STEVENS
INSTITUTE of TECHNOLOGY
THE INNOVATION UNIVERSITY

CS 146: Intro to Web Programming and Project Development

Instructor: Iraklis Tsekourakis

Lieb 213

Email: itsekour@stevens.edu

TCP/IP

Objectives

Students will be able to:

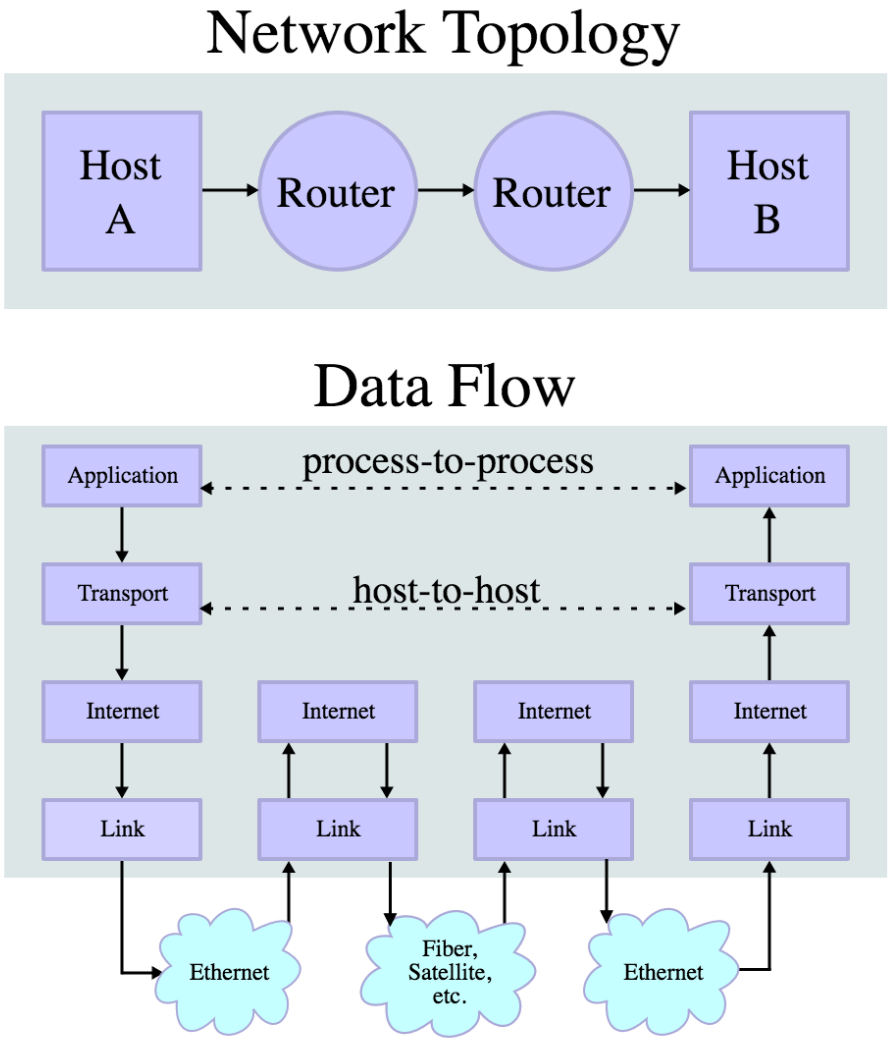
- Define the layers in TCP/IP
- Understand classes of networks
- Work with IP addresses and subnet masks to determine how many hosts can be connected

