Introduction to Computer Networks

IP Forwarding (§5.6.1-5.6.2)

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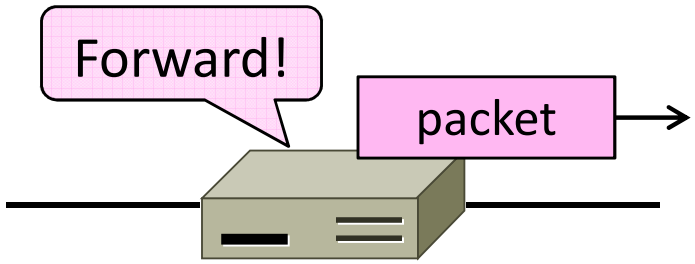
Topic

- How do routers forward packets?
  - We'll look at how IP does it
  - (We'll cover routing later)



Recap

- We want the network layer to:
  - Scale to large networks
    - Using addresses with hierarchy
  - Support diverse technologies
    - Internetworking with IP
  - Use link bandwidth well
    - Lowest-cost routing

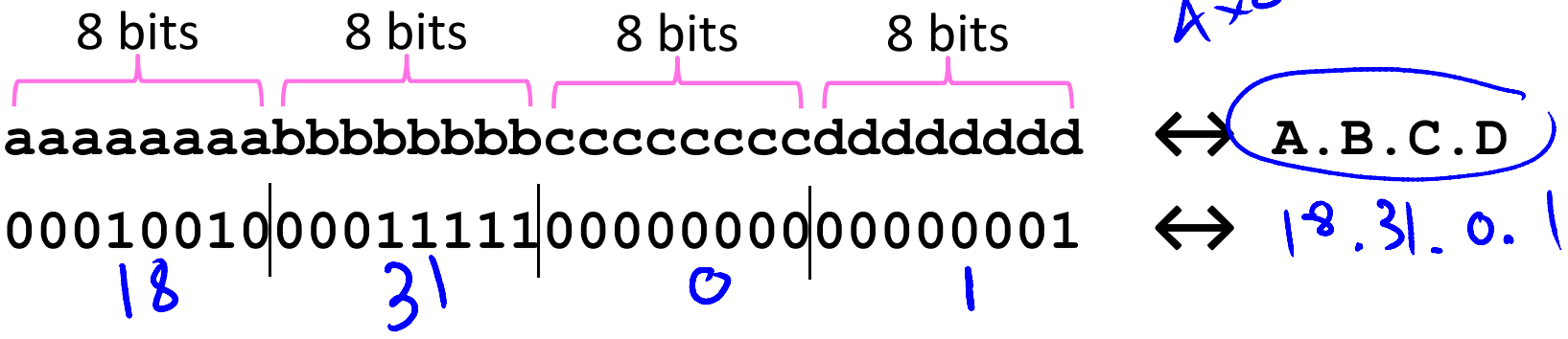
This lecture

More later

Next time

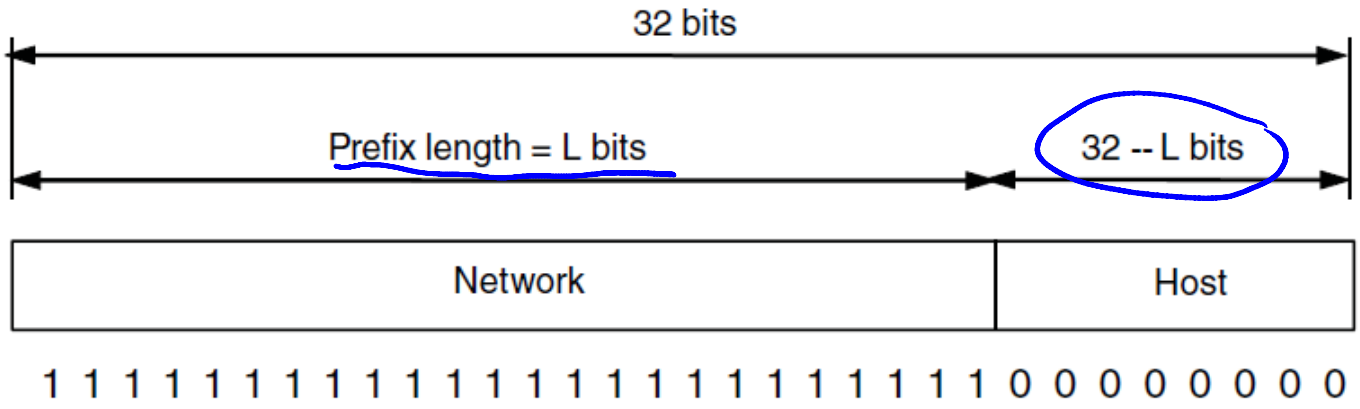
IP Addresses

- IPv4 uses 32-bit addresses
  - Later we'll see IPv6, which uses 128-bit addresses
- Written in "dotted quad" notation
  - Four 8-bit numbers separated by dots



