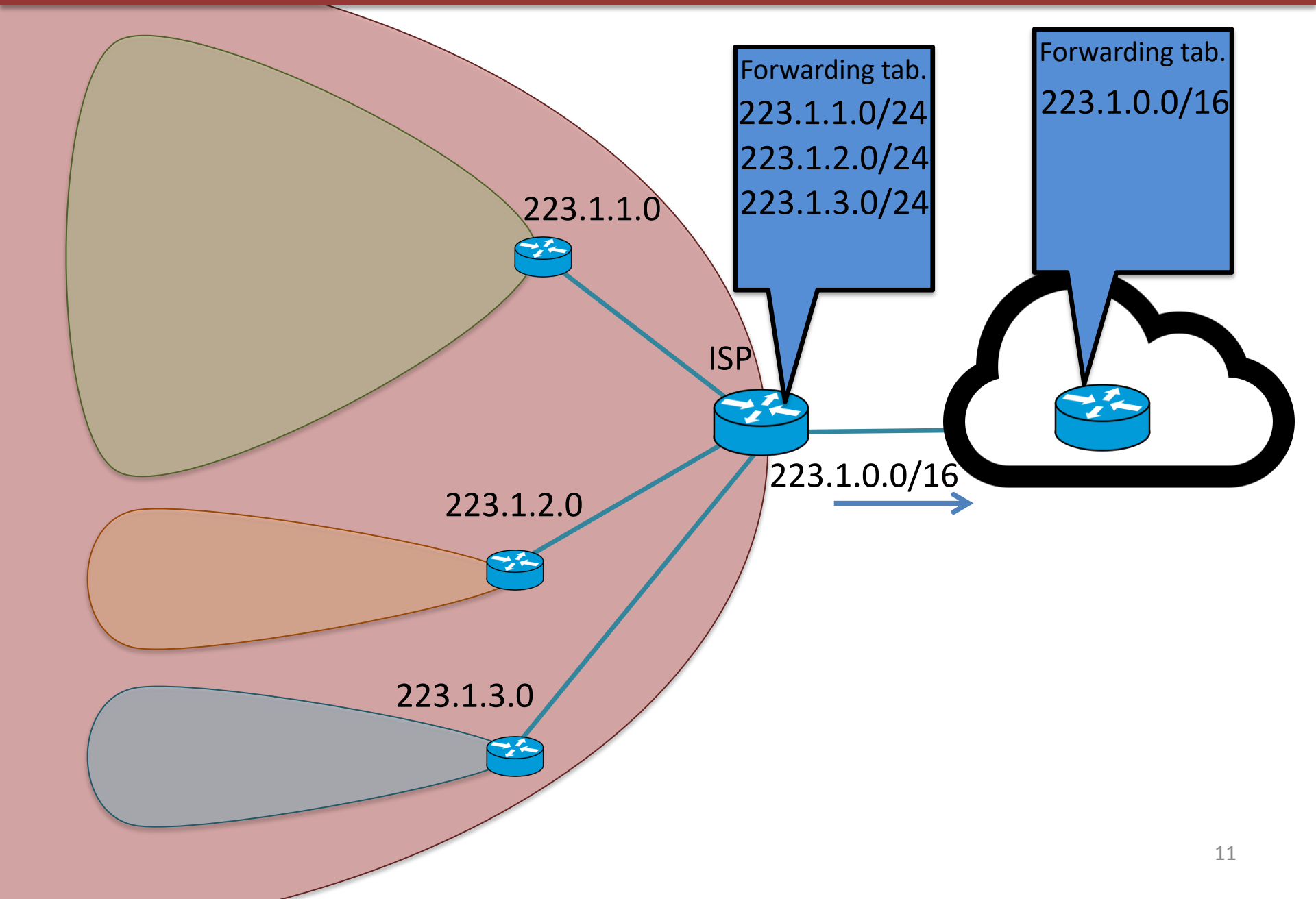
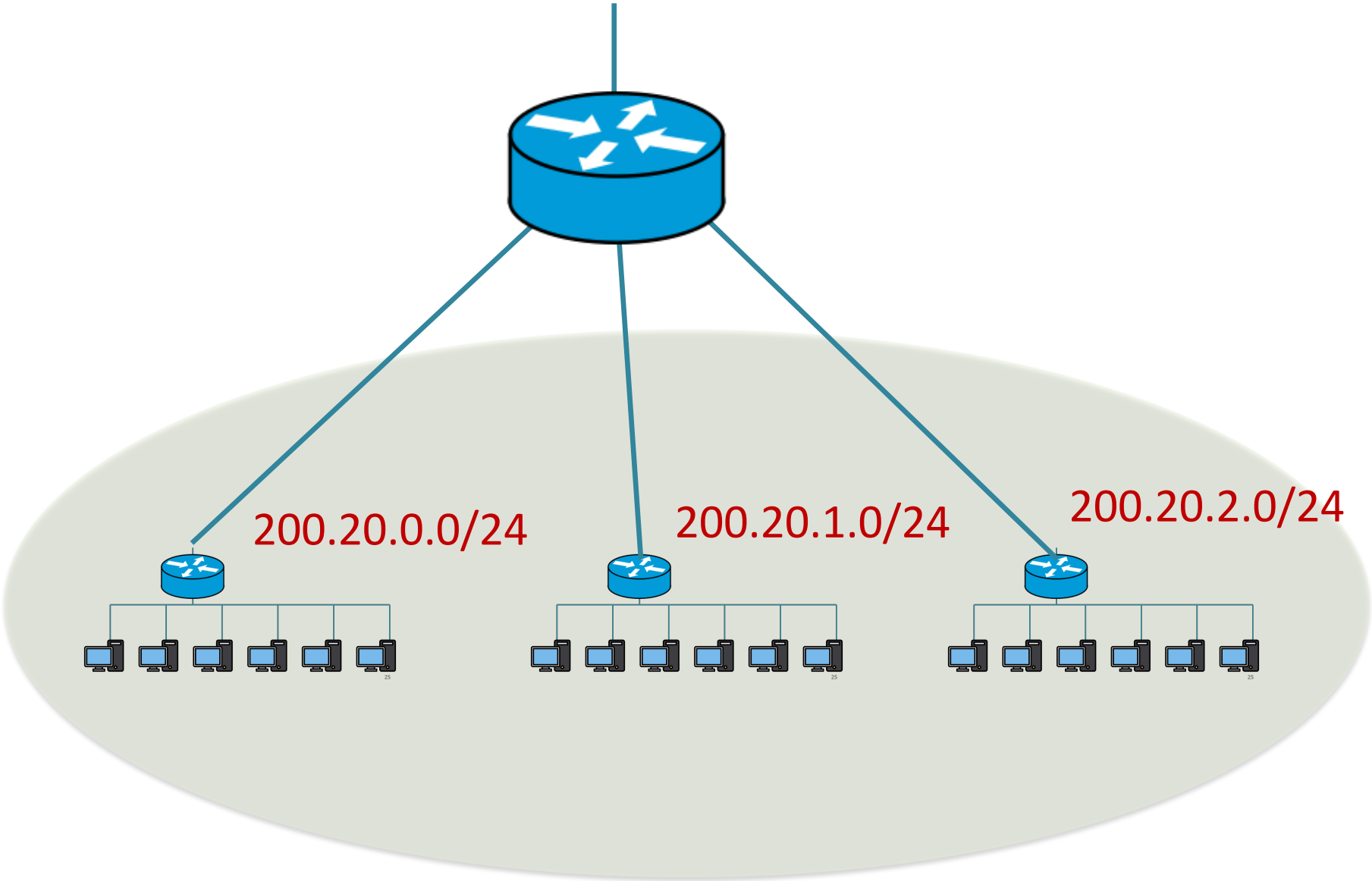
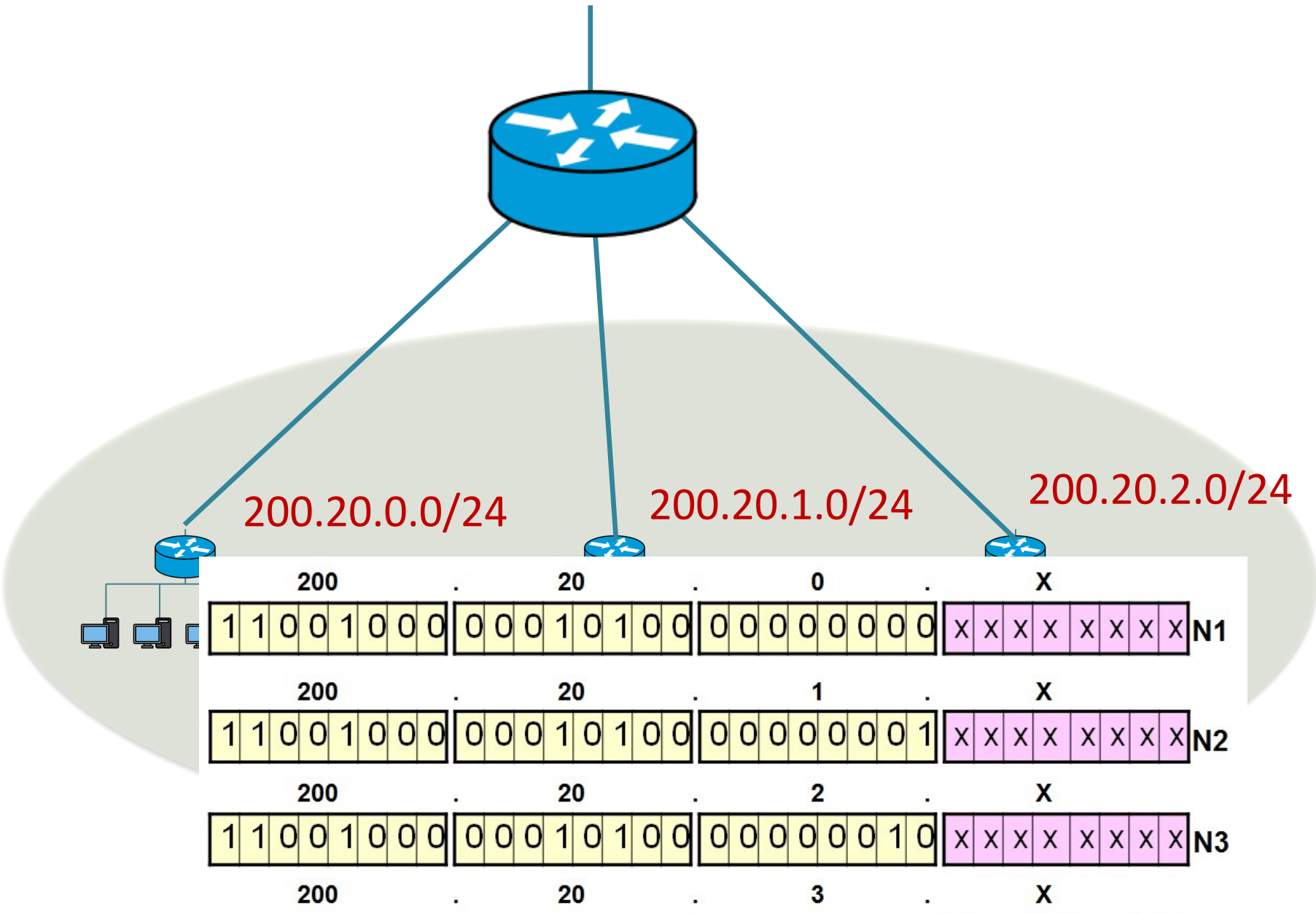
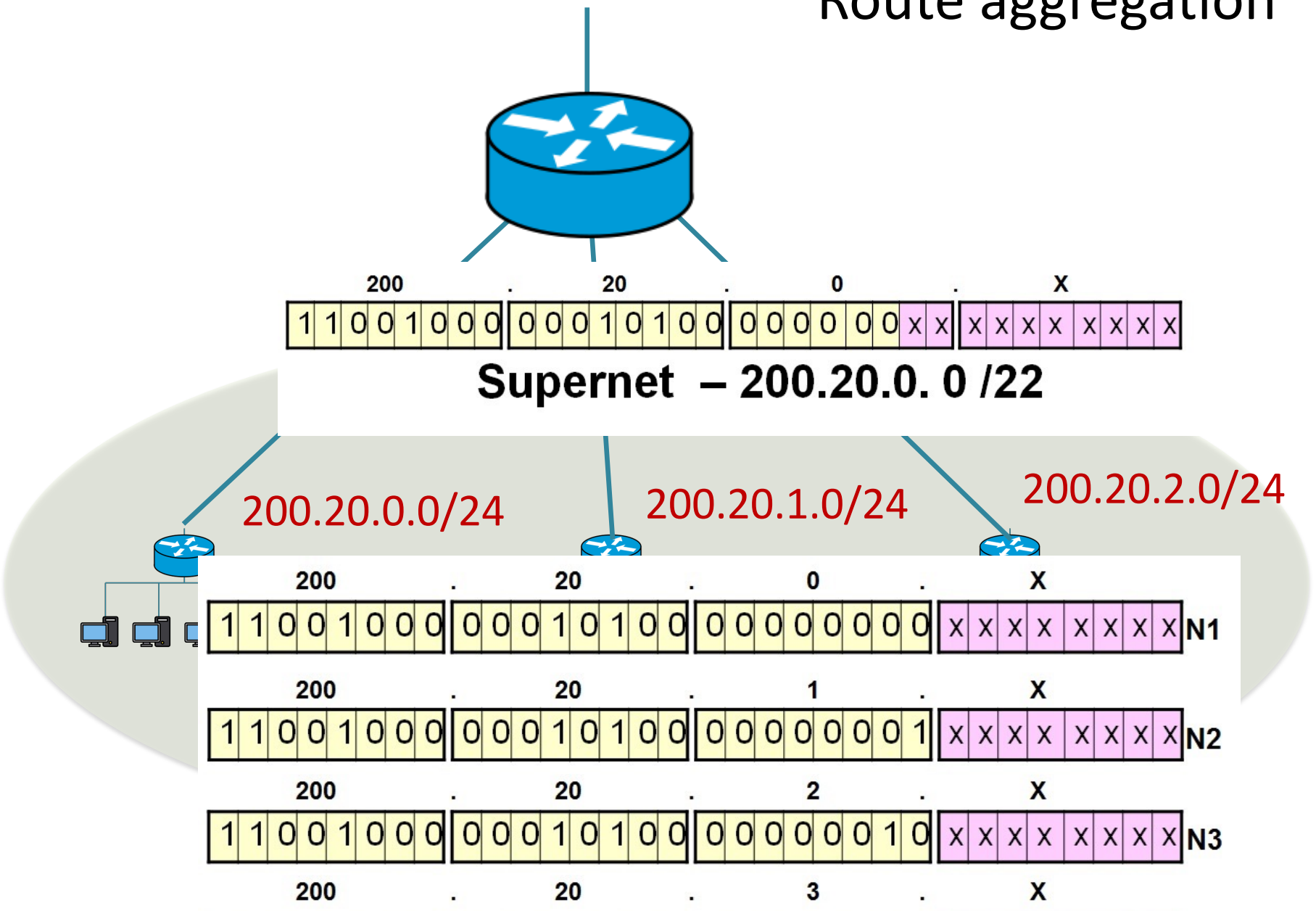
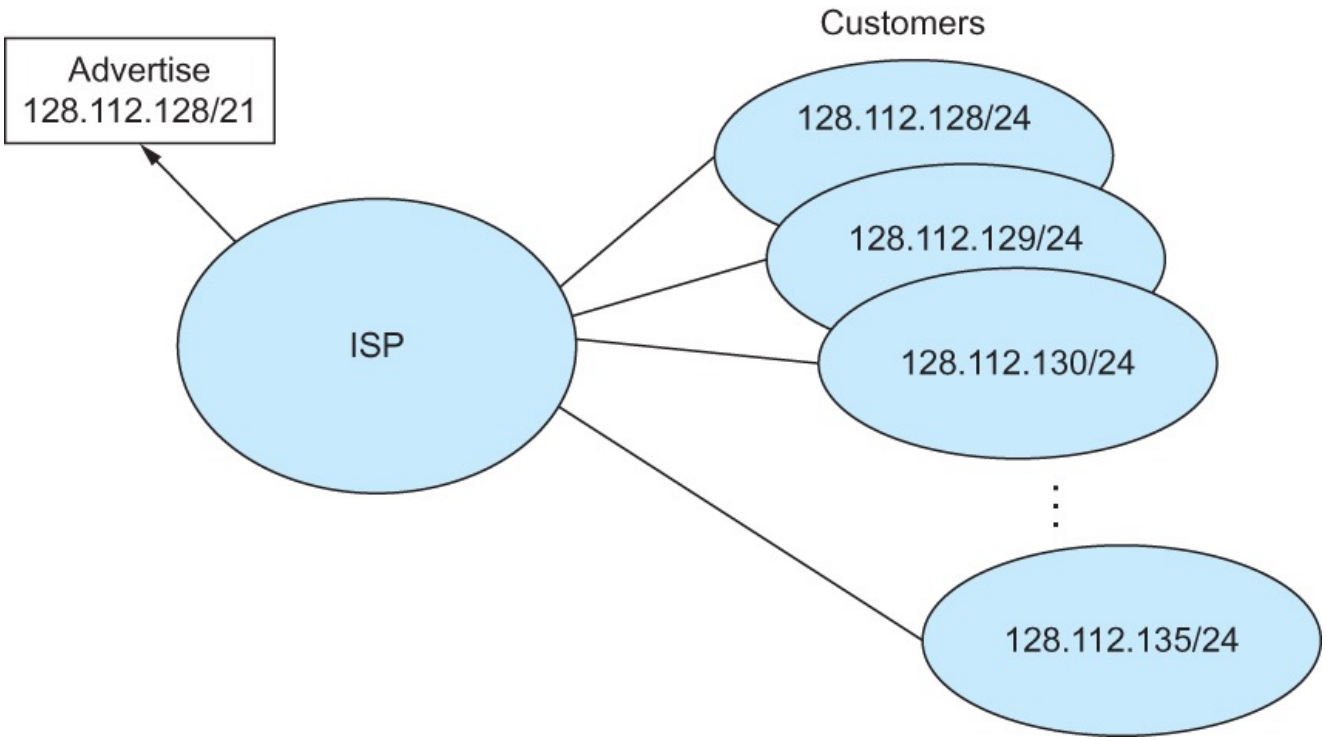



