

Chapter 4

Network Layer:

The Data Plane

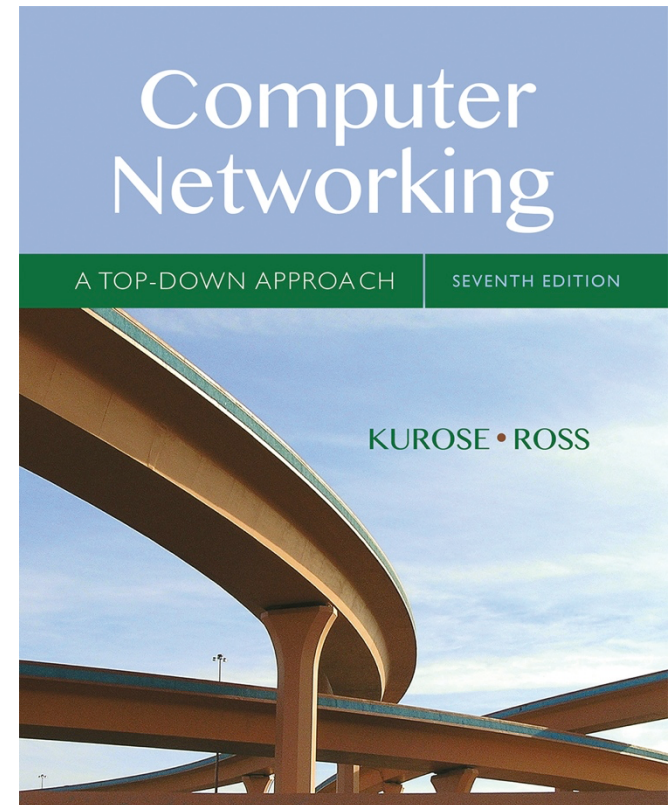
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Computer Networking: A Top Down Approach