TCP/IP – Internet Protocol Suite

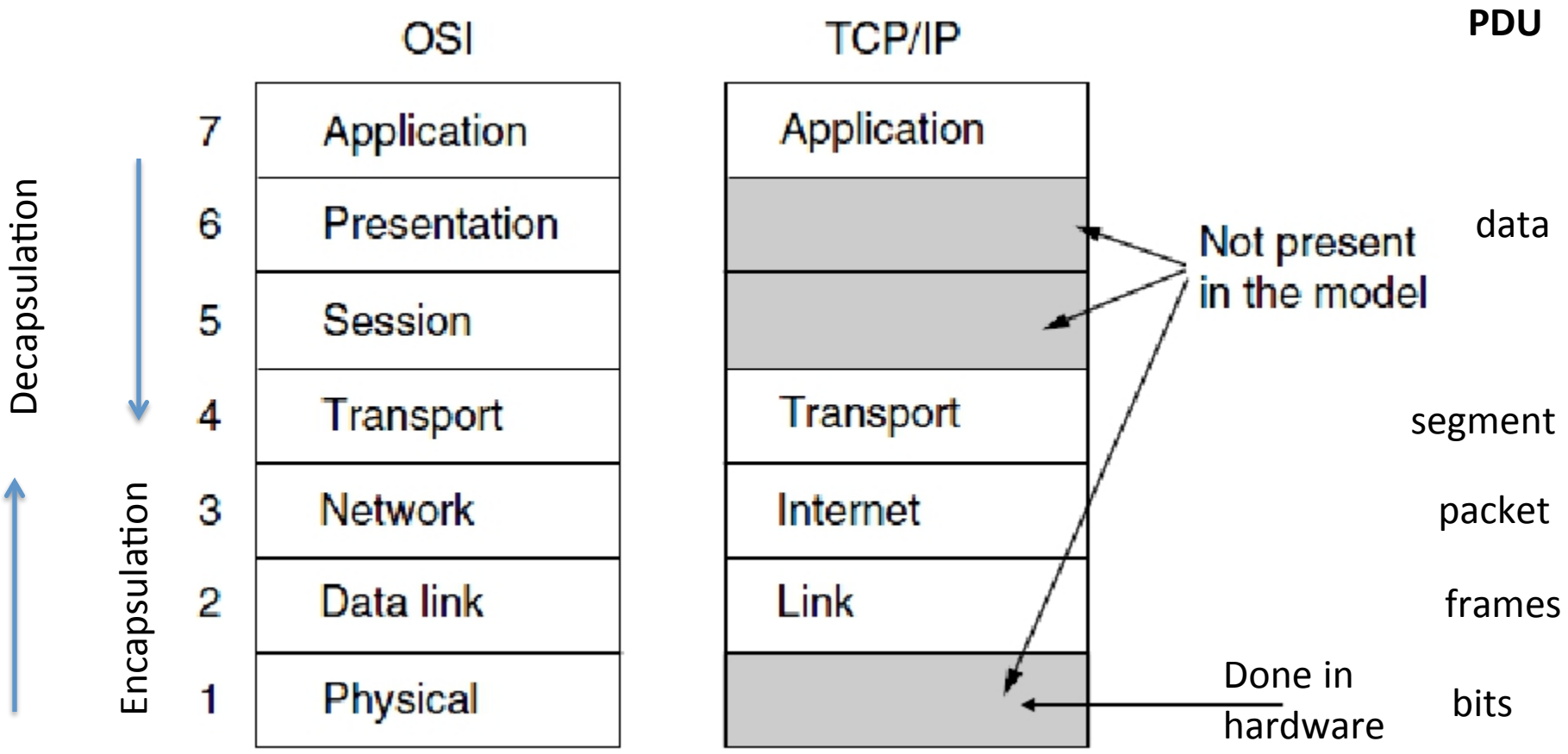
- **T**ransmission **C**ontrol **P**rotocol / **I**nternet **P**rotocol
- TCP/IP is a bit too complex to be categorized in a single layer of the OSI model
- It is a series of tools that works on different layers and is used by many other application layer protocols
- HTTP and DNS for example rely on TCP/IP to work properly
- Most current networking uses TCP/IP
  - Past: IPX/SPX, NetBeui etc.