200.20.0.0/24
200.20.1.0/24
200.20.2.0/24


200.20.0.0/24
200.20.1.0/24
200.20.2.0/24
200 . 20 . 0 . X
1 1 0 0 1 0 0 0 | 0 0 0 1 0 1 0 0 | 0 0 0 0 0 0 0 0 | x x x x x x x x N1
200 . 20 . 1 . X
1 1 0 0 1 0 0 0 | 0 0 0 1 0 1 0 0 | 0 0 0 0 0 0 0 1 | x x x x x x x x N2
200 . 20 . 2 . X
1 1 0 0 1 0 0 0 | 0 0 0 1 0 1 0 0 | 0 0 0 0 0 0 1 0 | x x x x x x x x N3
200 . 20 . 3 . X

Route aggregation

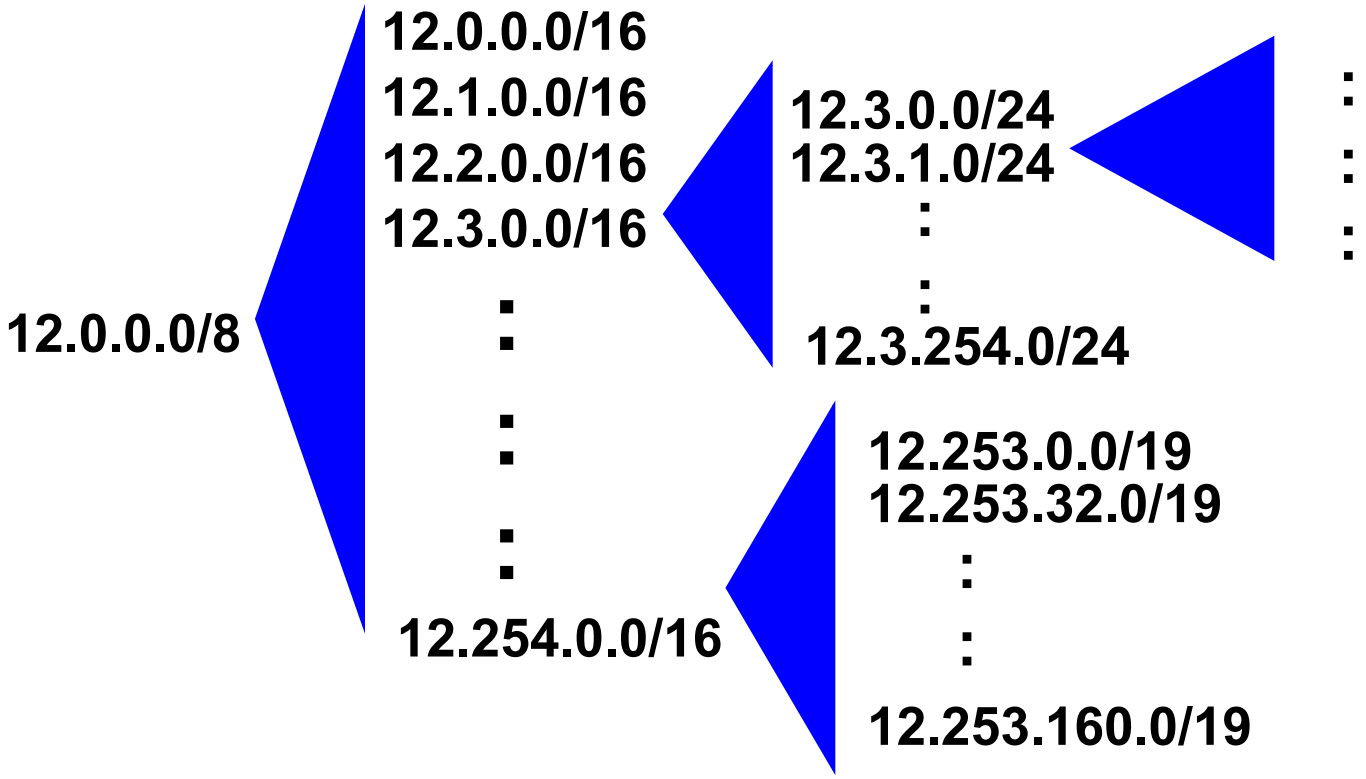




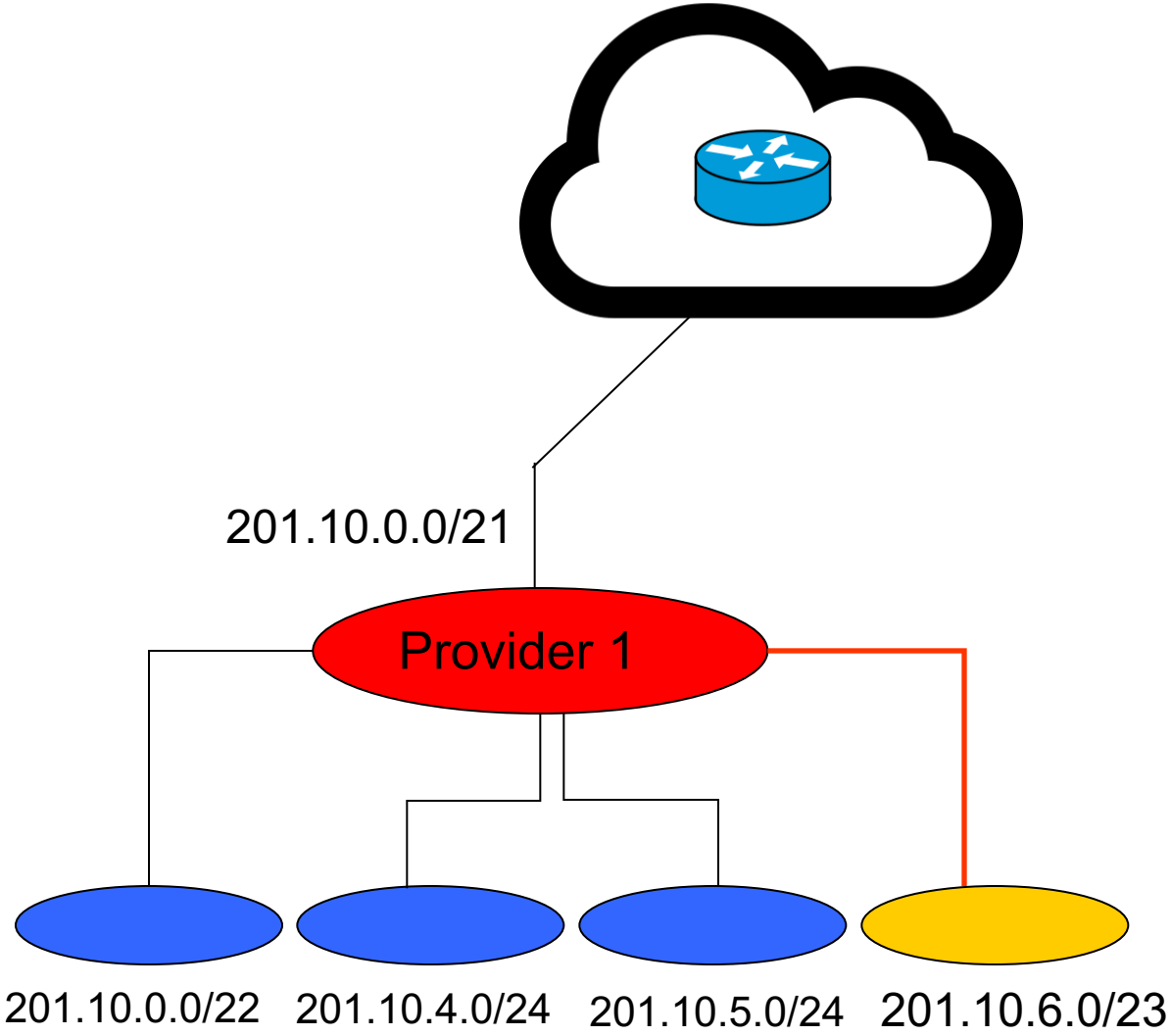
Route aggregation with CIDR

Hierarchical Address Allocation

- Hierarchy is key to scalability
  - Address allocated in contiguous chunks (prefixes)
  - Today, the Internet has about 400,000 prefixes



CIDR Makes Packet Forwarding Harder



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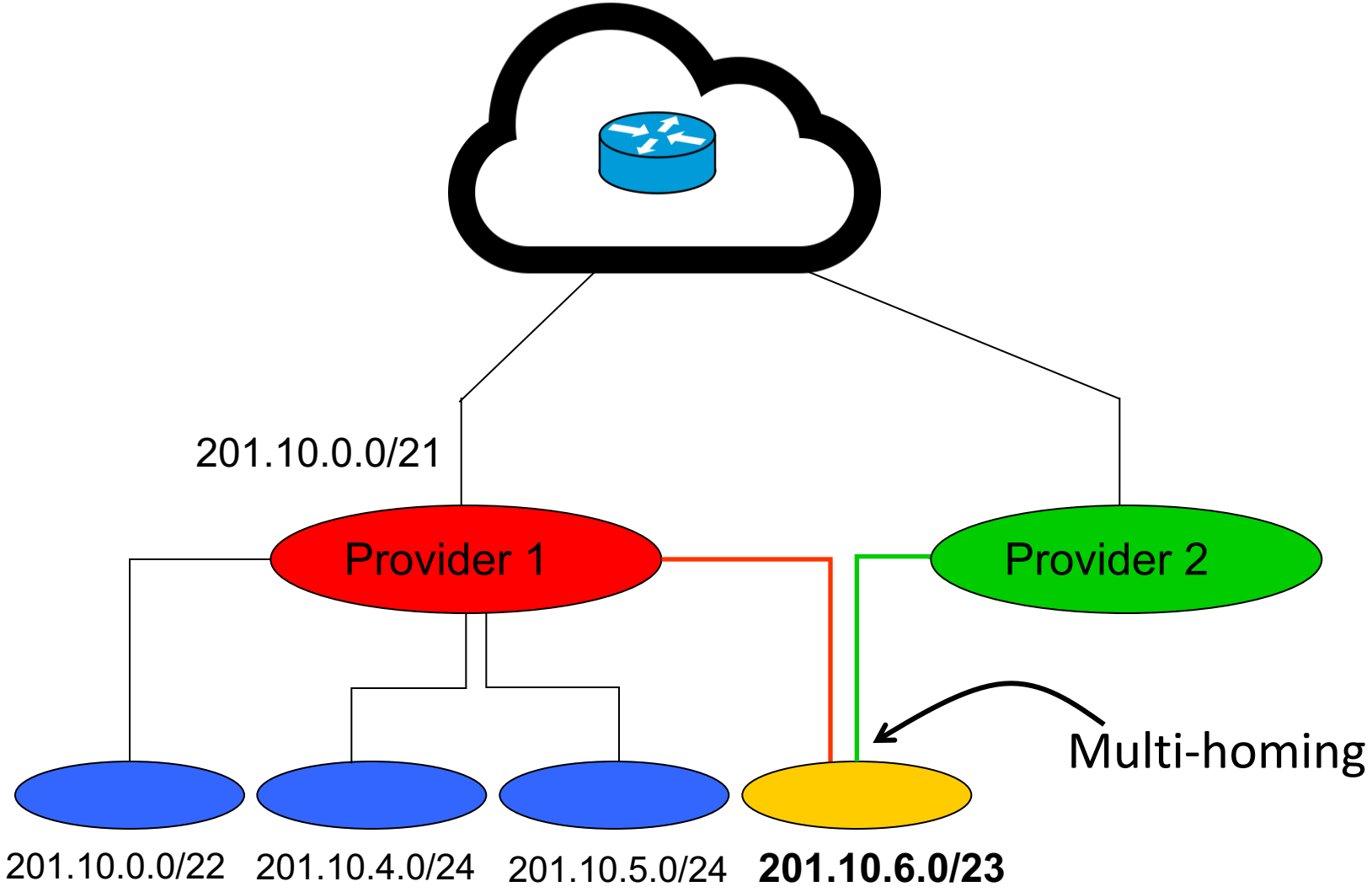