7th edition

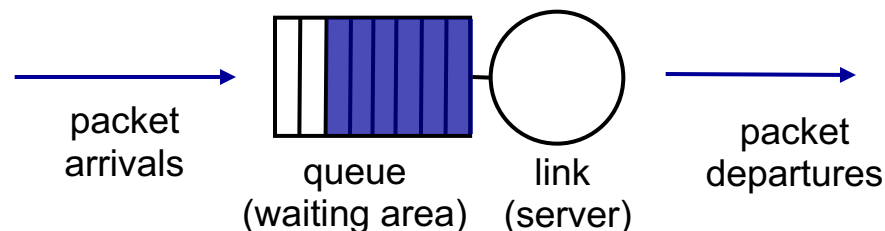
Jim Kurose, Keith Ross

Pearson/Addison Wesley

April 2016

Scheduling mechanisms

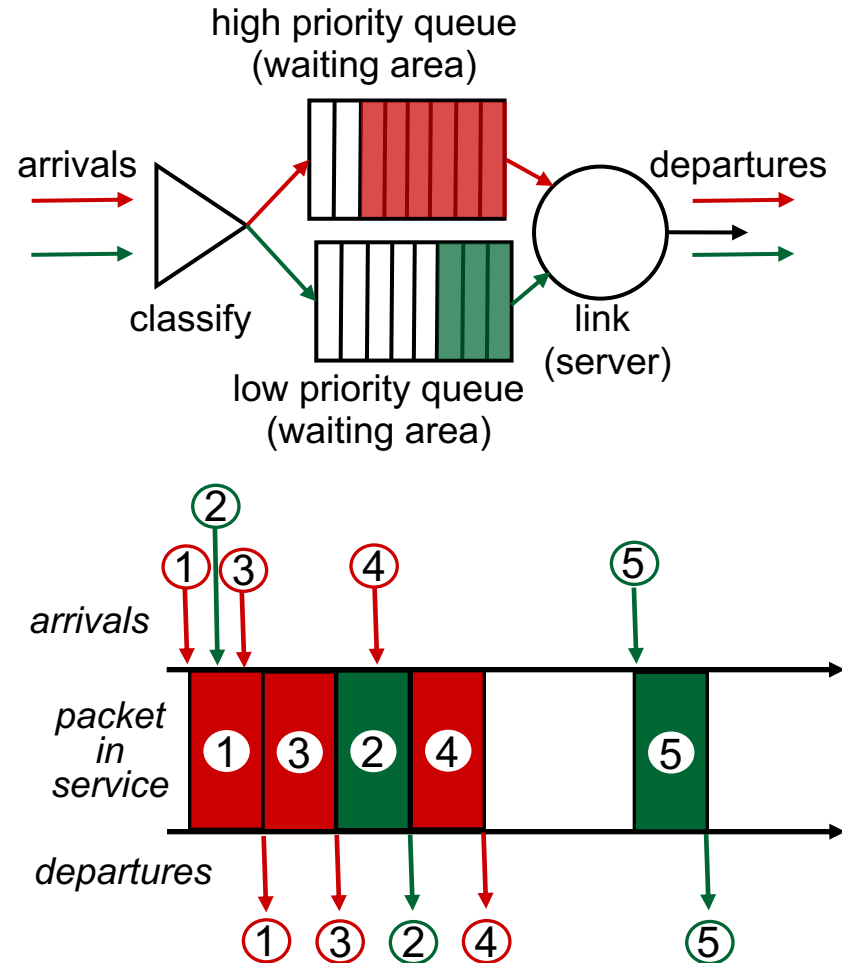
- *scheduling*: choose next packet to send on link
- *FIFO (first in first out) scheduling*: send in order of arrival to queue
 - real-world example?
 - *discard policy*: if packet arrives to full queue: who to discard?
 - *tail drop*: drop arriving packet
 - *priority*: drop/remove on priority basis
 - *random*: drop/remove randomly



Scheduling policies: priority

priority scheduling: send highest priority queued packet

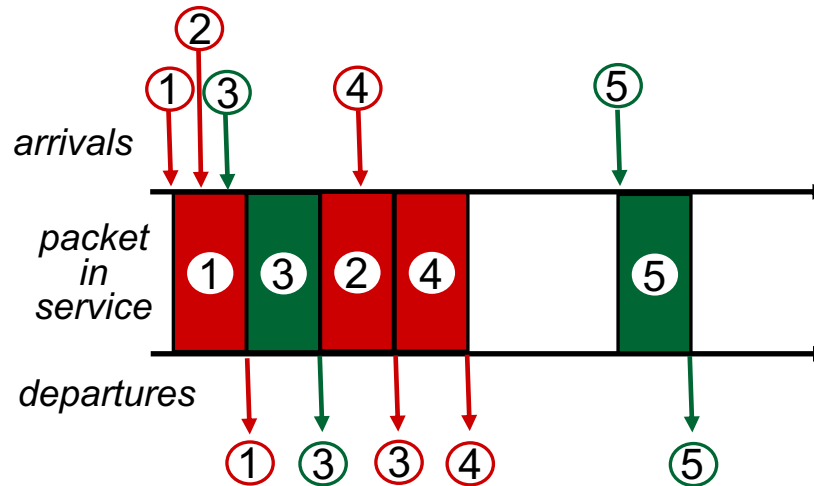
- multiple *classes*, with different priorities
 - class may depend on marking or other header info, e.g. IP source/dest, port numbers, etc.
 - real world example?



Scheduling policies: still more

Round Robin (RR) scheduling:

