

Lecture 10: Addressing

CSE 123: Computer Networks
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HW 2 due Friday



Lecture 10 Overview



- Class-based addressing
- Subnetting
- Classless addressing

IP Forwarding



- Router needs to know where to forward a packet
- Forwarding table contains:
 - ◆ List of network names (e.g., LANs) and **next-hop** routers
 - ◆ Attached (local) networks have entries specifying which interface
 - » **Link-local** hosts are delivered using Layer-2 forwarding
- Address of incoming internetwork packet needs to say:
 - ◆ What is the destination network? (For use by most routers)
 - ◆ What is the destination host? (For use by the final router)



Addressing Considerations

- Fixed length or variable length addresses?
- Issues:
 - ◆ Flexibility
 - ◆ Processing costs
 - ◆ Header size
- Engineering choice: IP uses fixed length addresses

IP Addresses



- 32-bits in an IPv4 address
 - ◆ Dotted decimal format a.b.c.d
 - ◆ Each represent 8 bits of address
- Hierarchical: Network part and host part
 - ◆ E.g. IP address 128.54.70.238
 - ◆ 128.54 refers to the UCSD campus network
 - ◆ 70.238 refers to the host ieng6.ucsd.edu
- Which part is network vs. host?



Class-based Addressing

- Most significant bits determines “class” of address

Class A	0	Network	Host	127 nets, 16M hosts		
Class B	1	0	14 Network	16 Host	16K nets, 64K hosts	
Class C	1	1	0	21 Network	8 Host	2M nets, 254 hosts

- Special addresses
 - ◆ Class D (1110) for multicast, Class E (1111) experimental
 - ◆ 127.0.0.1: local host (a.k.a. the loopback address)
 - ◆ Host bits all set to 0: network address
 - ◆ Host bits all set to 1: broadcast address

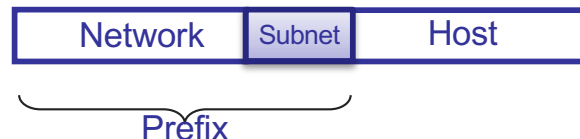
**To what class network does
132.239.180.101 belong?**

- A. A**
- B. B**
- C. C**
- D. Can't tell**



Routing over LANs: Subnetting

- Individual networks may be composed of several LANs
 - ◆ Only want traffic destined to local hosts on physical network
 - ◆ Routers need a way to know which hosts on which LAN
- Networks can be arbitrarily decomposed into **subnets**
 - ◆ Each subnet is simply a prefix of the host address portion
 - ◆ Subnet prefix can be of any length, specified with **netmask**



Subnet Addresses



- Every (sub)network has an address and a **netmask**
 - ◆ Netmask tells which bits of the network address is important
 - ◆ Convention suggests it be a proper prefix
- Netmask written as an all-ones (bits) IP address
 - ◆ E.g., Class B netmask is 255.255.0.0 (i.e, 11111111111111110000000000000000)
 - ◆ Sometimes expressed in terms of number of 1s, e.g., /16
- Need to size subnet appropriately for each LAN
 - ◆ Only have remaining bits to specify host addresses

**What is the prefix of
132.239.180.101 if the
netmask is 255.255.192.0?**

- A. 132.239.0.0**
- B. 132.239.192.0**
- C. 132.239.180.0**
- D. 132.239.128.0**



IP Address Problem (circa 1991)

- Address space depletion
 - ◆ In danger of running out of classes A and B
- Why?
 - ◆ Class C too small for most organizations (only ~250 addresses)
 - ◆ Very few class A – very careful about giving them out (who has 16M hosts anyway?)
 - ◆ Class B – greatest problem

CIDR



- Classless Inter-Domain Routing (1993)
 - ♦ Networks described by variable-length prefix and length
 - ♦ Allows arbitrary allocation between network and host address



- ♦ e.g. 10.95.1.2 contained within 10.64.0.0/10:
 - » 10.64.0.0 is network and remainder (31.1.2) is host
 - » 0000101001 / 0111110000000100000010
- Pro: Finer grained allocation; aggregation
- Con: More expensive lookup: **longest prefix match**

Longest Matching Prefix



- Forwarding table contains many prefix/length tuples
 - ◆ They *need not* be disjoint!
 - ◆ E.g. 200.23.16.0/20 and 200.23.18.0/23
 - ◆ What to do if a packet arrives for destination 200.23.18.1?
 - ◆ Need to find the longest prefix in the table which matches it (200.23.18.0/23)
- Not a simple table, requires multiple memory lookups
 - ◆ Lots and lots of research done on this problem
 - ◆ Lots of this work was historically done by UCSD faculty

Can an IP address match two forwarding table entries of the same length?