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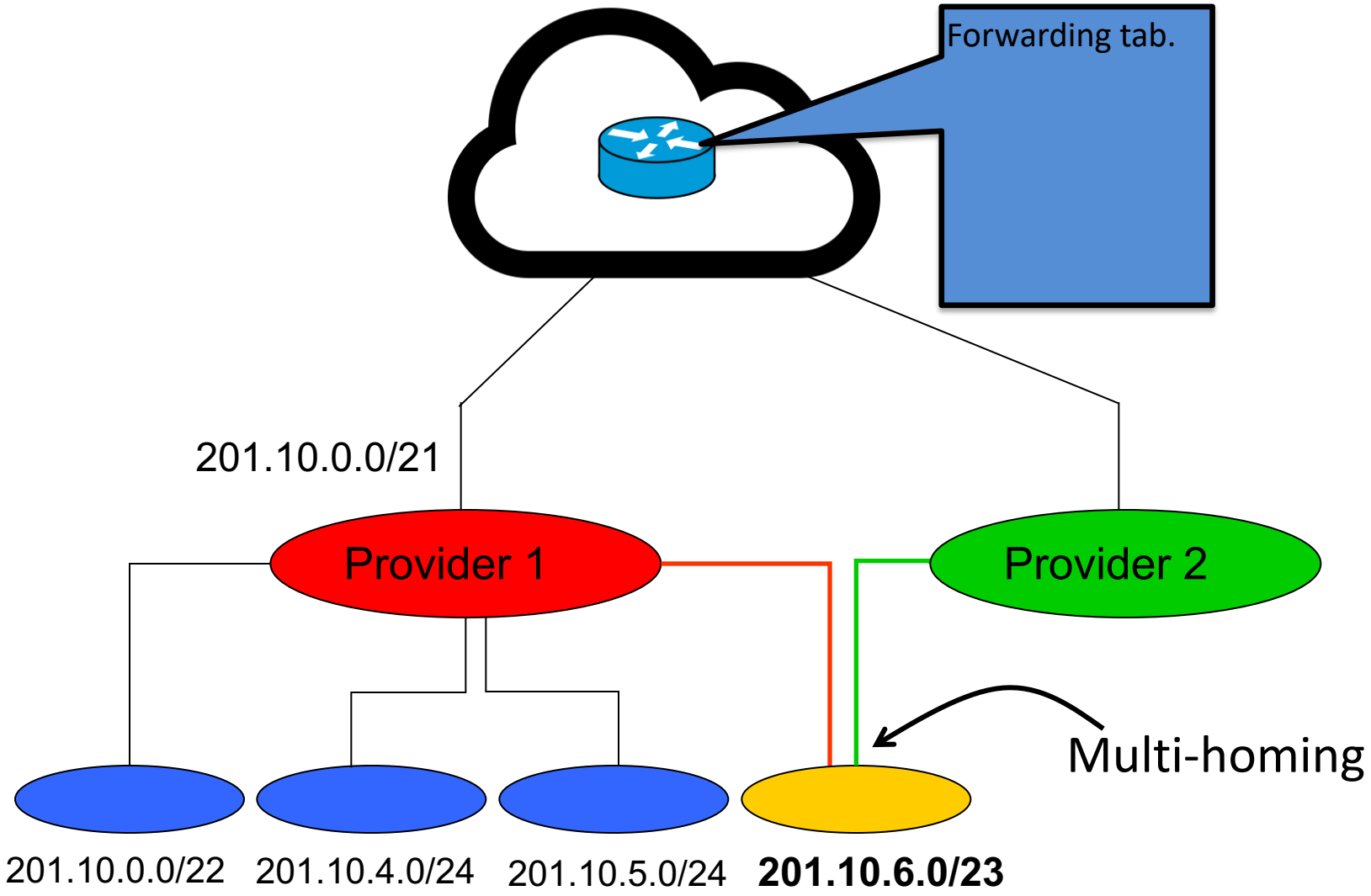

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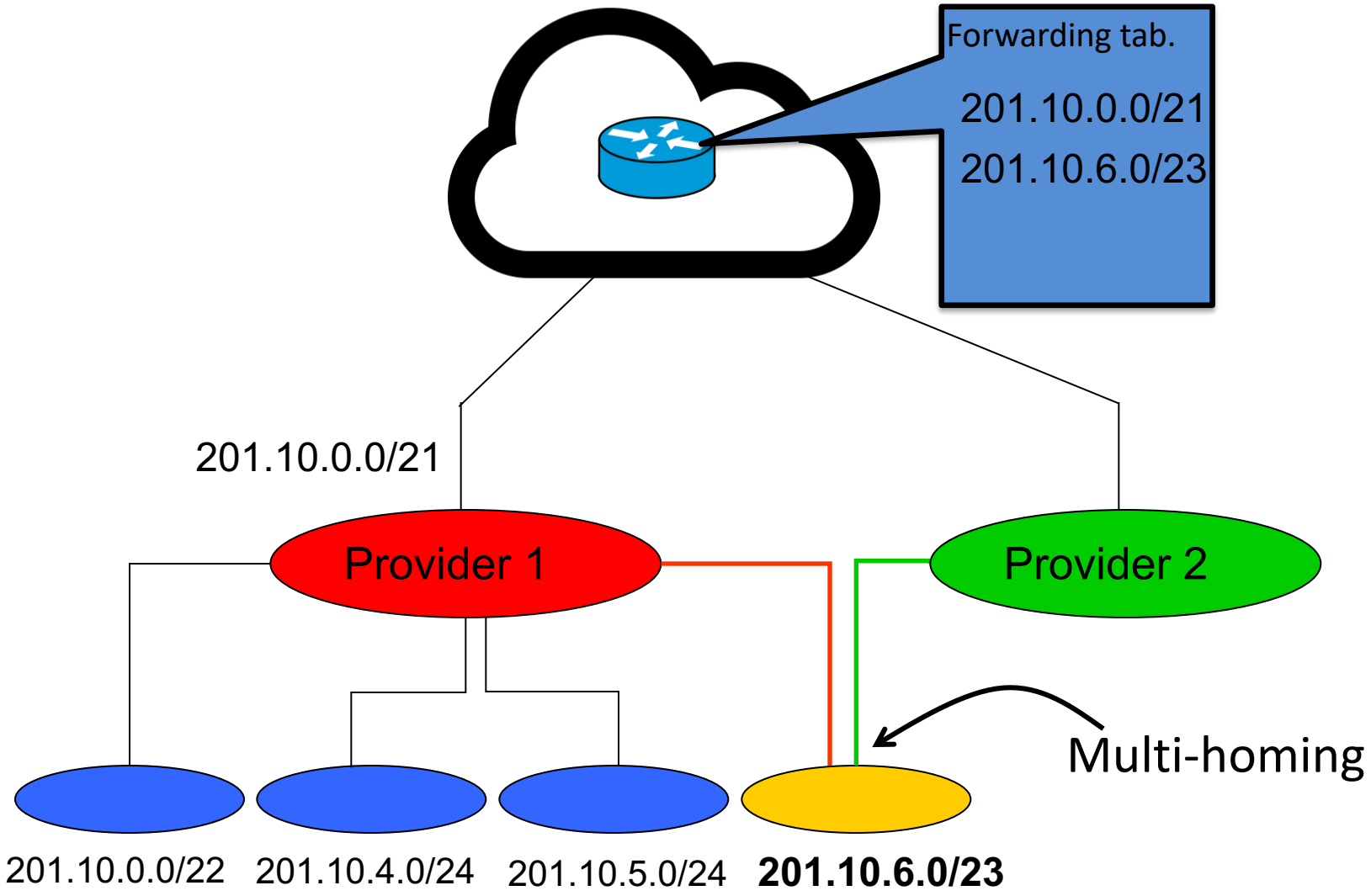

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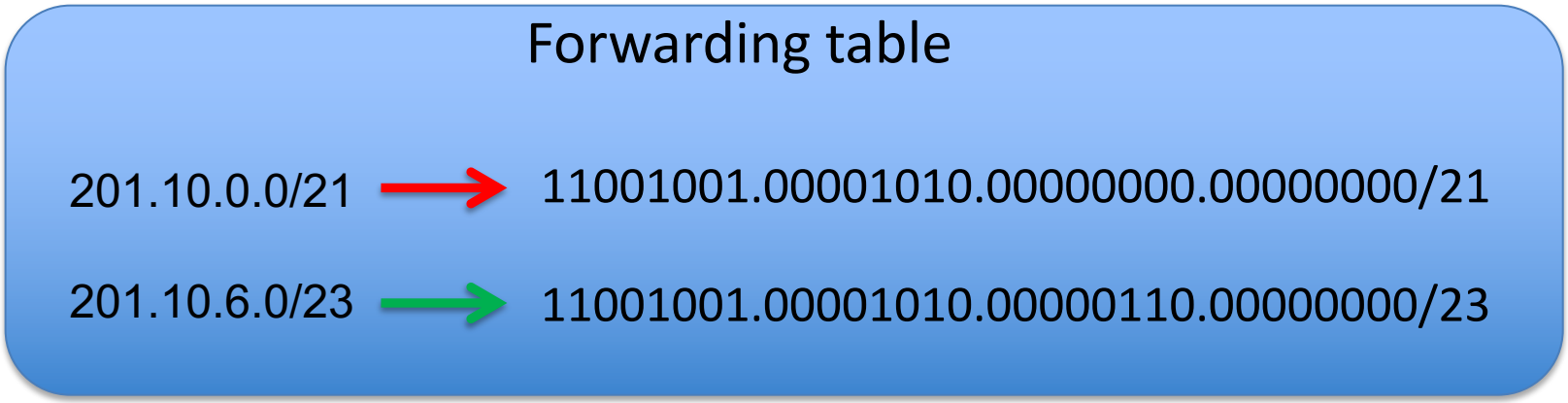
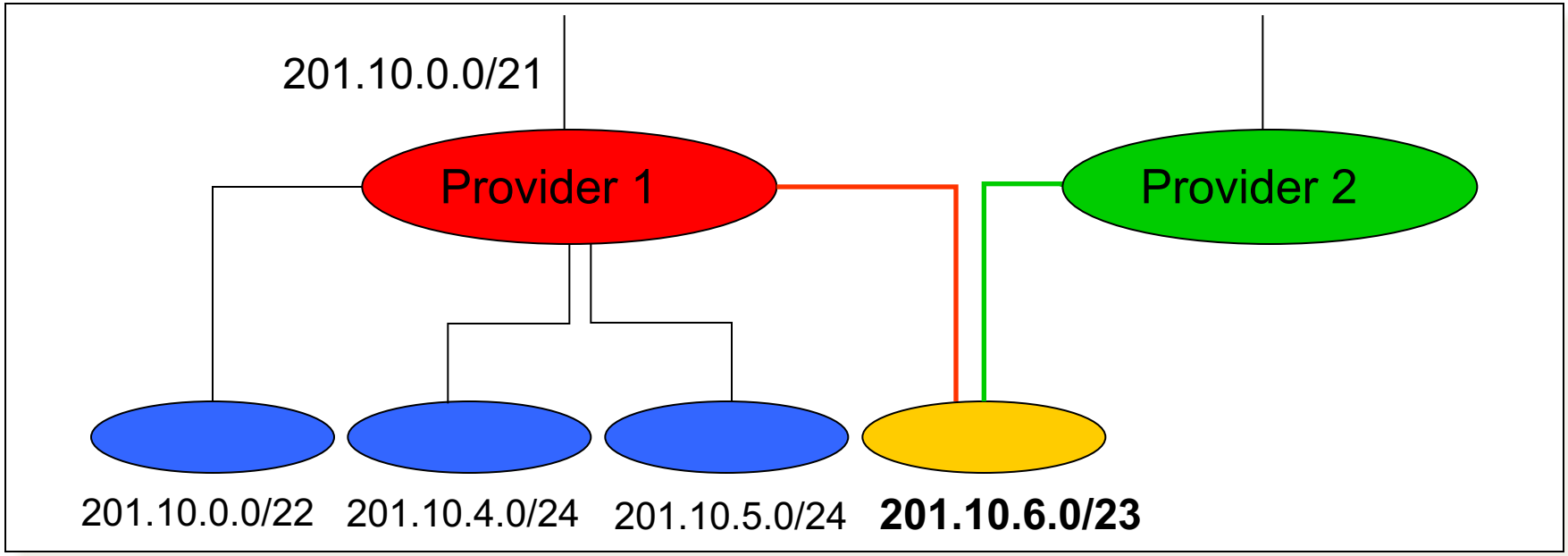


A packet with dest. Addr.: 201.10.6.17

11001001.00001010.00000110.00010001

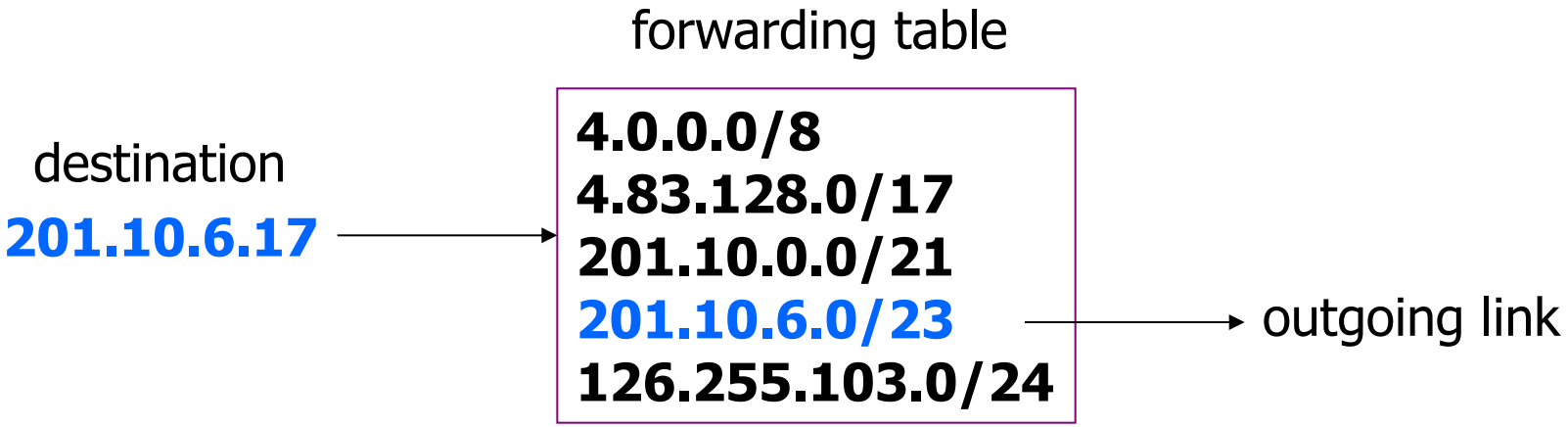
CIDR Makes Packet Forwarding Harder

- Forwarding table may have many matches
  - E.g., entries for 201.10.0.0/21 and 201.10.6.0/23
  - The IP address 201.10.6.17 would match both!