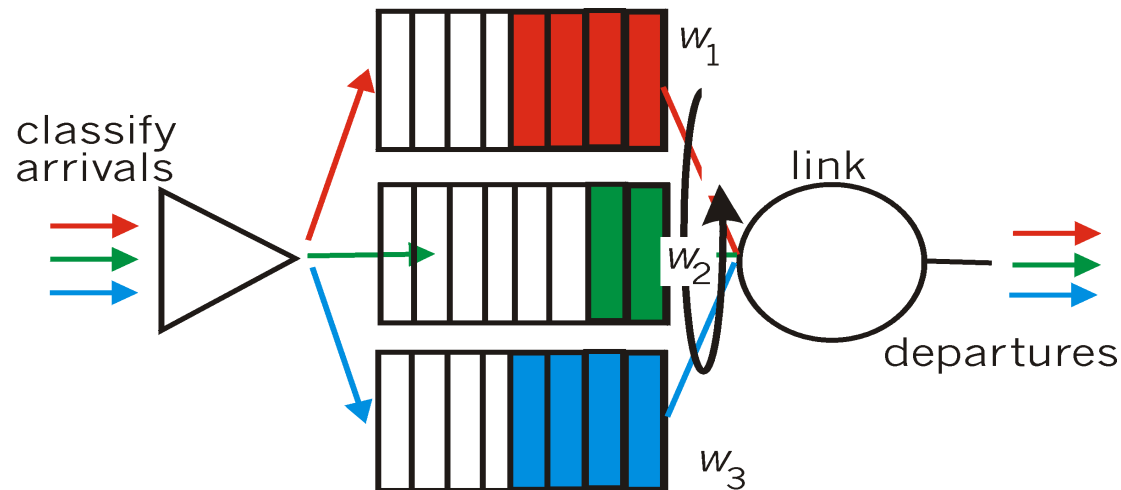
- multiple classes
- cyclically scan class queues, sending one complete packet from each class (if available)
- real world example?



Scheduling policies: still more

Weighted Fair Queuing (WFQ):

- generalized Round Robin
- each class gets weighted amount of service in each cycle
- real-world example?



Chapter 4: outline

4.1 Overview of Network layer

- data plane
- control plane

4.2 What's inside a router

4.3 IP: Internet Protocol

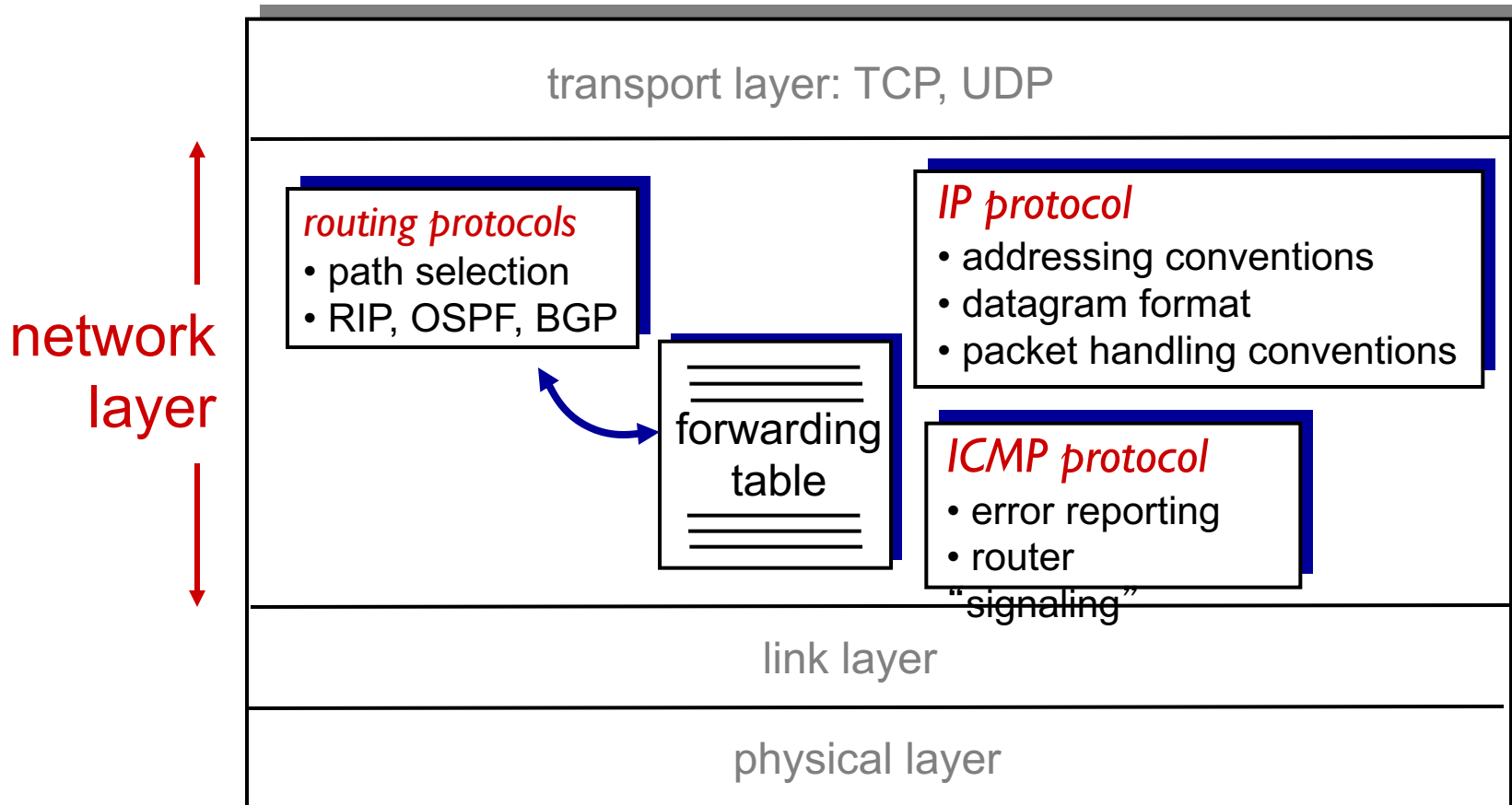
- datagram format
- fragmentation
- IPv4 addressing
- network address translation
- IPv6