TCP/IP suite

- Specifies how data should be packetized, addressed, transmitted, routed and received
- Organized into abstraction layers as OSI
- The application on each host executes read and write operations as if the processes were directly connected to each other by some kind of data pipe



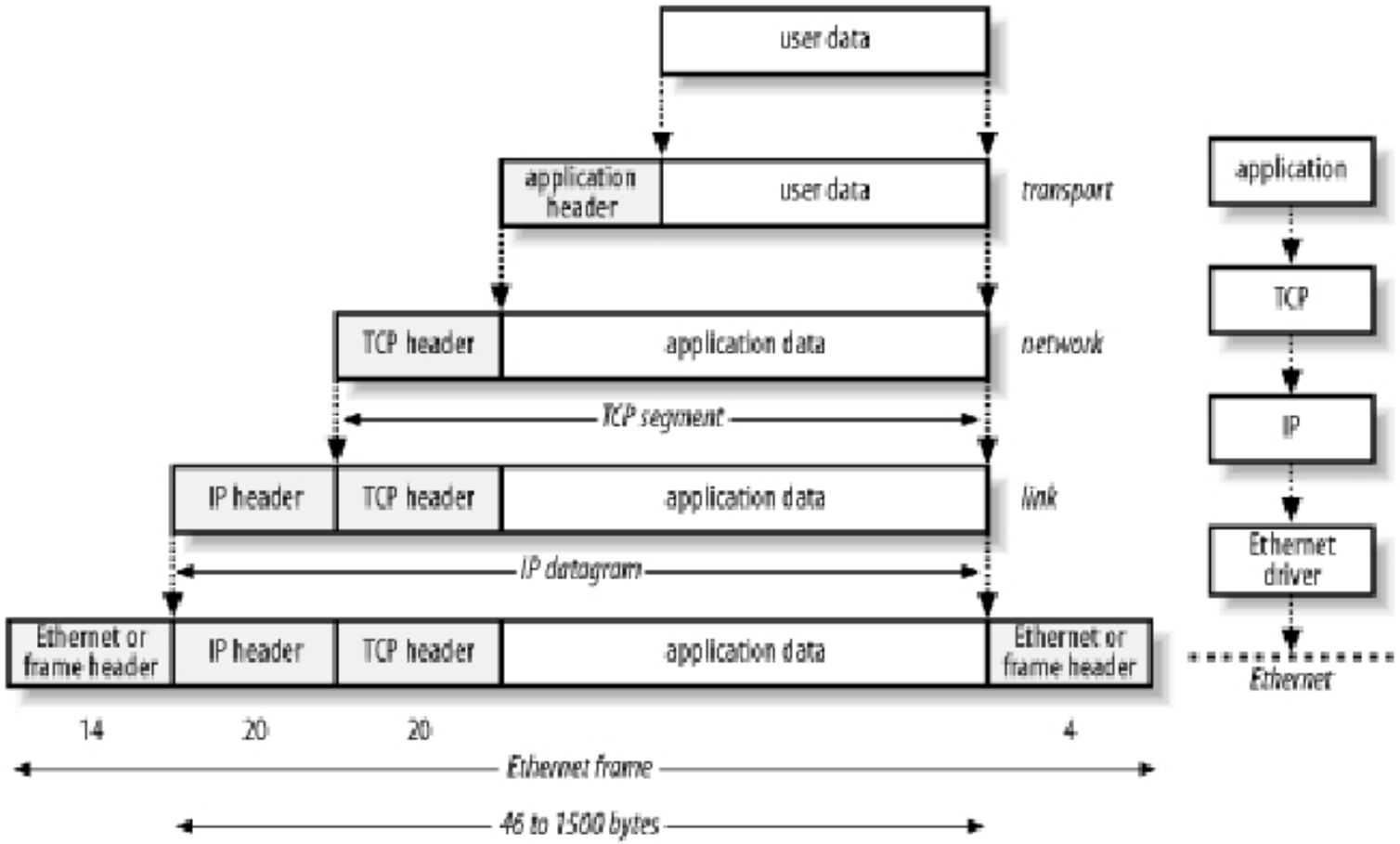
OSI vs TCP/IP


OSI
TCP/IP
PDU
Decapsulation
Encapsulation
7
6
5
4
3
2
1
Application
Presentation
Session
Transport
Network
Data link
Physical
Application
Transport
Internet
Link
Not present in the model
Done in hardware
data
segment
packet
frames
bits