Longest Prefix Match Forwarding

- Destination-based forwarding
  - Packet has a destination address
  - Router identifies longest-matching prefix
  - Cute algorithmic problem: very fast lookups



Getting an IP address: DHCP Protocol

IP addresses: how to get one?

Q: How does a *host* get its IP address?

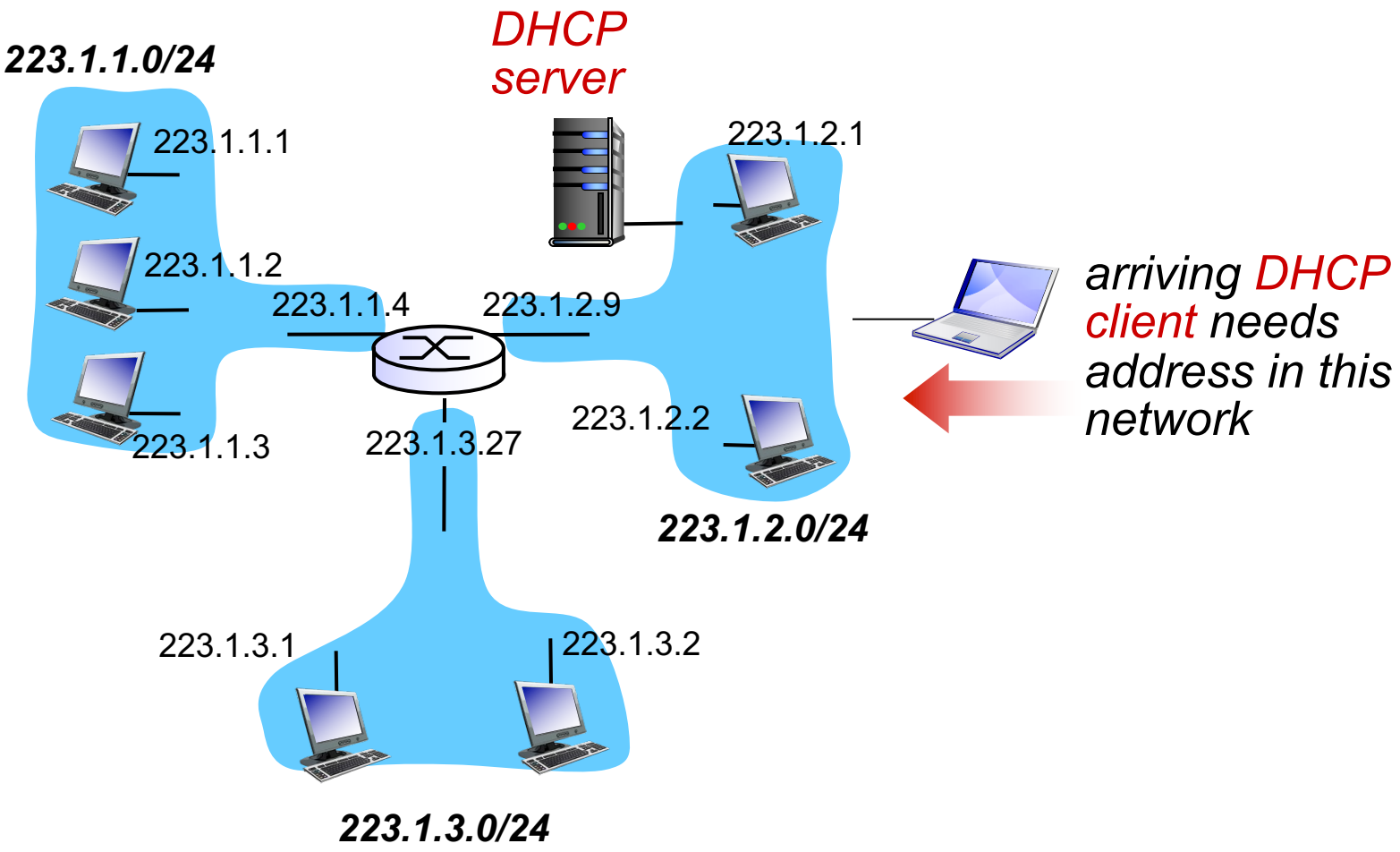
- hard-coded by system admin in a file
  - Windows: control-panel->network->configuration->tcp/ip->properties
  - UNIX: /etc/…
- DHCP: Dynamic Host Configuration Protocol: dynamically get address from a server
  - "plug-and-play"

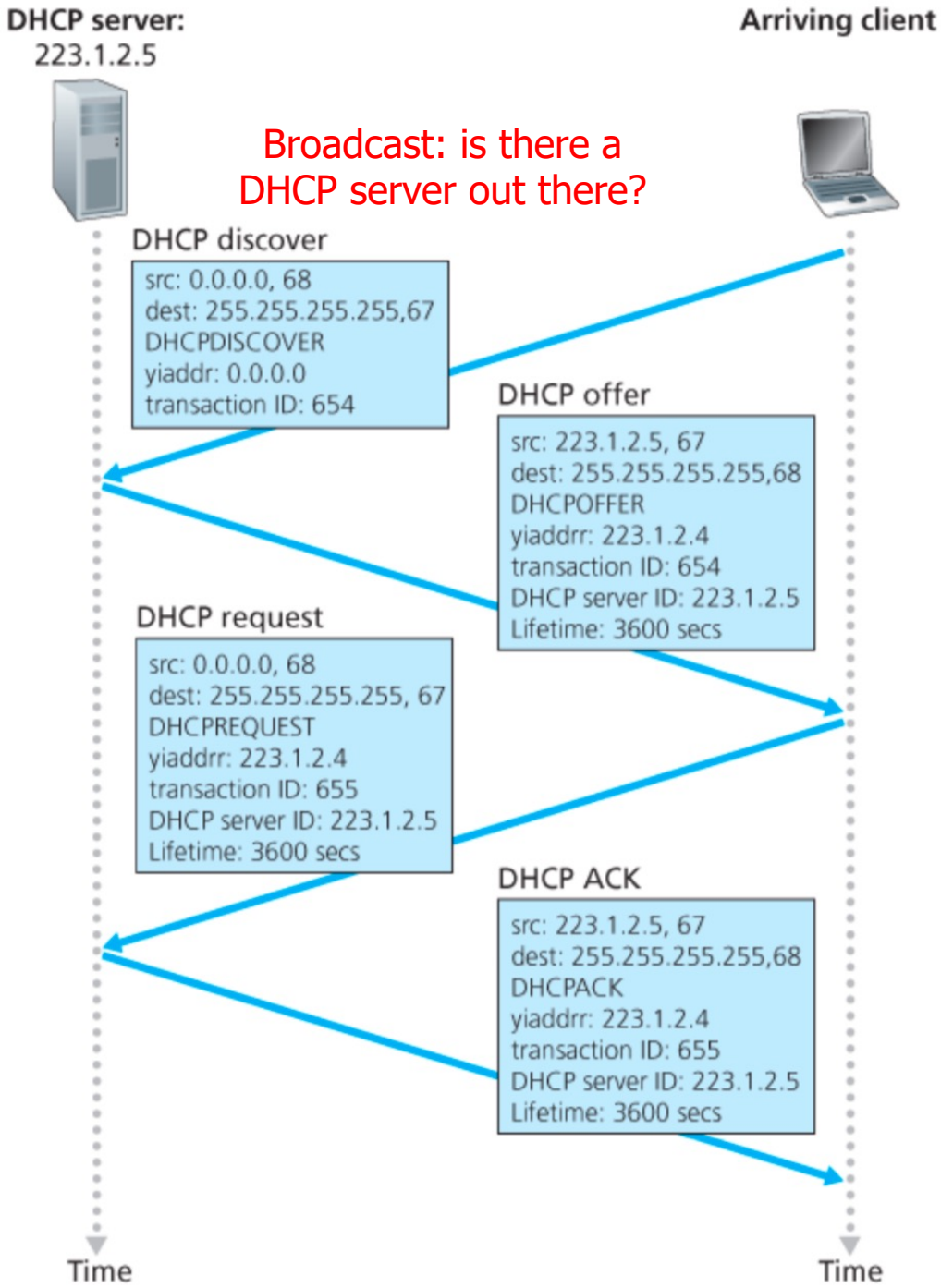
DHCP: Dynamic Host Configuration Protocol

goal: allow host to *dynamically* obtain its IP address from network server when it joins network

- can renew its lease on address in use
- allows reuse of addresses (only hold address while connected/"on")
- support for mobile users who want to join network

DHCP client-server scenario




DHCP server:
223.1.2.5
Arriving client
Broadcast: is there a
DHCP server out there?
DHCP discover
src: 0.0.0.0, 68
dest: 255.255.255.255,67
DHCPDISCOVER
yiaddr: 0.0.0.0
transaction ID: 654
DHCP offer
src: 223.1.2.5, 67
dest: 255.255.255.255,68
DHCPOFFER
yiaddrr: 223.1.2.4
transaction ID: 654
DHCP server ID: 223.1.2.5
Lifetime: 3600 secs
DHCP request
src: 0.0.0.0, 68
dest: 255.255.255.255, 67
DHCPREQUEST
yiaddrr: 223.1.2.4
transaction ID: 655
DHCP server ID: 223.1.2.5
Lifetime: 3600 secs
DHCP ACK
src: 223.1.2.5, 67
dest: 255.255.255.255,68
DHCPACK
yiaddrr: 223.1.2.4
transaction ID: 655
DHCP server ID: 223.1.2.5
Lifetime: 3600 secs
Time
Time

A note on the “broadcast address”

```
en0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
        ether 38:f9:d3:21:07:2a
        inet6 fe80::8dd:b8b2:372d:5f01%en0 prefixlen 64 secured scopeid 0xa
        inet 10.104.216.101 netmask 0xfffff000 broadcast 10.104.223.255
        nd6 options=201<PERFORMNUD,DAD>
        media: autoselect
        status: active
```