4.4 Generalized Forward and SDN

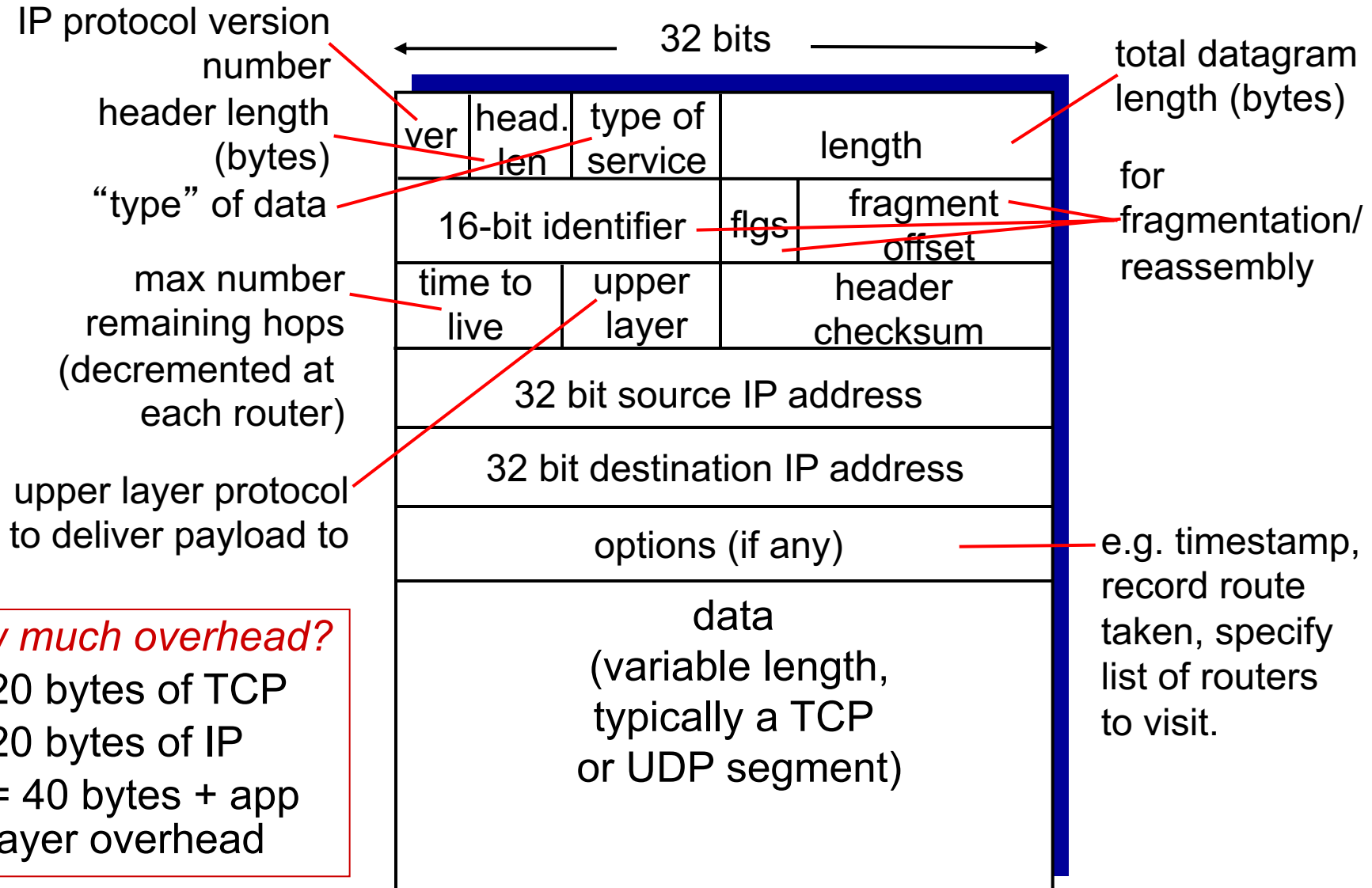
- match
- action
- OpenFlow examples of match-plus-action in action

