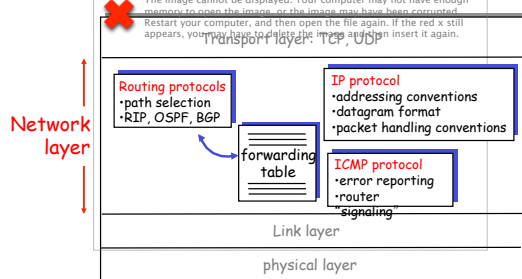


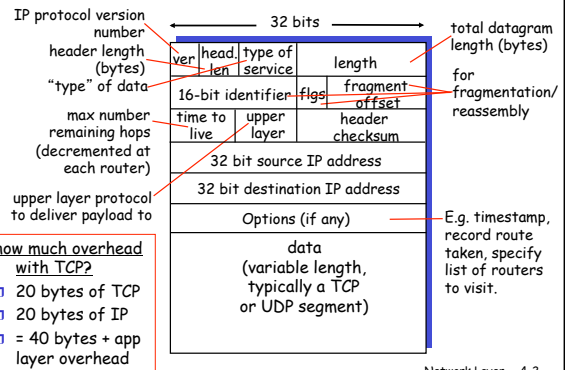
## The Internet Network layer

Host, router network layer functions:



Network Layer 4-1

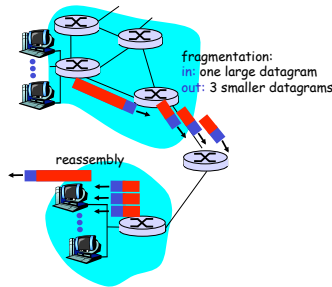
## IP datagram format



Network Layer 4-2

## 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



Network Layer 4-3

## IP Fragmentation and Reassembly

Example

- 4000 byte datagram
- MTU = 1500 bytes

length	ID	fragflag	offset
=4000	=x	=0	=0

One large datagram becomes several smaller datagrams

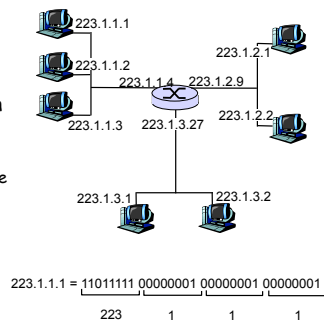
1480 bytes in data field  
offset = 1480/8

length	ID	fragflag	offset
=1500	=x	=1	=0
=1500	=x	=1	=185
=1040	=x	=0	=370

Network Layer 4-4

## IP Addressing: introduction

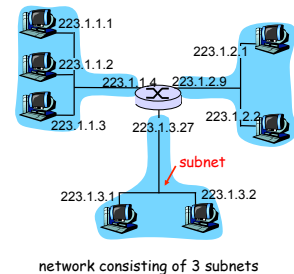
- IP address: 32-bit identifier for host, router interface
- interface: connection between host/router and physical link
  - router's typically have multiple interfaces
  - host typically has one interface
  - IP addresses associated with each interface



Network Layer 4-5

## 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



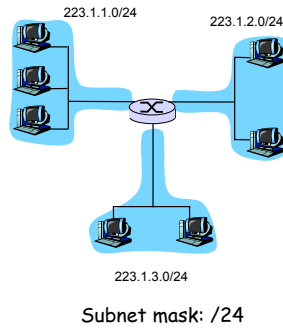
network consisting of 3 subnets

Network Layer 4-6

## Subnets

### Recipe

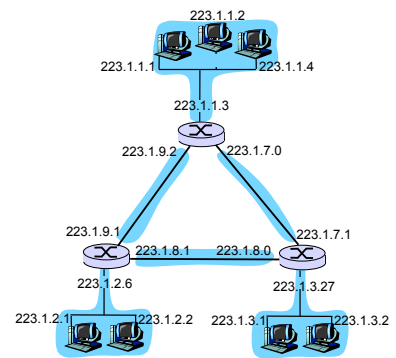
- To determine the subnets, detach each interface from its host or router, creating islands of isolated networks. Each isolated network is called a **subnet**.



Network Layer 4-7

## Subnets

How many?



Network Layer 4-8

## DHCP: Dynamic Host Configuration Protocol

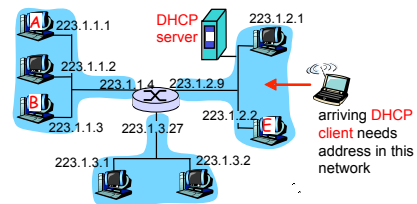
**Goal:** allow host to *dynamically* obtain its IP address from network server when it joins network  
Can renew its lease on address in use  
Allows reuse of addresses (only hold address while connected an "on")  
Support for mobile users who want to join network (more shortly)

DHCP overview:

- host broadcasts "DHCP discover" msg
- DHCP server responds with "DHCP offer" msg
- host requests IP address: "DHCP request" msg
- DHCP server sends address: "DHCP ack" msg

Network Layer 4-9

## DHCP client-server scenario



Network Layer 4-10

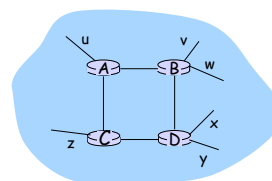
## Intra-AS Routing

- also known as **Interior Gateway Protocols (IGP)**
- most common Intra-AS routing protocols:
  - RIP: Routing Information Protocol
  - OSPF: Open Shortest Path First
  - IGRP: Interior Gateway Routing Protocol (Cisco proprietary)

Network Layer 4-11

## RIP ( Routing Information Protocol)

- distance vector algorithm
- included in BSD-UNIX Distribution in 1982
- distance metric: # of hops (max = 15 hops)



From router A to subnets:

destination	hops
u	1
v	2
w	2
x	3
y	3
z	2

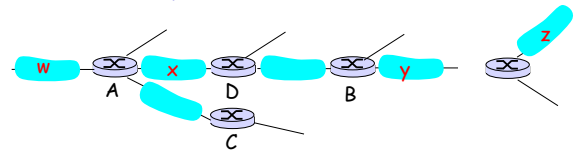
Network Layer 4-12

## RIP advertisements

- distance vectors: exchanged among neighbors every 30 sec via Response Message (also called advertisement)
- each advertisement: list of up to 25 destination nets within AS (autonomous system)

Network Layer 4-13

## RIP: Example



Destination Network	Next Router	Num. of hops to dest.
W	A	2
Y	B	2
Z	B	7
X	--	1
...	...	...

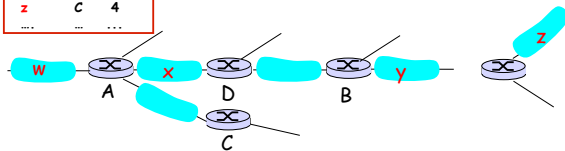
Routing table in D

Network Layer 4-14

## RIP: Example

Dest	Next	hops
W	-	1
X	-	1
Z	C	4
...	...	...

Advertisement from A to D



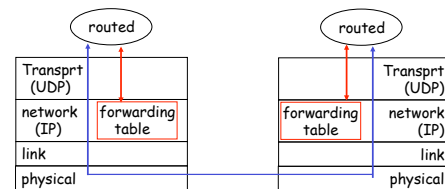
Destination Network	Next Router	Num. of hops to dest.
W	A	2
Y	B	2
Z	<del>B</del> A	<del>7</del> 5
X	--	1
...	...	...

Routing table in D

Network Layer 4-15

## RIP Table processing

- RIP routing tables managed by application-level process called route-d (daemon)
- advertisements sent in UDP packets, periodically repeated



Network Layer 4-16