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```

inet 10.104.216.101 ➔

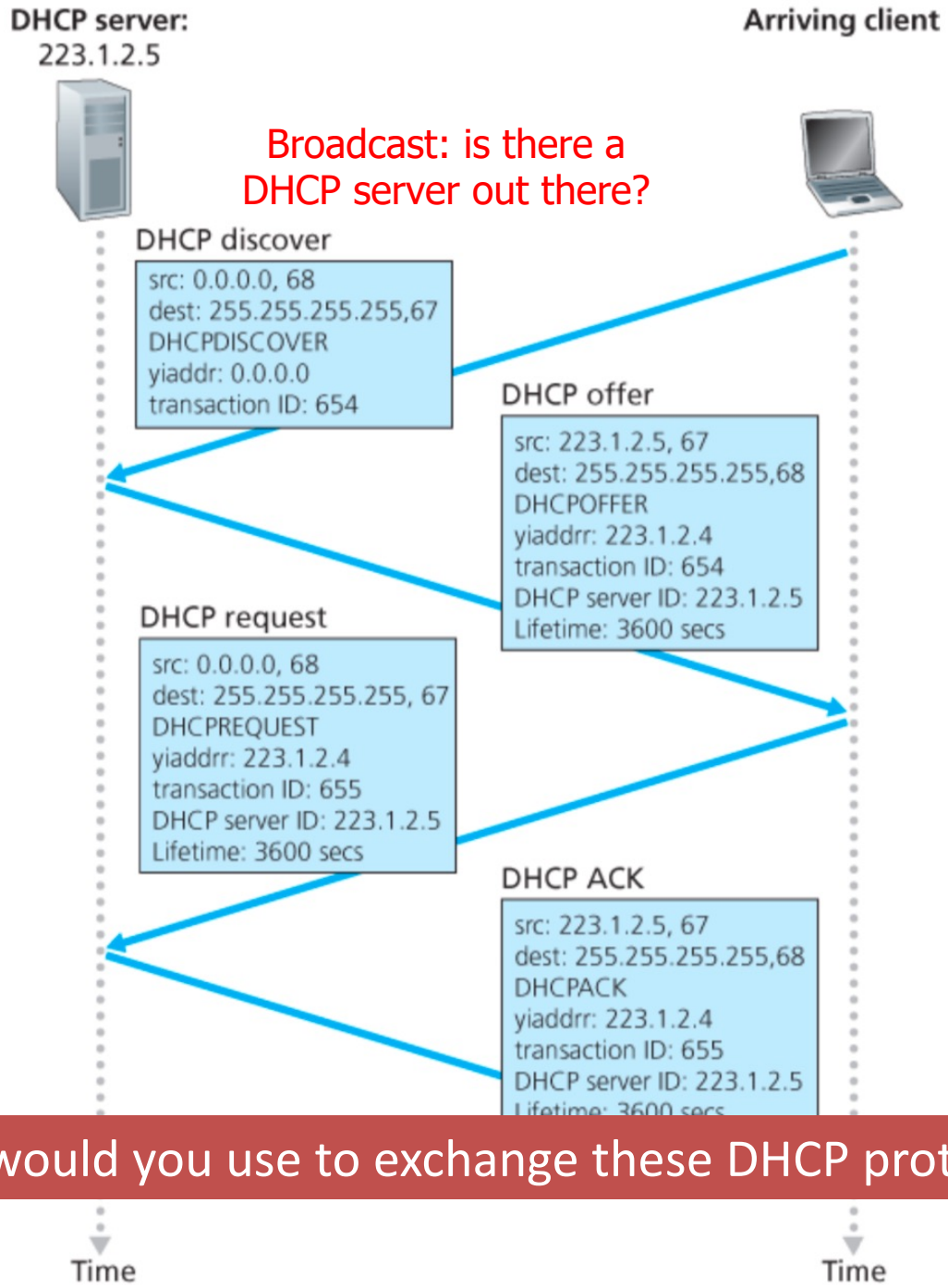
00001010.01101000.1101**1000.01100101**

netmask ff:ff:f0:00 ➔

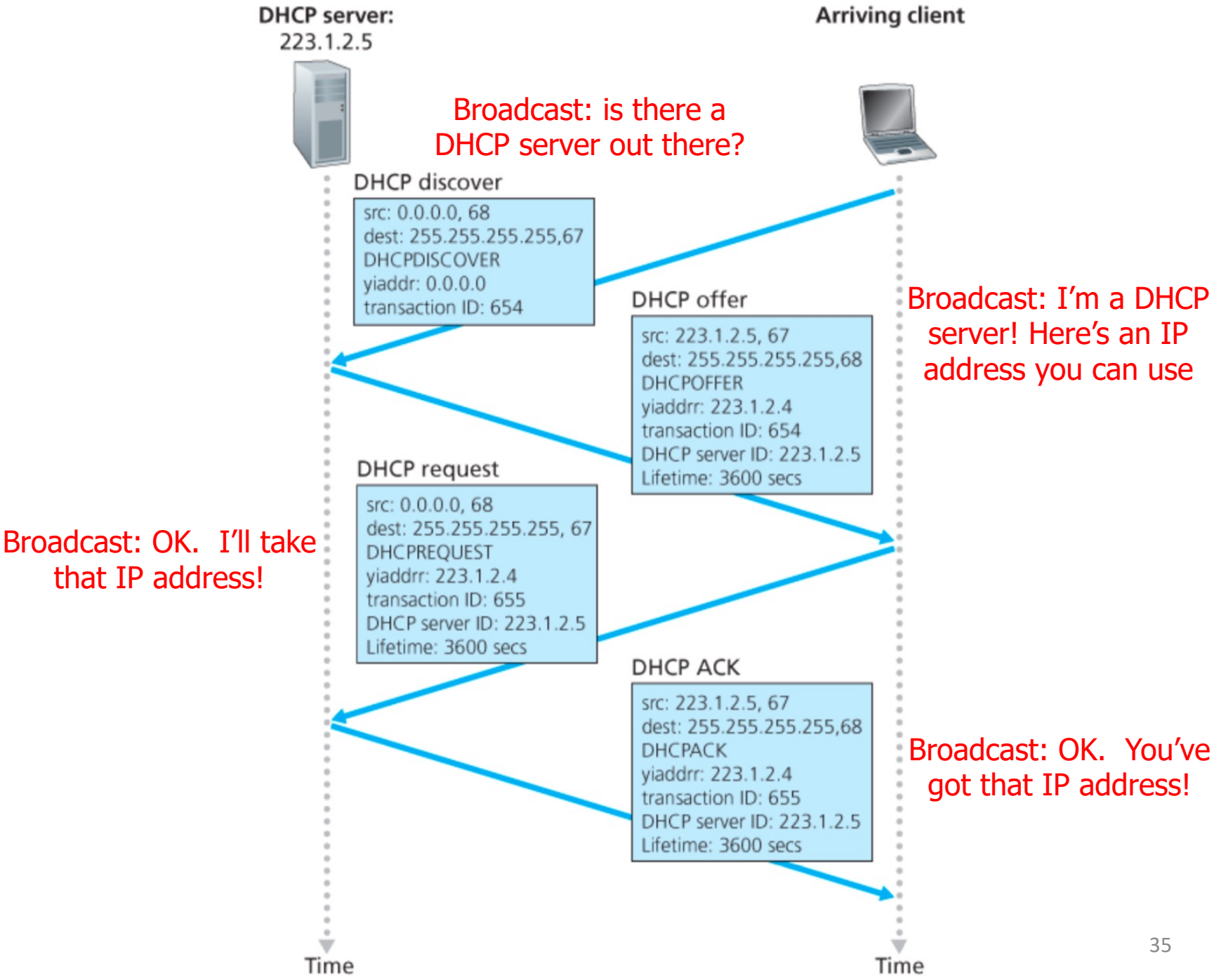
11111111.11111111.1111**0000.00000000**

broadcast 10.104.223.255 ➔

00001010.01101000.1101**1111.11111111**



Which protocol would you use to exchange these DHCP protocol messages?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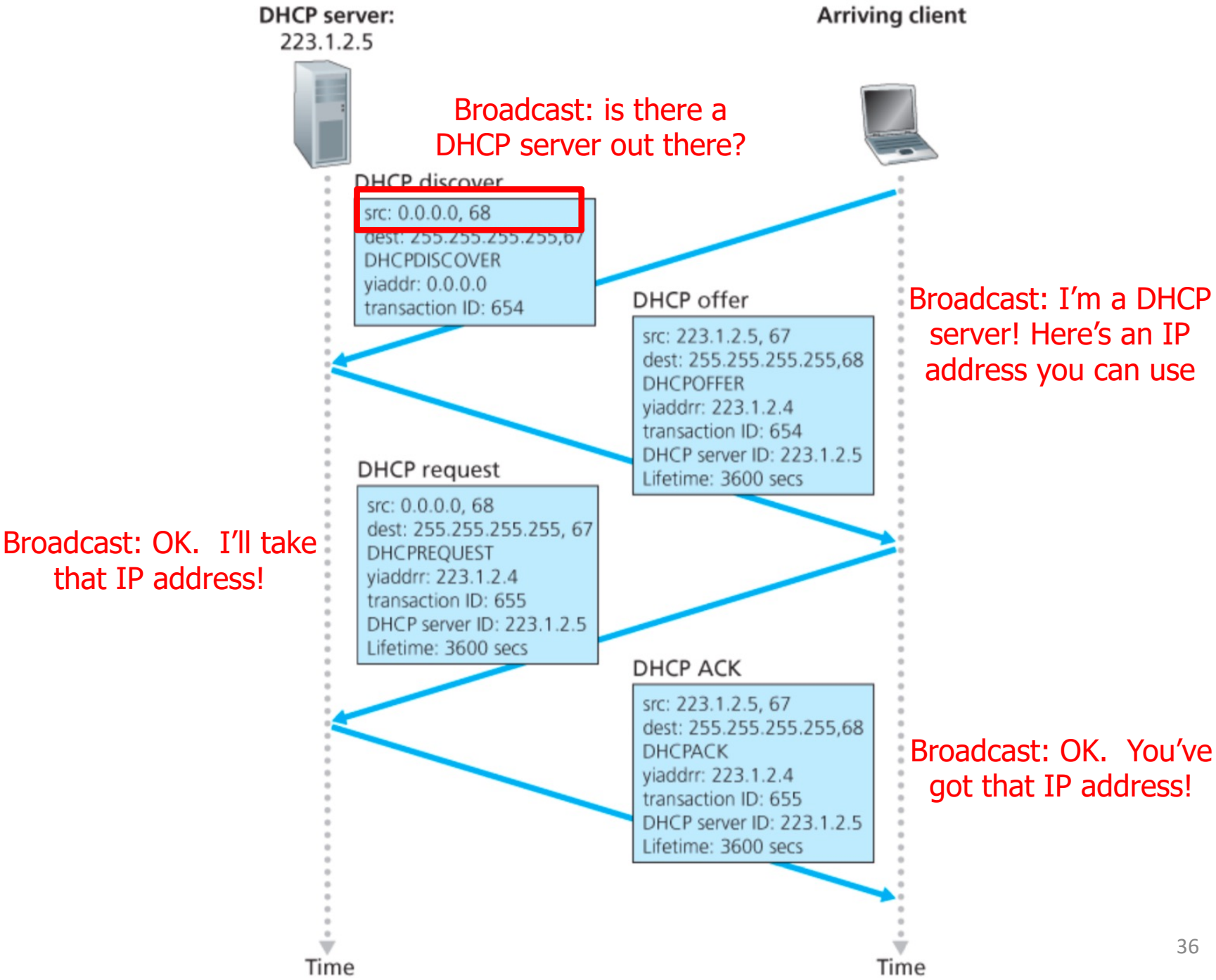
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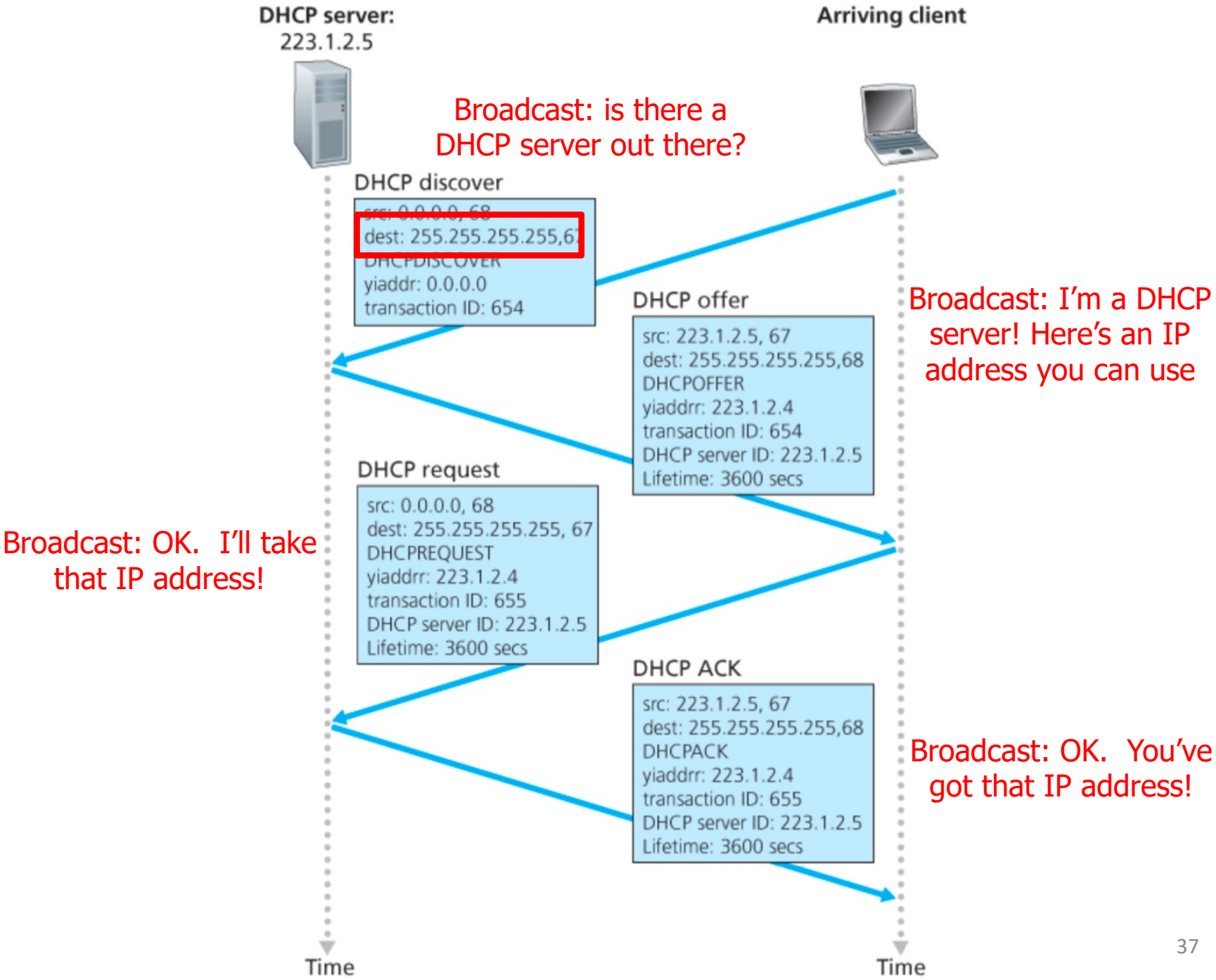