The Internet network layer

host, router network layer functions:

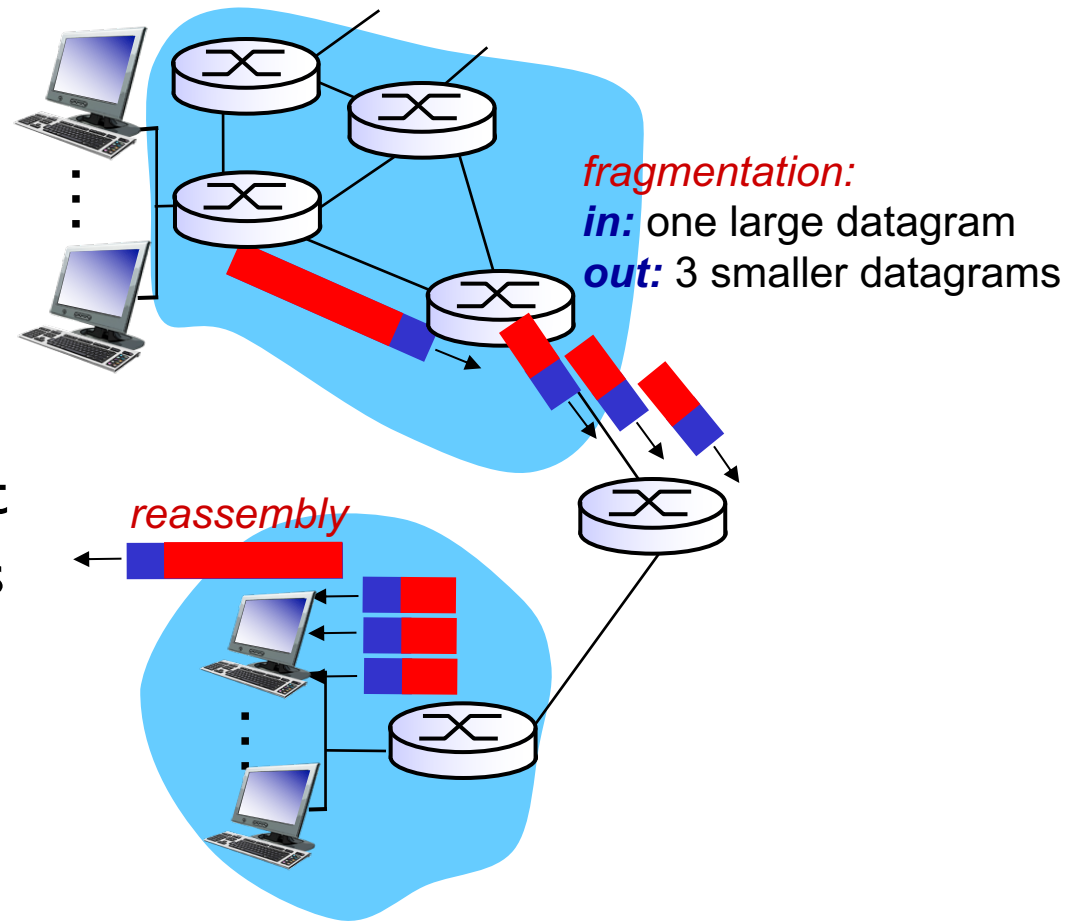


IP datagram format



IP fragmentation, reassembly

- network links have MTU (max.transfer size) - largest possible link-level frame
 - different link types, different MTUs
- large IP datagram divided (“fragmented”) within net
 - one datagram becomes several datagrams
 - “reassembled” only at final destination
 - IP header bits used to identify, order related fragments