TCP/IP Layers

- Organized in layers like OSI model, but has only 4 instead of 7
- Link layer
  - Provides connectivity functions
- Internet Layer
  - Communication methods between multiple links of a computer (IP)
  - Facilitates interconnection of networks
- Transport Layer
  - General framework to transmit data between hosts using protocols (TCP)
- Application Layer
  - Specific protocols based on functionalities and communication services

Headers from each Layer



Internet Protocol v4

- Most common Internet layer protocol
  - main task: routing information
- Routable protocol (subnets)
- Uses 32-bit addresses yields 2^32 (4,294,967,296) addresses
  - Though some are reserved for private networks (~18 million) and multicast addresses (~270 million)
- Limitation of addresses motivated the development of IPv6

OH NO! – No More Addresses

- Crisis: In February 2011, the global Internet Assigned Numbers Authority (IANA) allocated the last blocks of IPv4 address space to the five regional Internet registries. At the time, experts warned that within months all available IPv4 addresses in the world would be distributed to ISPs.
- The day of reckoning still looms – it's just been pushed out as the major Internet players have developed ingenious ways to stretch those available numbers (NAT*) But these conservation efforts can only work for so long

http://www.networkworld.com/article/2174297

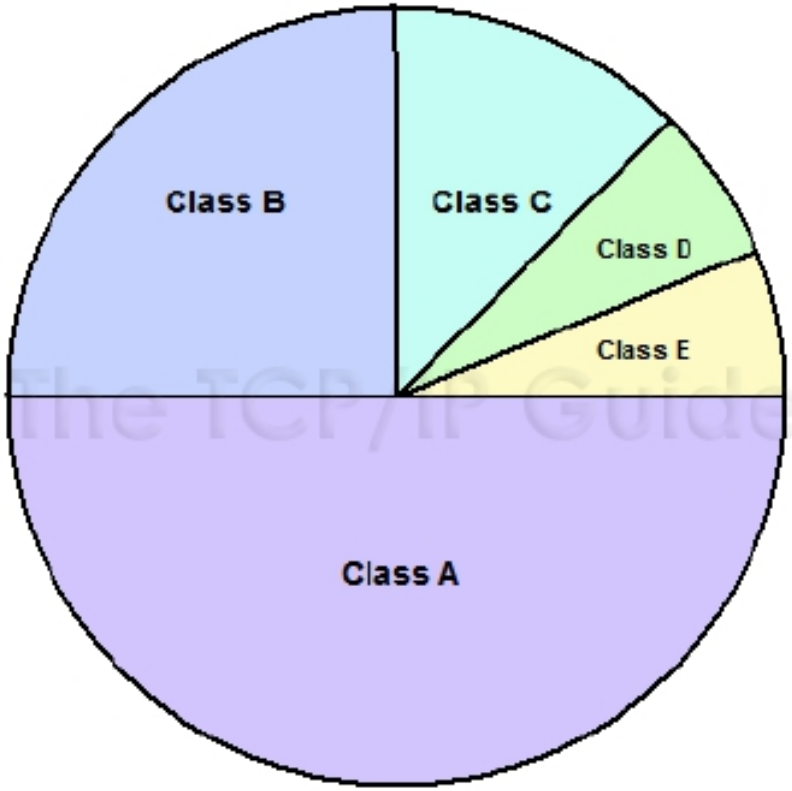
IP Basic Address Structure

- Addresses have two portions
  - **Network ID** – a certain number of bits, starting from the leftmost bit, used to identify the network the host is on
  - **Host ID** – the remaining bits on the right, used to identify the host on the network
- Networks are organized in classes
  - A, B, and C are the most common
  - D is for multi-cast and E for future applications