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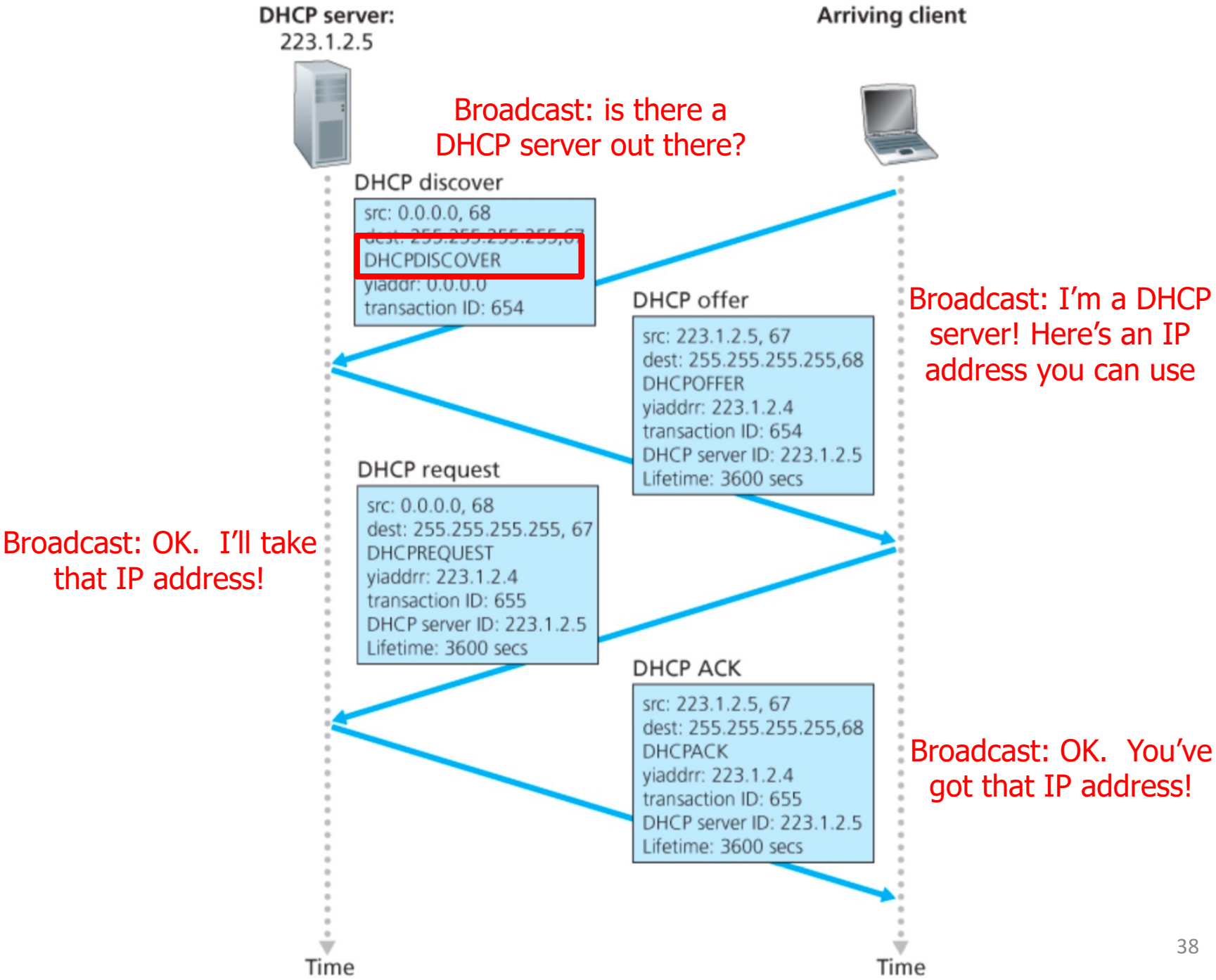
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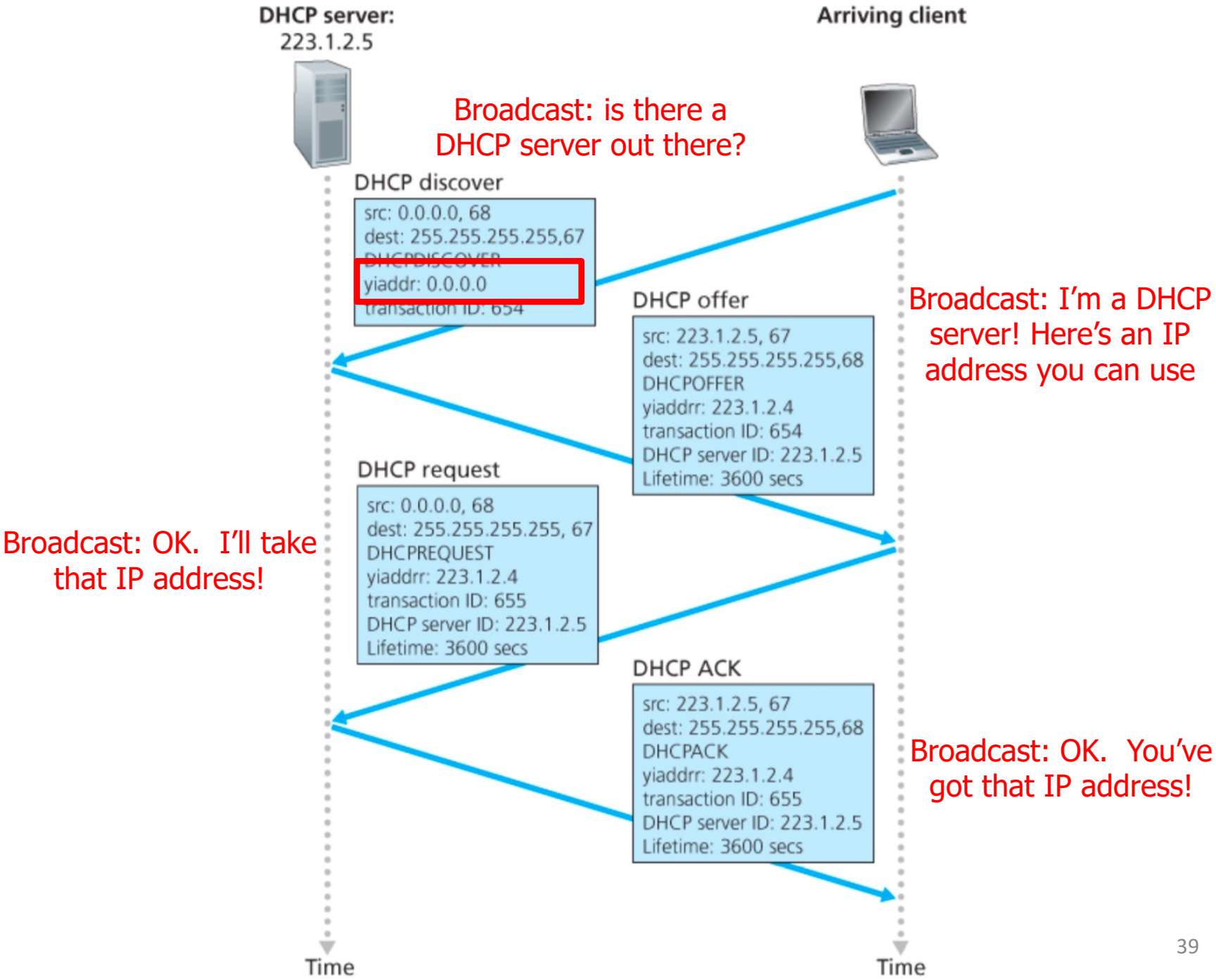
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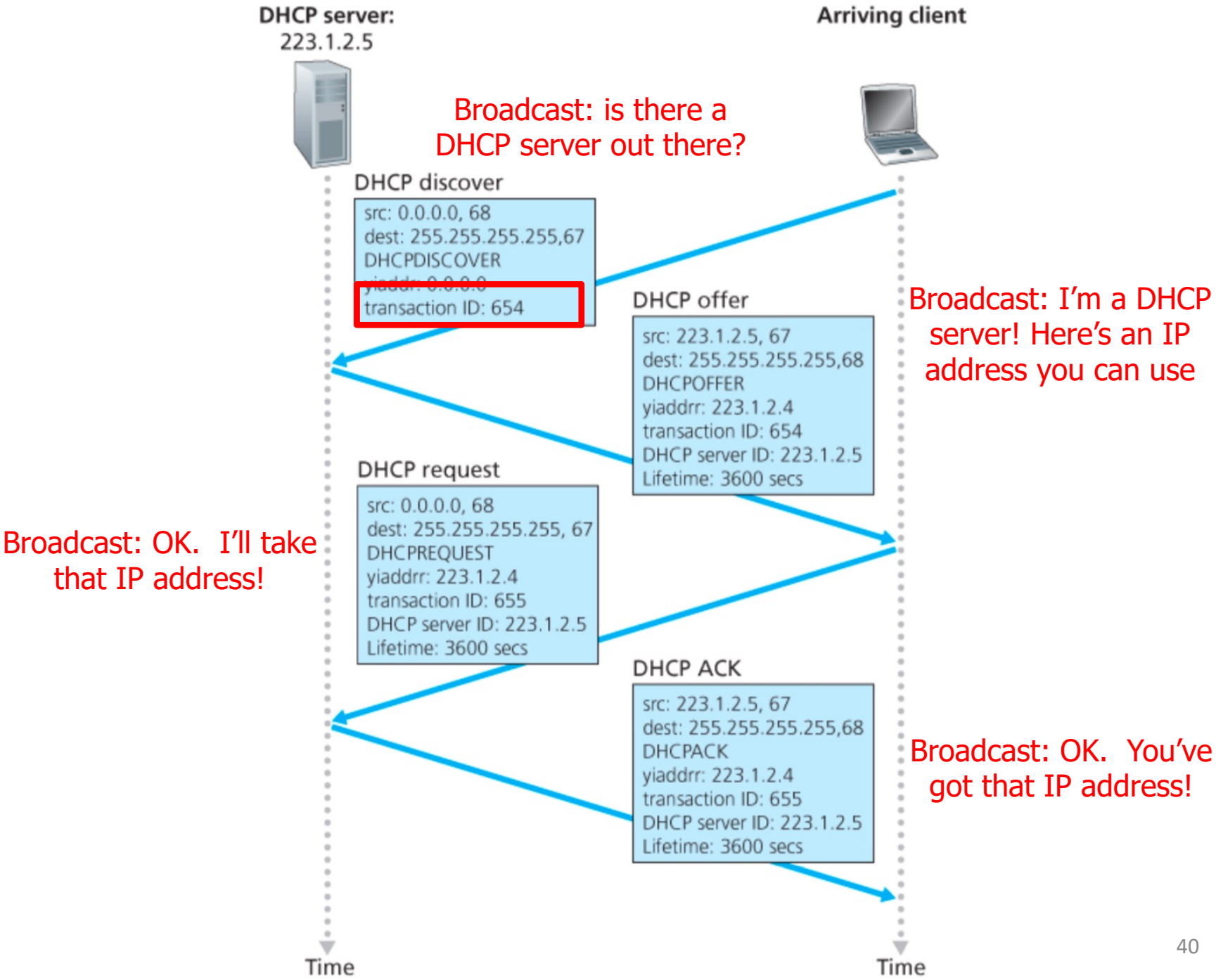
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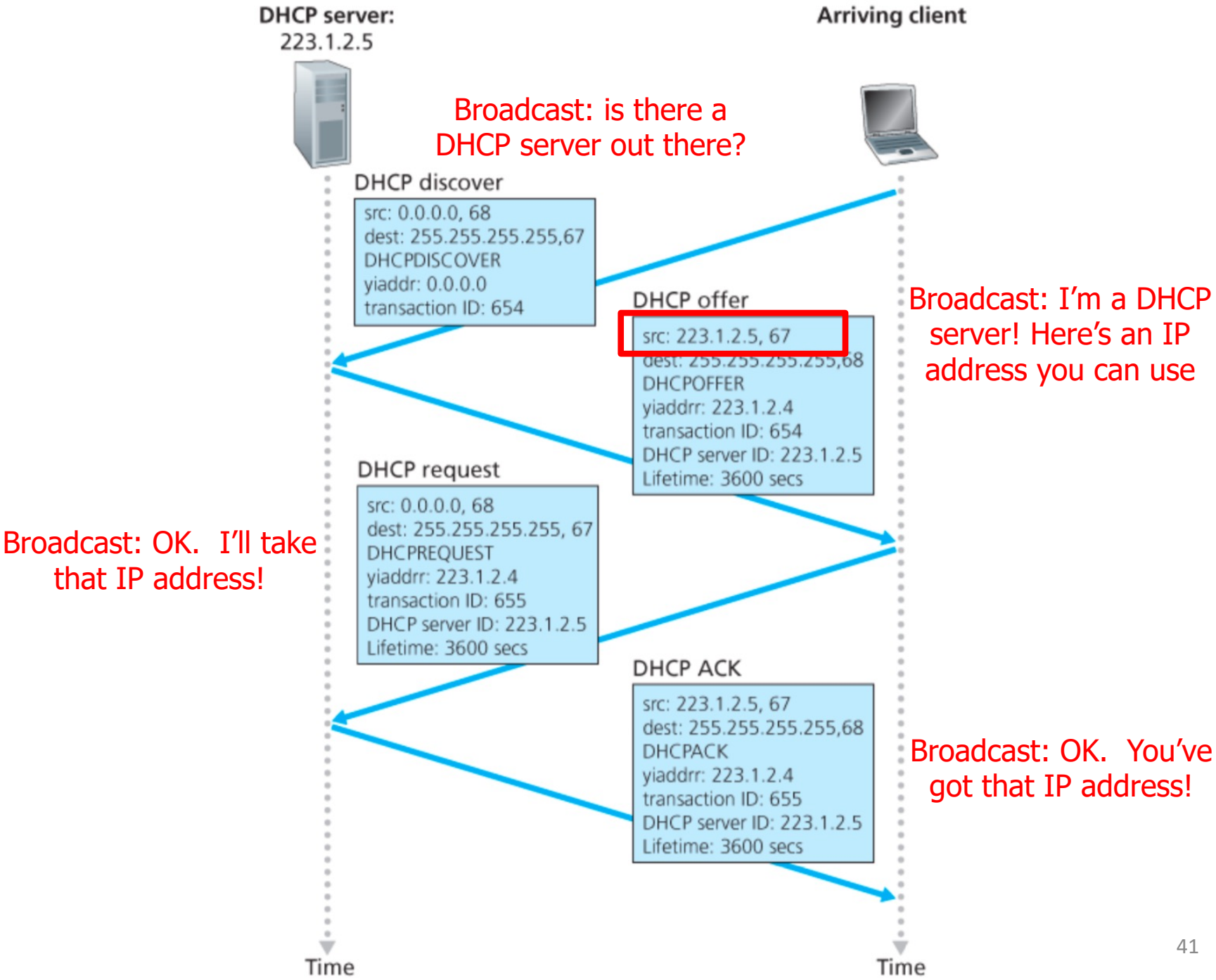
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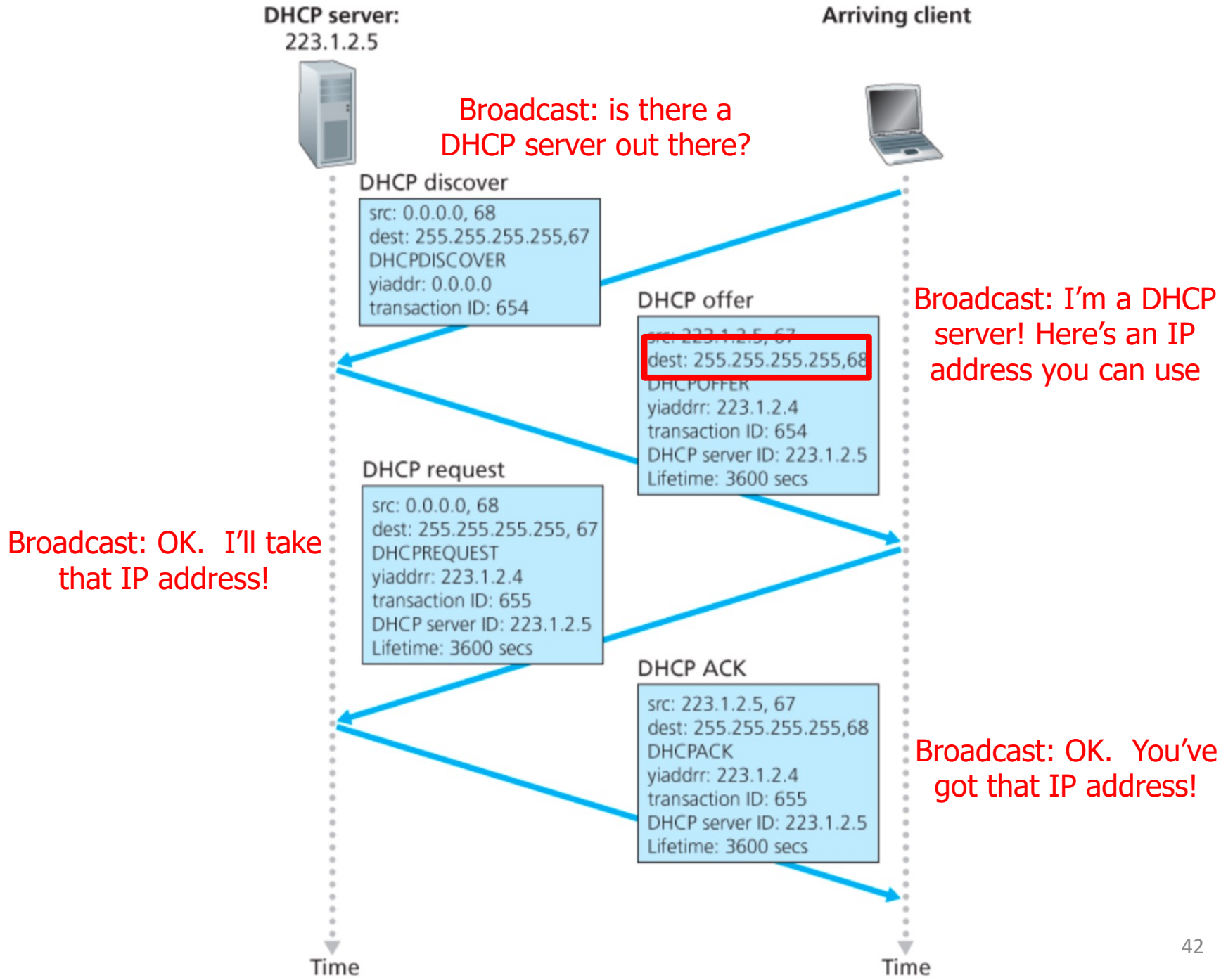
transaction ID: 655
DHCP server ID: 223.1.2.5
Lifetime: 3600 secs
Broadcast: OK. You've got that IP address!
Time
Time