IP fragmentation, reassembly

example:

- ❖ 4000 byte datagram
- ❖ MTU = 1500 bytes

	length =4000	ID =x	fragflag =0	offset =0	
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*one large datagram becomes
several smaller datagrams*

1480 bytes in
data field

offset =
1480/8

	length =1500	ID =x	fragflag =1	offset =0	
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	length =1500	ID =x	fragflag =1	offset =185	
--	-----------------	----------	----------------	----------------	--

	length =1040	ID =x	fragflag =0	offset =370	
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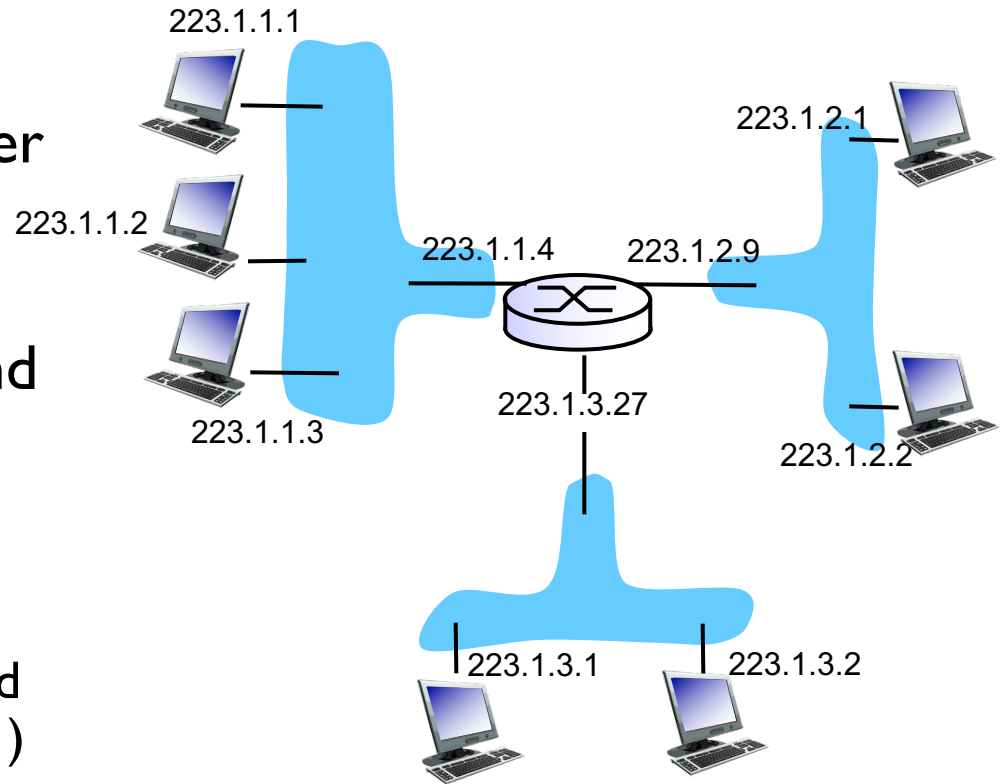
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4.4 Generalized Forward and SDN

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IP addressing: introduction

- **IP address:** 32-bit identifier for host, router interface
- **interface:** connection between host/router and physical link
 - router's typically have multiple interfaces
 - host typically has one or two interfaces (e.g., wired Ethernet, wireless 802.11)
- **IP addresses associated with each interface**