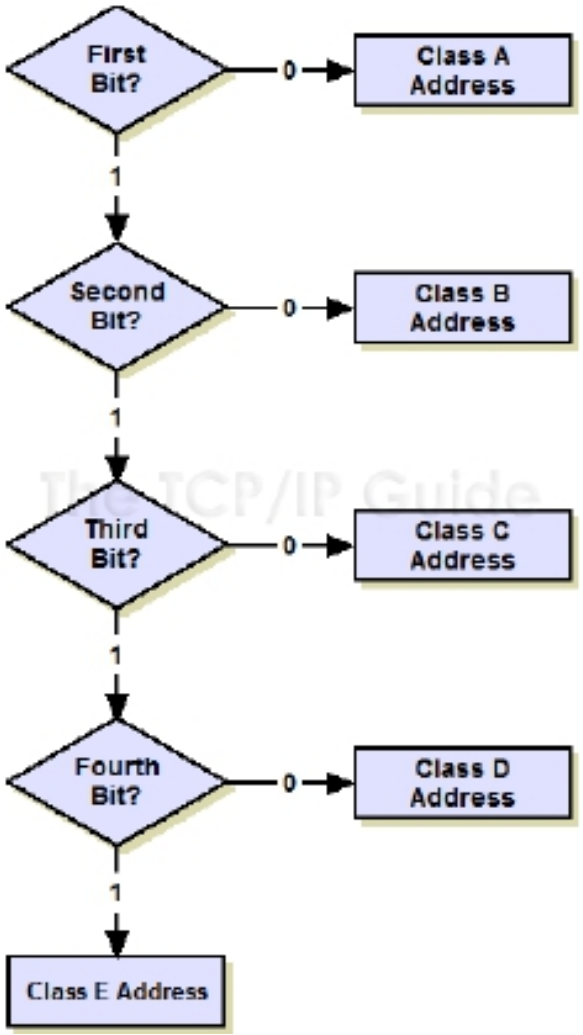
Classful Addressing

IP Address Class	Fraction of Total IP Address Space	Number Of Network ID Bits	Number Of Host ID Bits	Intended Use
Class A	1/2	8	24	Unicast addressing for very large organizations with hundreds of thousands or millions of hosts to connect to the Internet.
Class B	1/4	16	16	Unicast addressing for medium-to-large organizations with many hundreds to thousands of hosts to connect to the Internet.
Class C	1/8	24	8	Unicast addressing for smaller organizations with no more than about 250 hosts to connect to the Internet.
Class D	1/16	n/a	n/a	IP multicasting.
Class E	1/16	n/a	n/a	Reserved for “experimental use”.