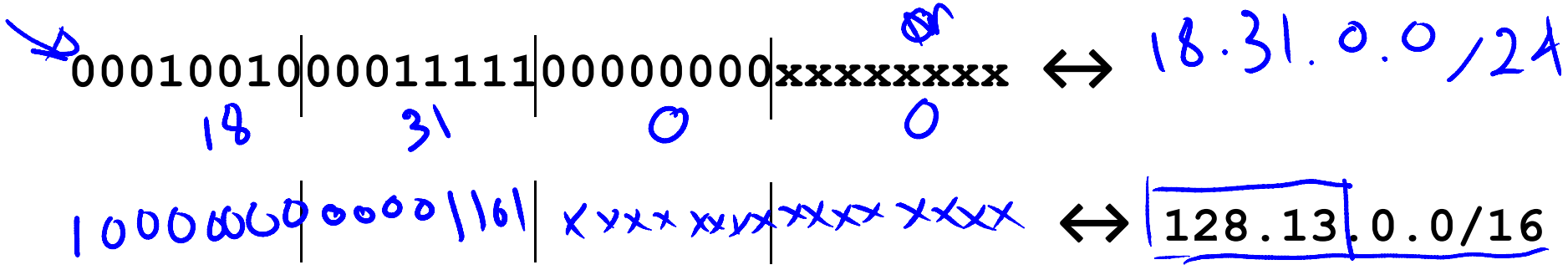
IP Prefixes

- Addresses are allocated in blocks called prefixes
  - Addresses in an L-bit prefix have the same top L bits
  - There are 2^{32-L} addresses aligned on 2^{32-L} boundary



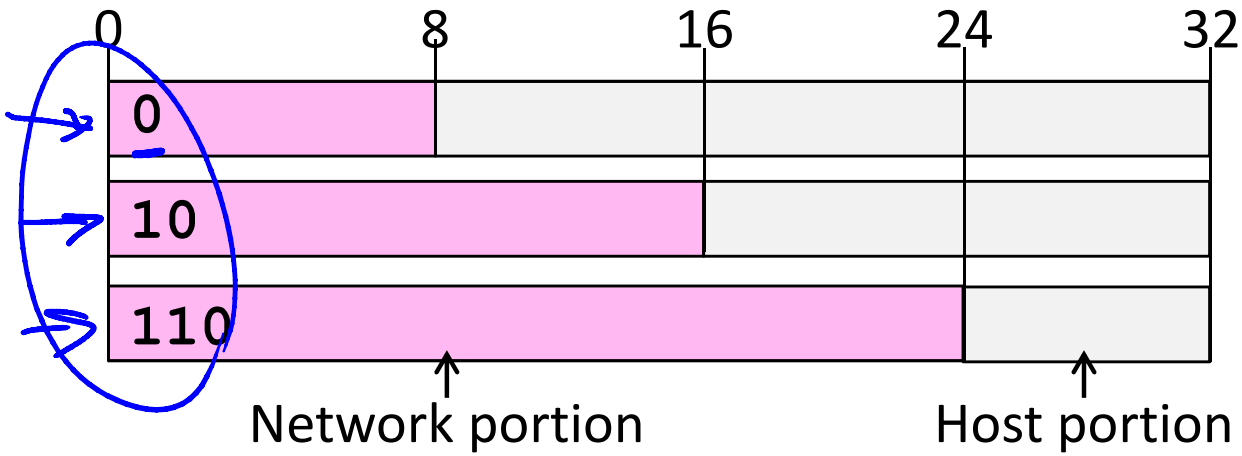
IP Prefixes (2)

- Written in "IP address/length" notation
  - Address is lowest address in the prefix, length is prefix bits
  - E.g., 128.13.0.0/16 is 128.13.0.0 to 128.13.255.255
  - So a /24 ("slash 24") is 256 addresses, and a /32 is one address