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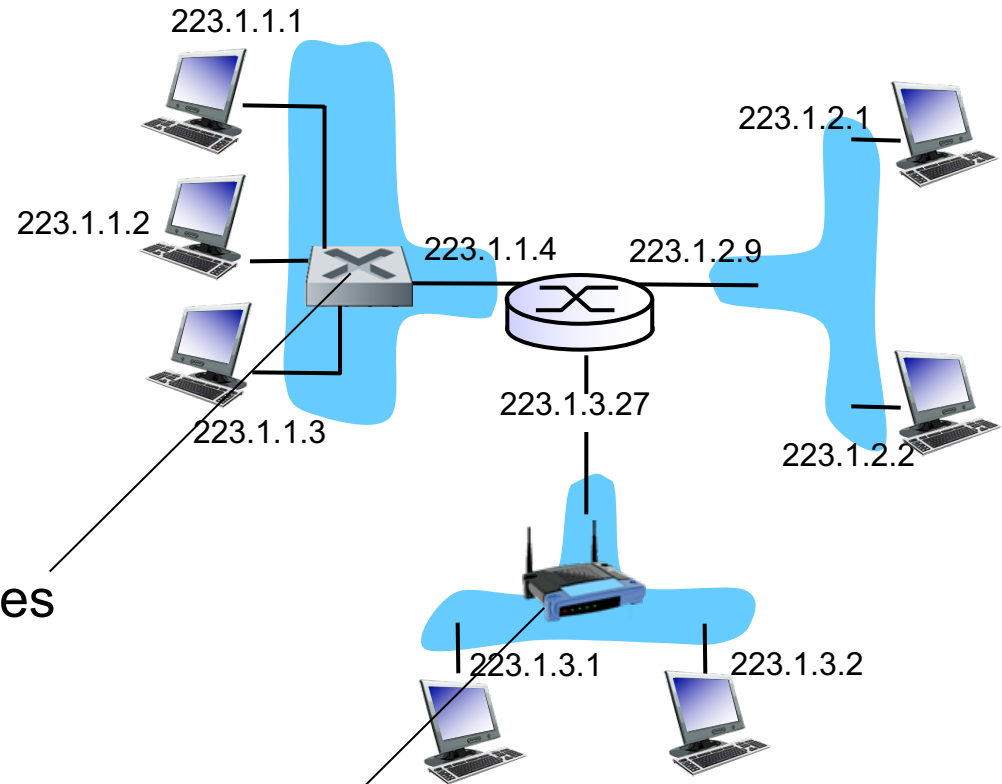
IP addressing: introduction

Q: how are interfaces actually connected?

A: we'll learn about that in chapter 5, 6.

A: wired Ethernet interfaces connected by Ethernet switches

For now: don't need to worry about how one interface is connected to another (with no intervening router)