A. Yes

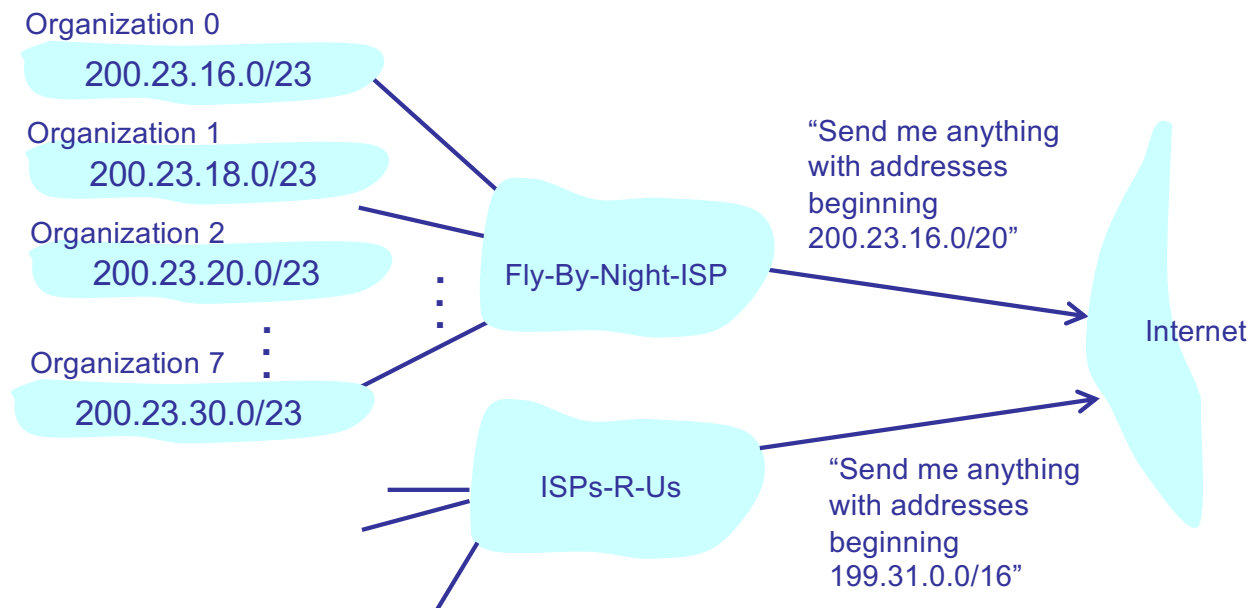
B. No

C. Only if the least significant bit is zero



Route Aggregation

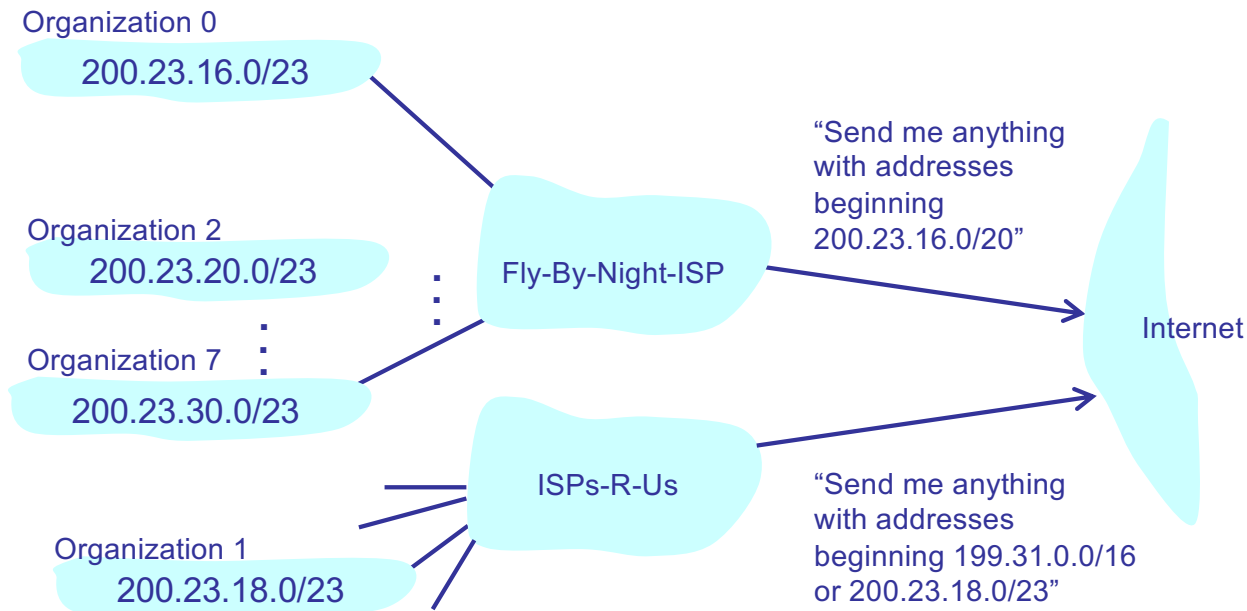
- Combine adjacent networks in forwarding tables
 - ◆ Helps keep forwarding table size down





Most Specific Route

- But what if address range is not contiguous?



For Next Time



- Read 4.2
- Finish up Homework 2
- Keep plugging on Project 1b