Classful IP Addressing

- Originally, IP addresses came in fixed size blocks with the class/size encoded in the high-order bits
  - They still do, but the classes are now ignored



Class A, 2^{24} addresses

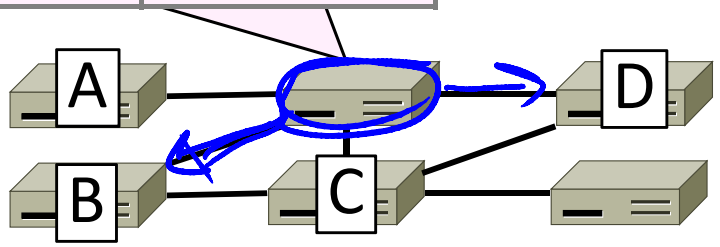
Class B, 2^{16} addresses

Class C, 2^{8} addresses

IP Forwarding

- All addresses on one network belong to the same prefix
- Node uses a table that lists the next hop for prefixes

Prefix	Next Hop
192.24.0.0/19	D
192.24.12.0/22	B



Longest Matching Prefix

- Prefixes in the table might overlap!
  - Combines hierarchy with flexibility

- Longest matching prefix forwarding rule:
  - For each packet, find the longest prefix that contains the destination address, i.e., the most specific entry
  - Forward the packet to the next hop router for that prefix

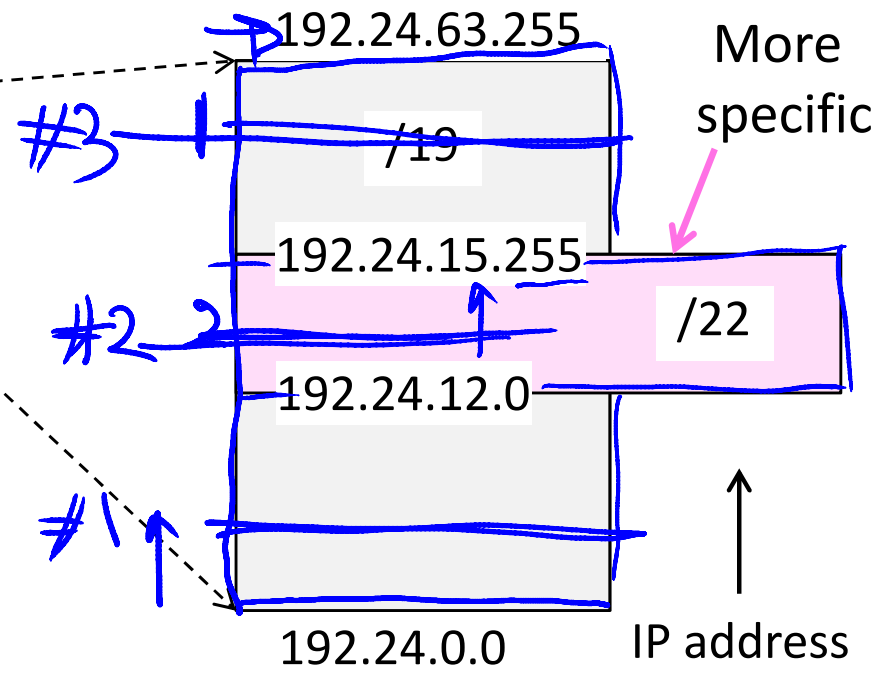
Longest Matching Prefix (2)