A: wireless WiFi interfaces connected by WiFi base station

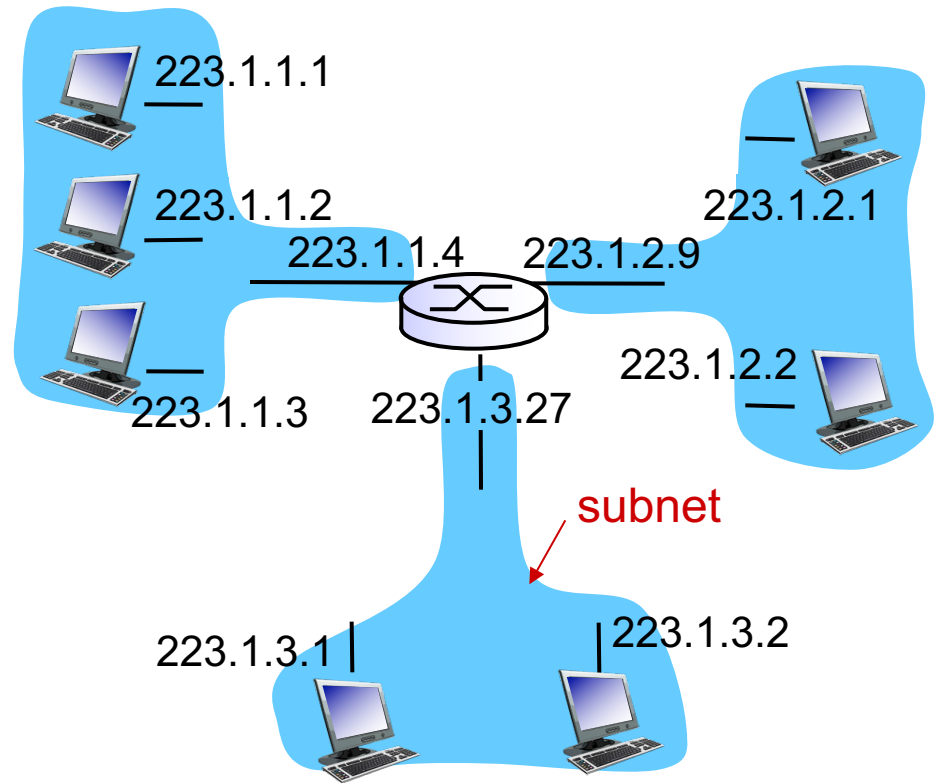
Subnets

■ IP address:

- subnet part - high order bits
- host part - low order bits

■ *what 's a subnet ?*

- device interfaces with same subnet part of IP address
- can physically reach each other *without intervening router*

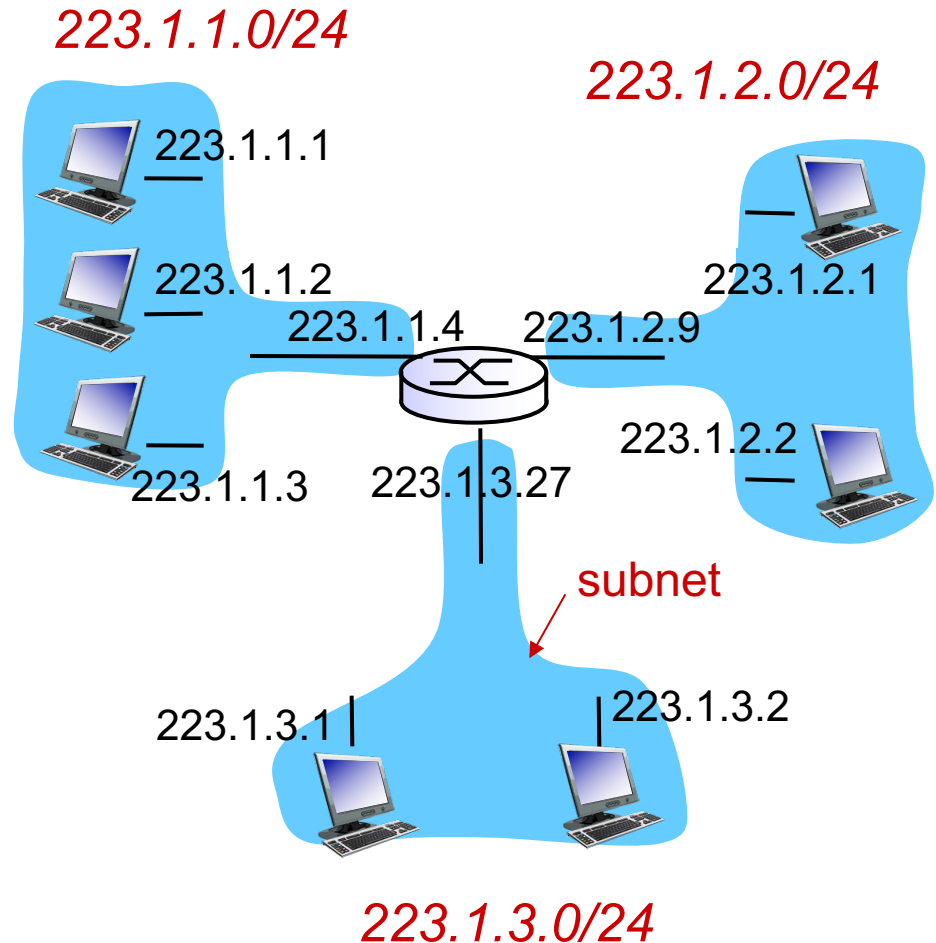


network consisting of 3 subnets

Subnets

recipe

- to determine the subnets, detach each interface from its host or router, creating islands of isolated networks
- each isolated network is called a *subnet*



subnet mask: /24

Subnets

how many?