Division of IPv4 Address Space



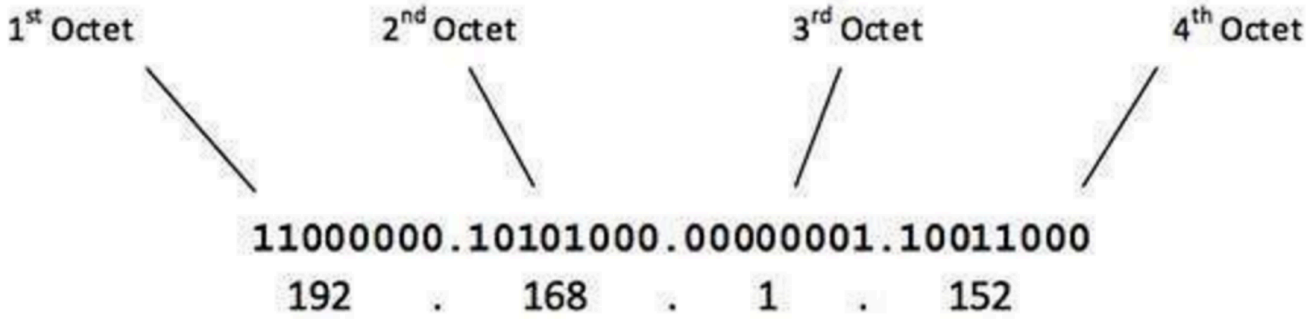
Quickly Deduce Class of Network



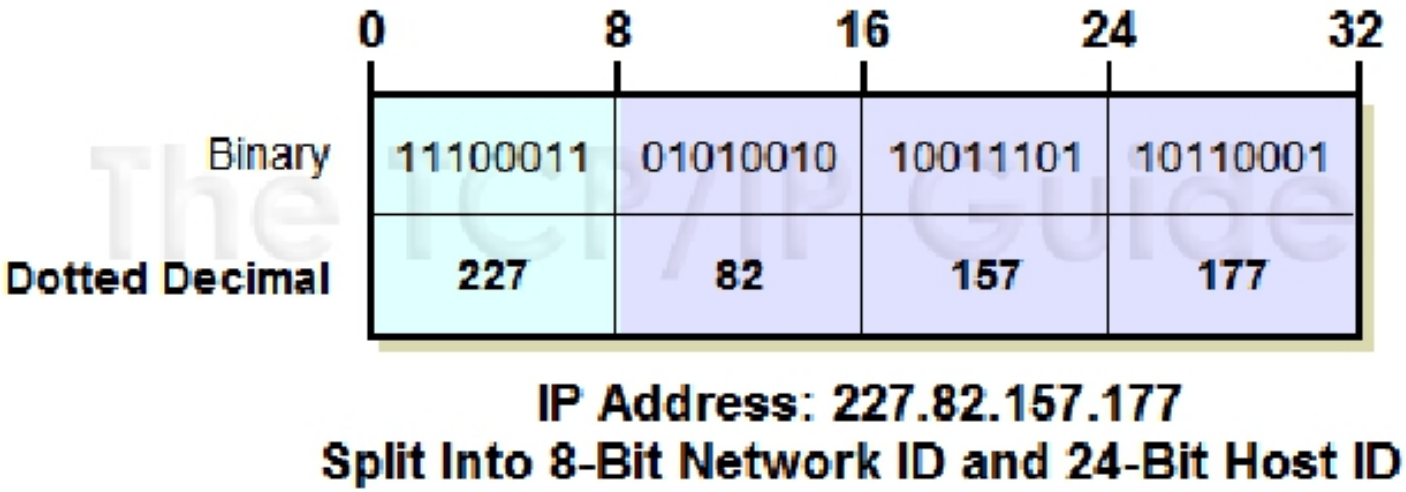
What class of network would IP address 149.50.43.211 fall into? **

IPv4 Address Classes

Class	1st Octet Decimal Range	1st Octet High Order Bits
A	1 – 126*	0
B	128 – 191	10
C	192 – 223	110
D	224 – 239	1110
E	240 – 254	1111