Prefix	Next Hop
192.24.0.0/19	D
192.24.12.0/22	B

192.24.6.0 → D

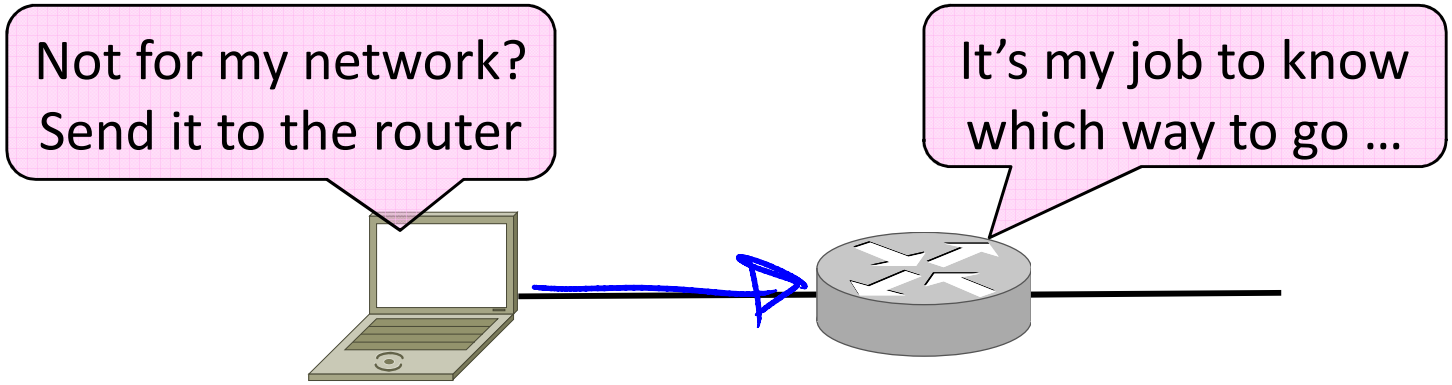
192.24.14.32 → B

192.24.54.0 → D



Host/Router Distinction

- In the Internet:
  - Routers do the routing, know which way to all destinations
  - Hosts send remote traffic (out of prefix) to nearest router



Host Forwarding Table

- Give using longest matching prefix
  - 0.0.0.0/0 is a default route that catches all IP addresses

Prefix	Next Hop
My network prefix	Send to that IP
0.0.0.0/0	Send to my router

Flexibility of Longest Matching Prefix

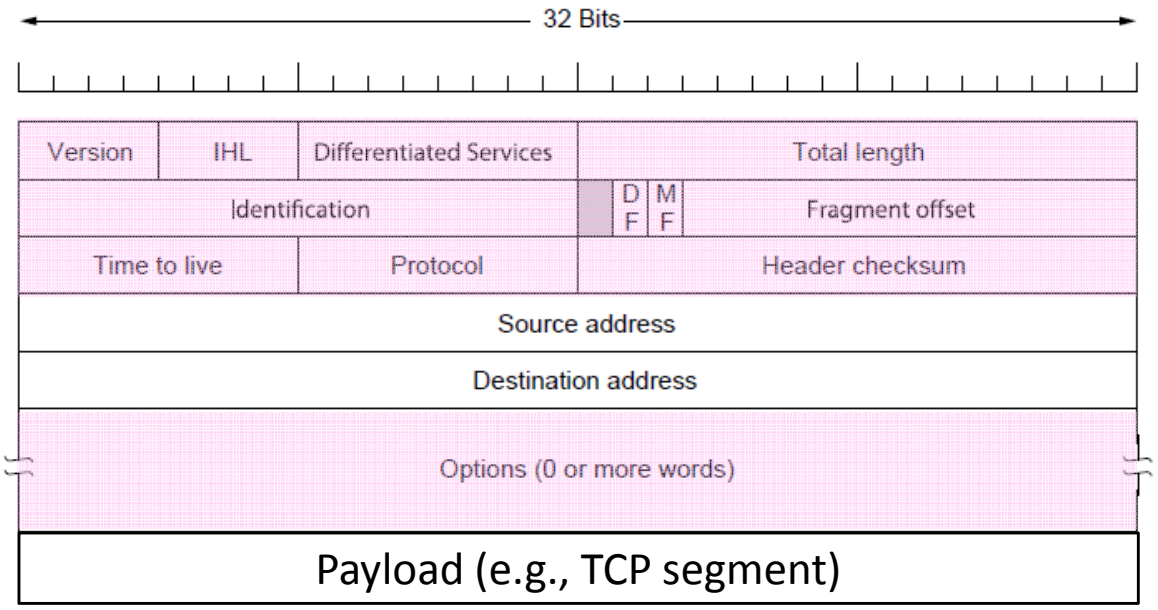
- Can provide default behavior, with less specifics
  - To send traffic going outside an organization to a border router
- Can special case behavior, with more specifics
  - For performance, economics, security, …

Performance of Longest Matching Prefix

- Uses hierarchy for a compact table
  - Relies on use of large prefixes
- Lookup more complex than table
  - Used to be a concern for fast routers
  - Not an issue in practice these days

Other Aspects of Forwarding

- It's not all about addresses …



Other Aspects (2)

- Decrement TTL value
  - Protects against loops
- Checks header checksum
  - To add reliability
- Fragment large packets
  - Split to fit it on next link
- Send congestion signals
  - Warns hosts of congestion
- Generates error messages
  - To help mange network
- Handle various options

Coming later

END