DHCP server:
223.1.2.5
Arriving client
Broadcast: is there a DHCP server out there?
DHCP discover
src: 0.0.0.0, 68
dest: 255.255.255.255,67
DHCPDISCOVER
yiaddr: 0.0.0.0
transaction ID: 654
DHCP offer
dest: 255.255.255.255,68
yiaddrr: 223.1.2.4
transaction ID: 654
DHCP server ID: 223.1.2.5
Lifetime: 3600 secs
Broadcast: I'm a DHCP server! Here's an IP address you can use
DHCP request
src: 0.0.0.0, 68
dest: 255.255.255.255, 67
DHCPREQUEST
yiaddrr: 223.1.2.4
transaction ID: 655
DHCP server ID: 223.1.2.5
Lifetime: 3600 secs
Broadcast: OK. I'll take that IP address!
DHCP ACK
src: 223.1.2.5, 67
dest: 255.255.255.255,68
DHCPACK
yiaddrr: 223.1.2.4
transaction ID: 655
DHCP server ID: 223.1.2.5
Lifetime: 3600 secs
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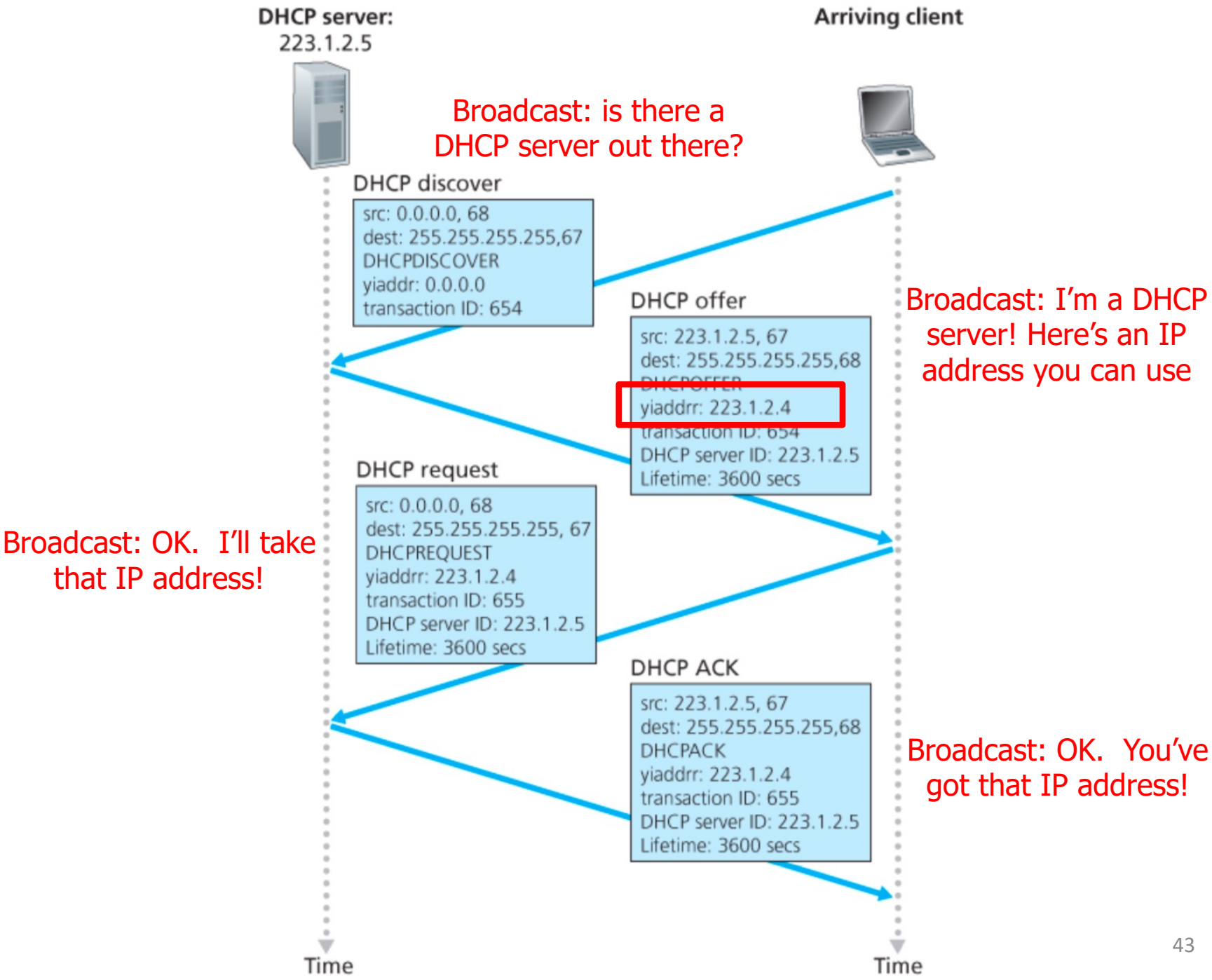
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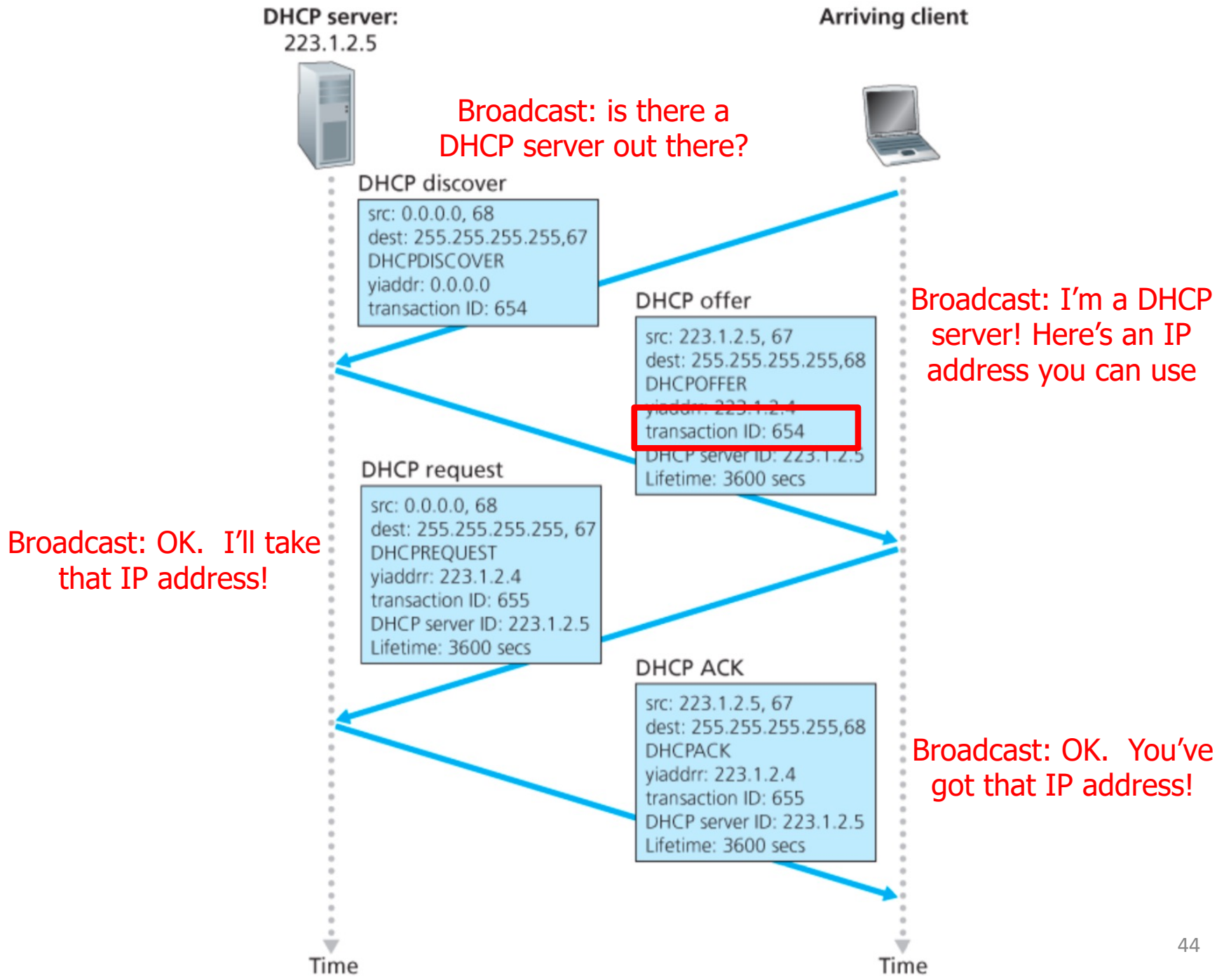
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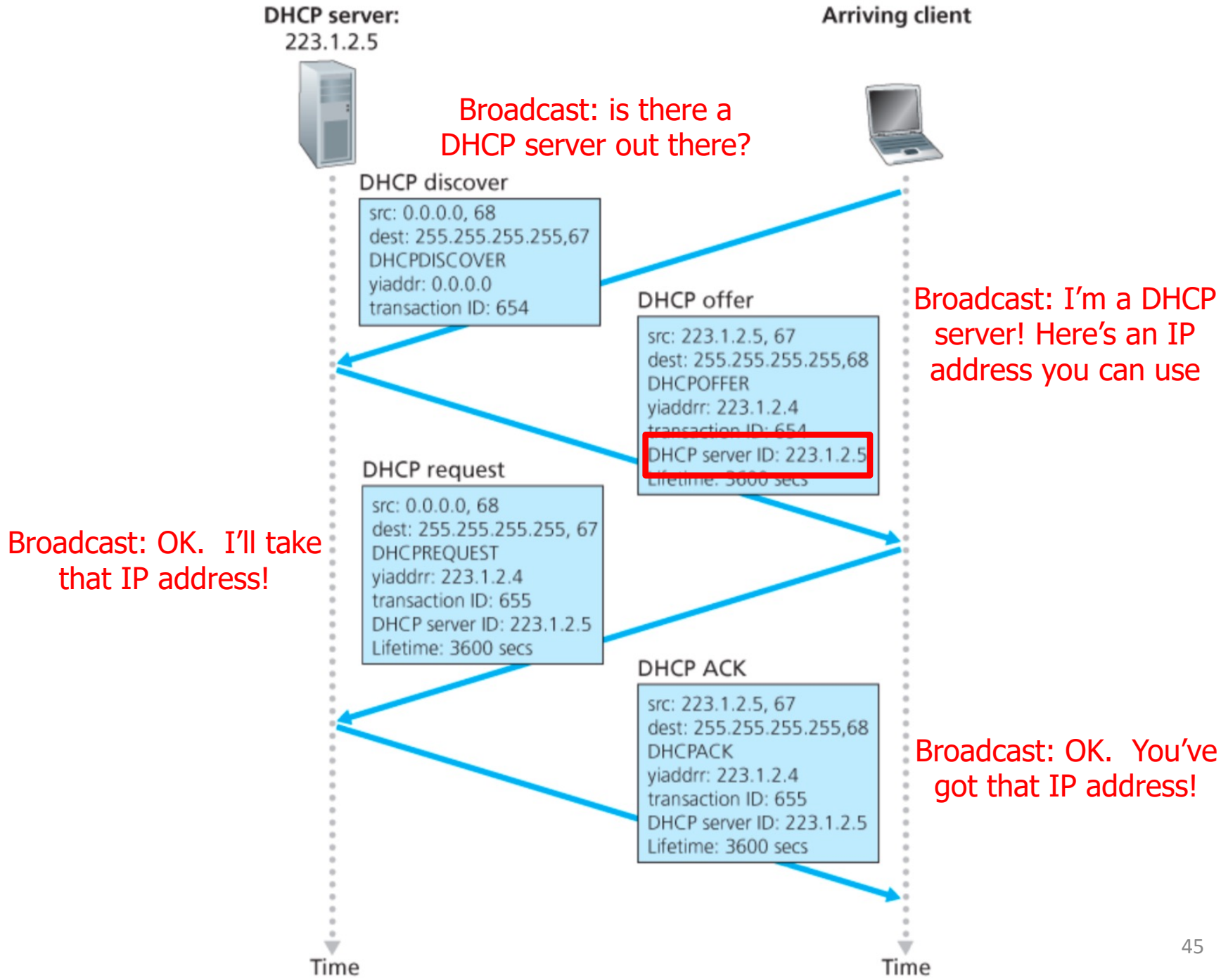
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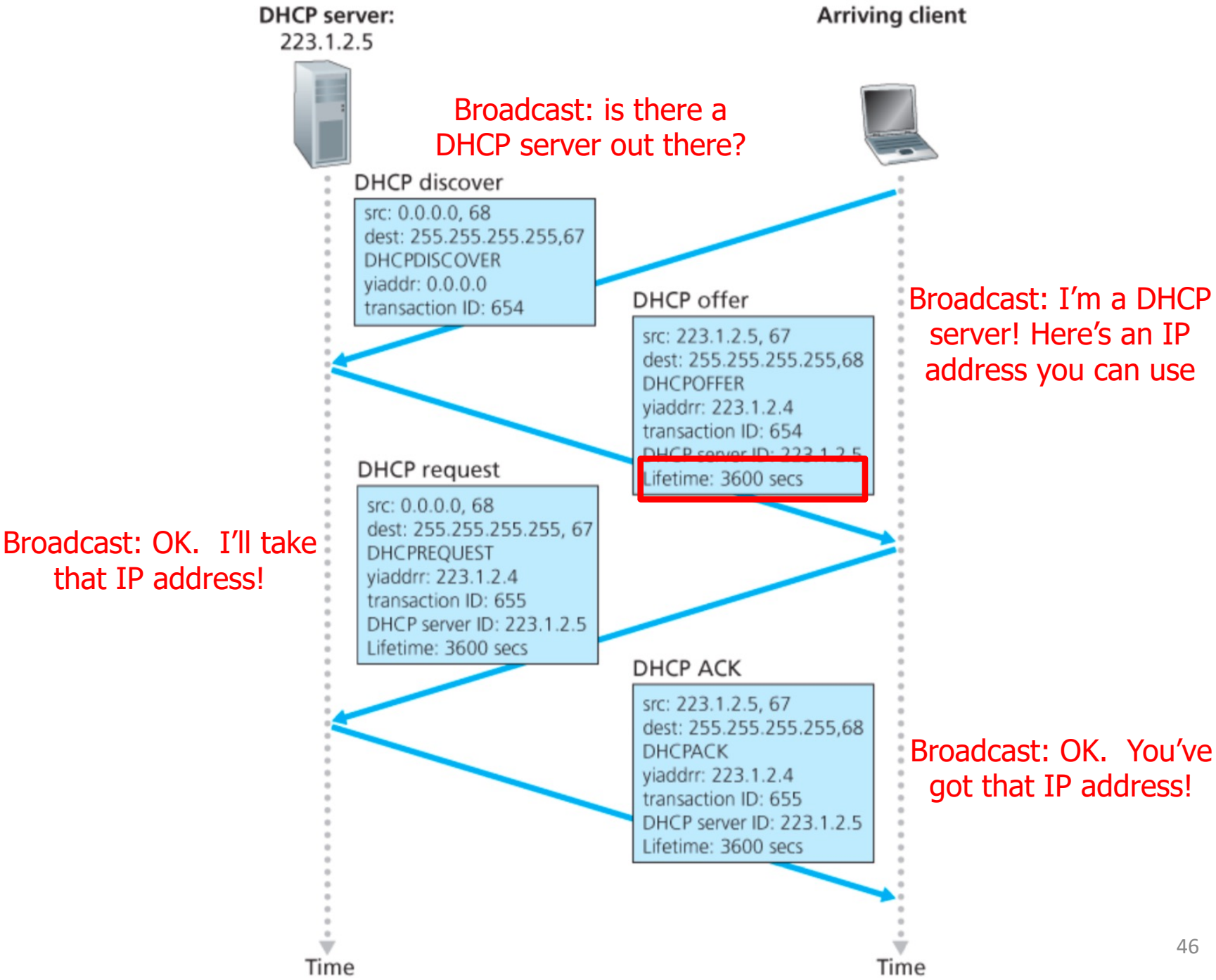
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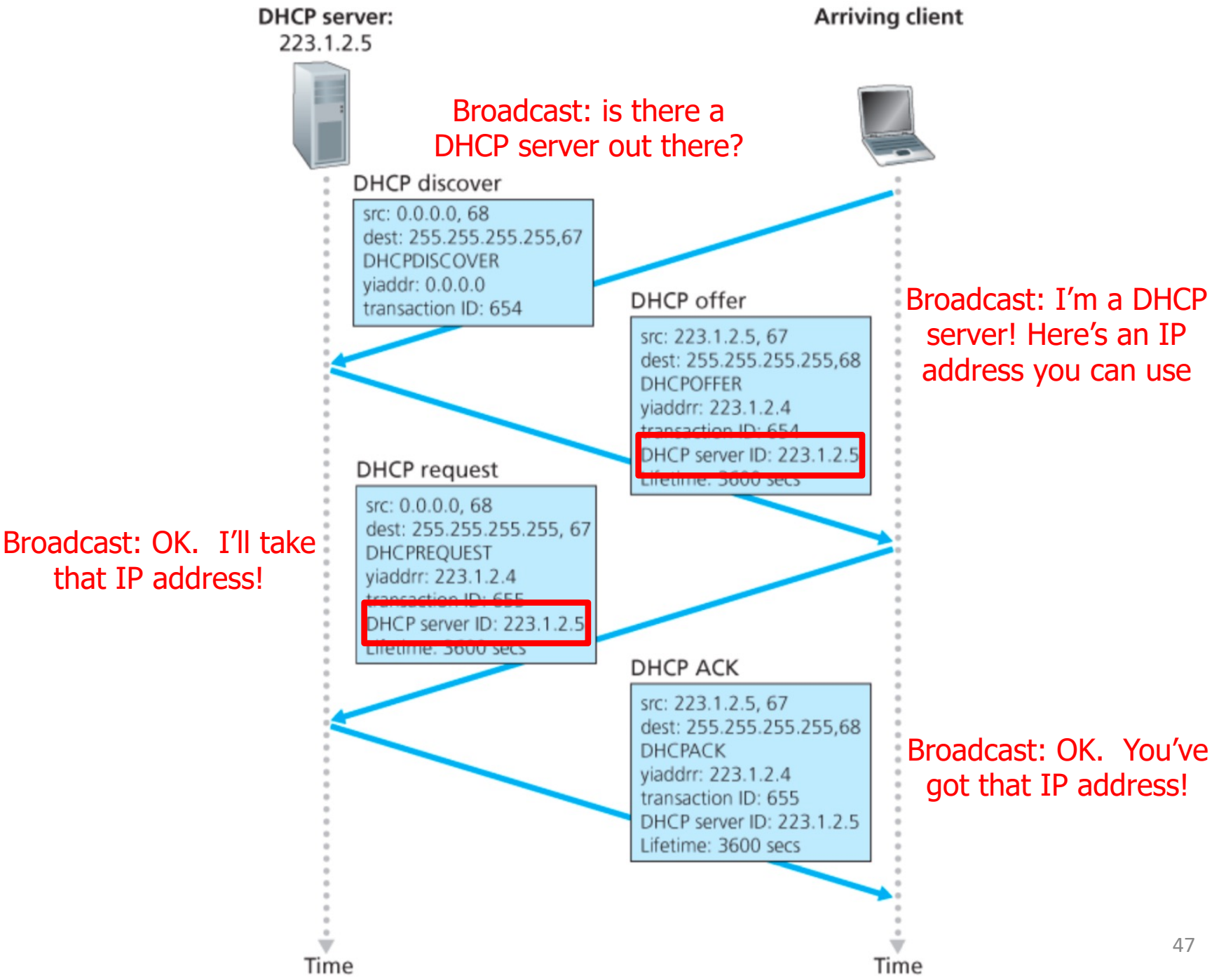
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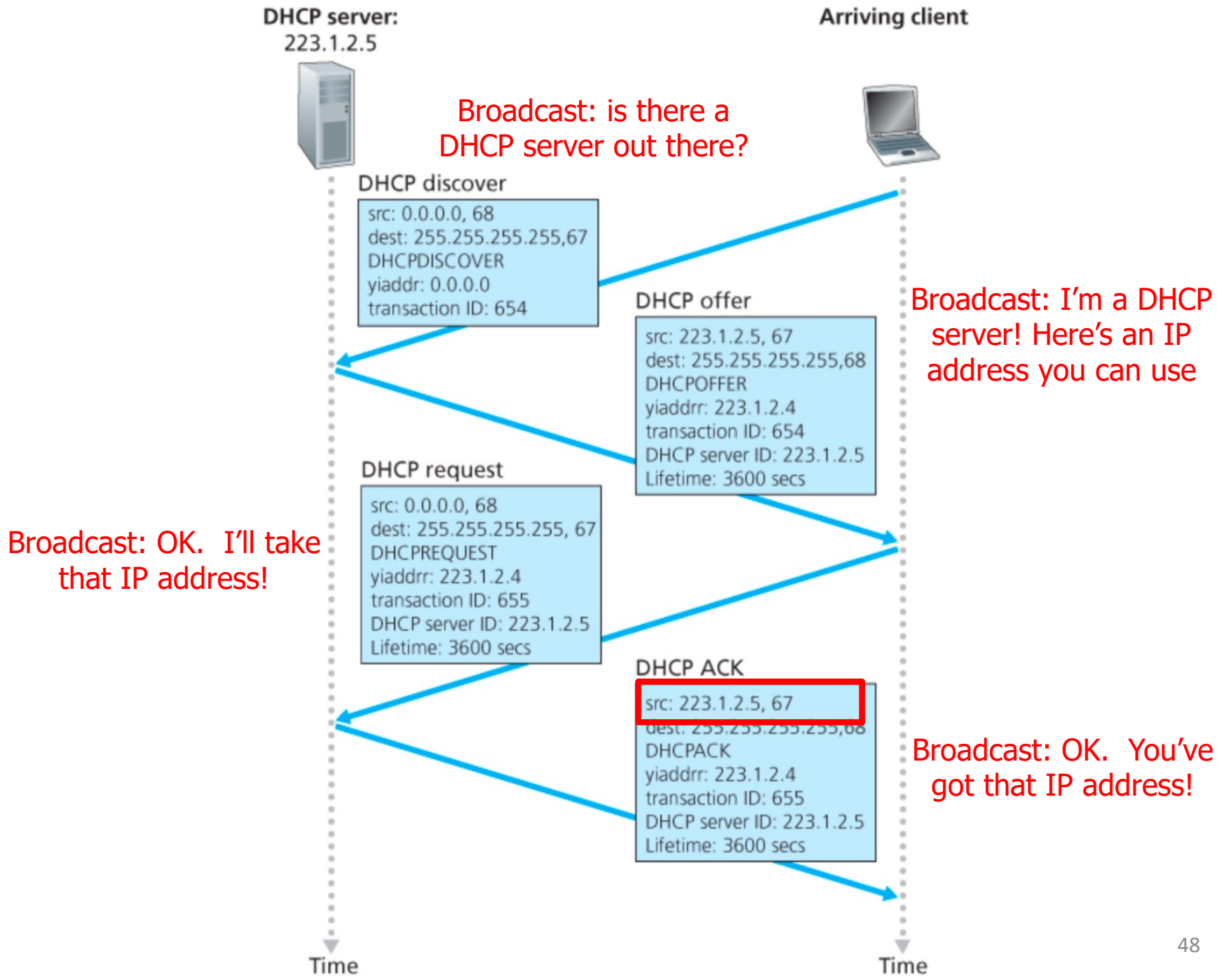
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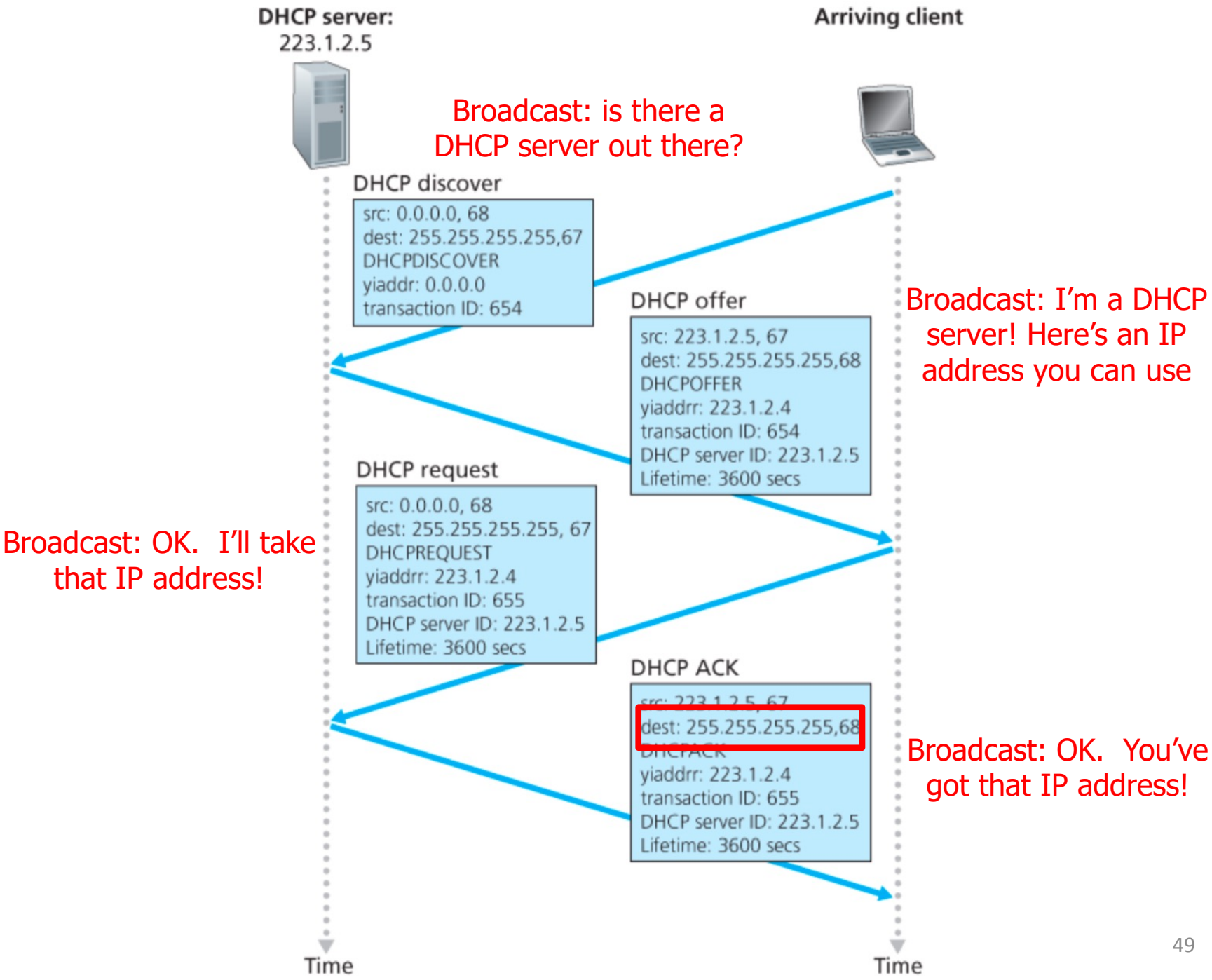
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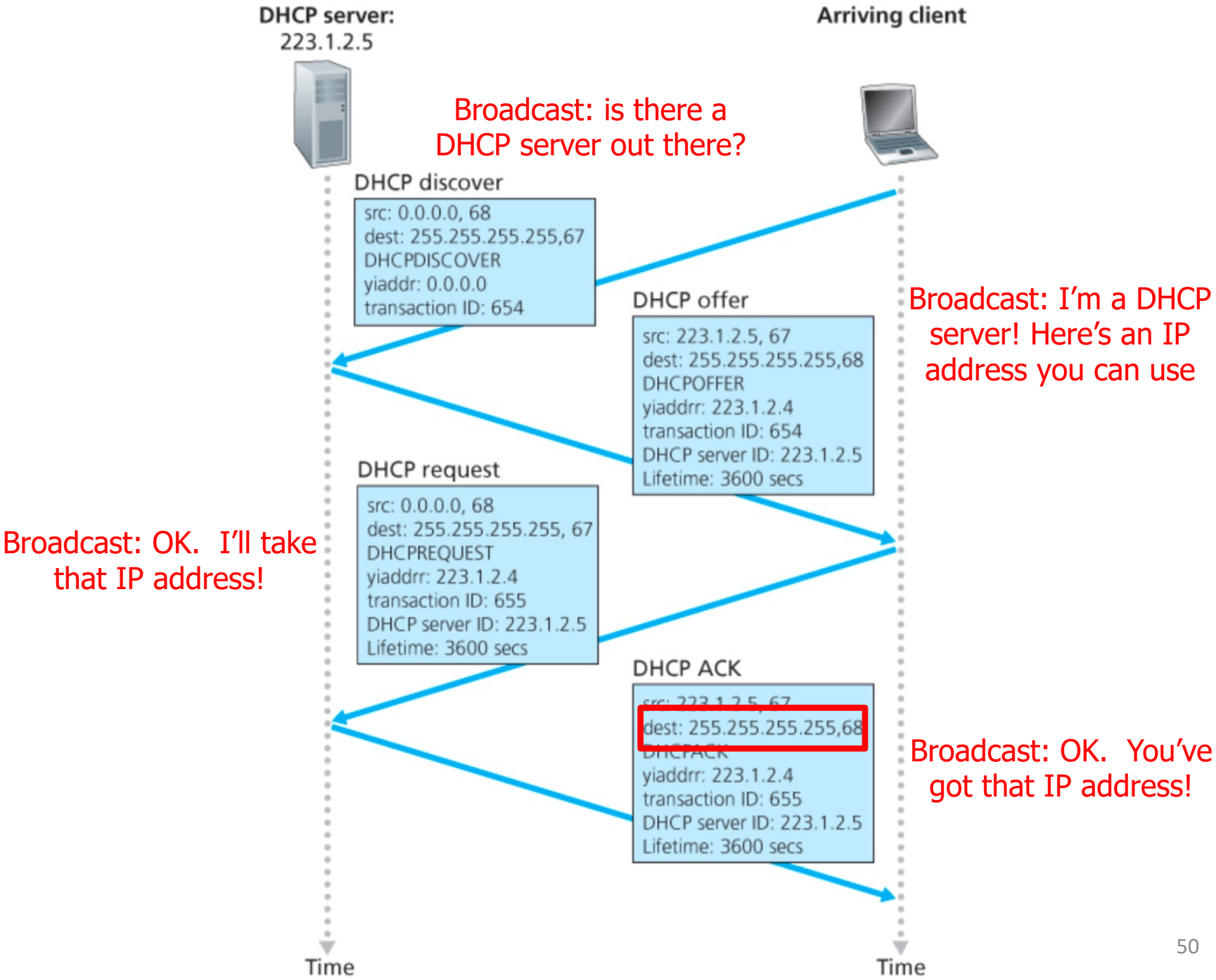
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