IP Address: Network and Host IDs



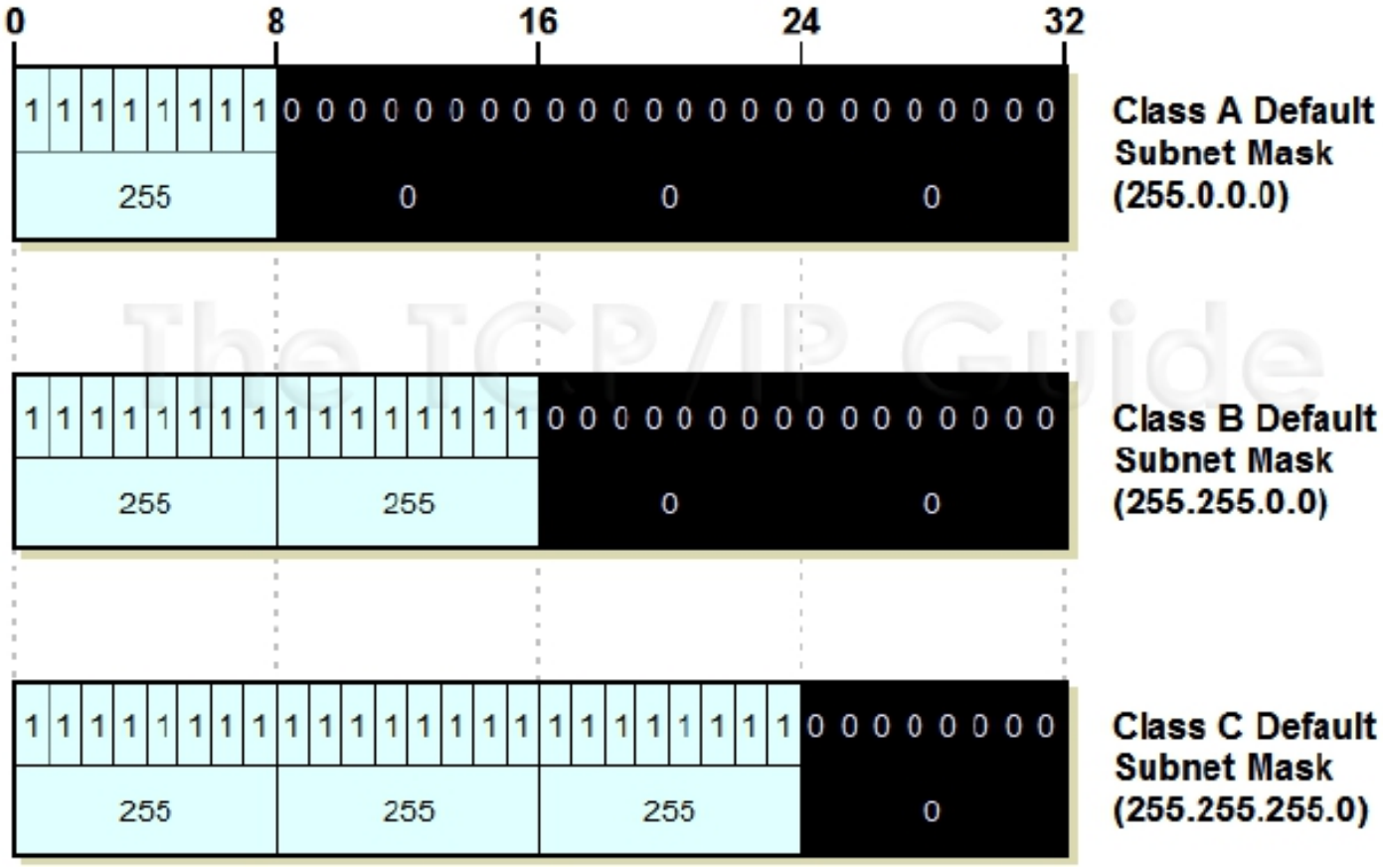
Problems with Classful Addressing

- **Lack of Internal Address Flexibility:** Big organizations are assigned large, “monolithic” blocks of addresses that don't match well the structure of their underlying internal networks.
- **Inefficient Use of Address Space:** The existence of only three block sizes (classes A, B and C) leads to waste of limited IP address space.
- **Proliferation of Router Table Entries:** As the Internet grows, more and more entries are required for routers to handle the routing of IP datagrams, which causes performance problems for routers. Attempting to reduce inefficient address space allocation leads to even more router table entries.

Solution to Problem: Subnetting

- Introduced in RFC 950 (Internet Standard Subnetting Procedure Specification) in 1985
- Instead of having just hosts, the network has *subnets* and hosts
- Allows an organization to have internal networks within the Internet
- Now we need to know which bits in the address are used for the subnet ID and host ID
  - Solution: subnet mask, a 32-bit number
- The network ID is found by doing a binary AND between the subnet mask and IP address

Default Subnet Masks



Special Cases

- Network ID followed by all 0s:
  - Refers to an entire (this) network
- Network ID followed by all 1s:
  - Used for broadcasting to all hosts on the local network
- Loopback Addresses: 127.0.0.1 to 127.255.255.254
  - IP datagrams are not passed down to link layer
  - Instead they loop back to the source device at the IP level
  - 127.0.0.1(localhost or home) is most commonly used for testing purposes

There's no place like 127.0.0.1!