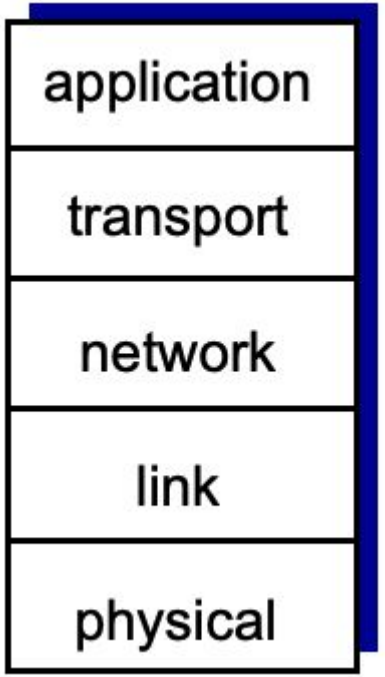
Socket Programming

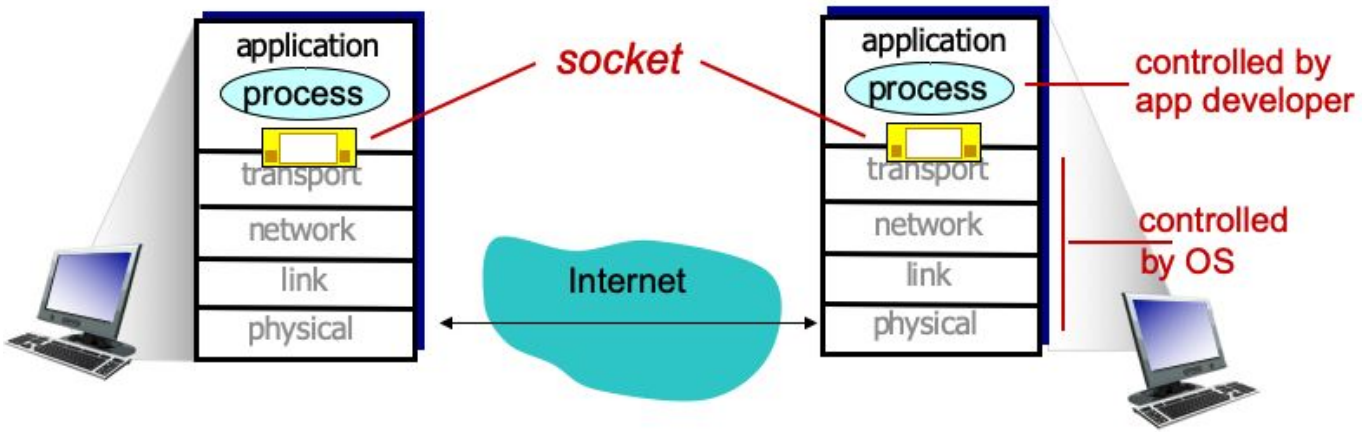
CS5700 Fall 2019

What is a socket? Where is a socket?



Socket

- Door (aka API) between application process and transport protocol
- Process sends/receives data to/from its socket



Communication paradigms

- The Internet offers two communication paradigms
- Stream paradigm
  - Sequence of individual bytes
  - Used by most applications
  - Built on TCP protocol
- Message paradigm
  - Sequence of individual messages
  - Built on UDP protocol

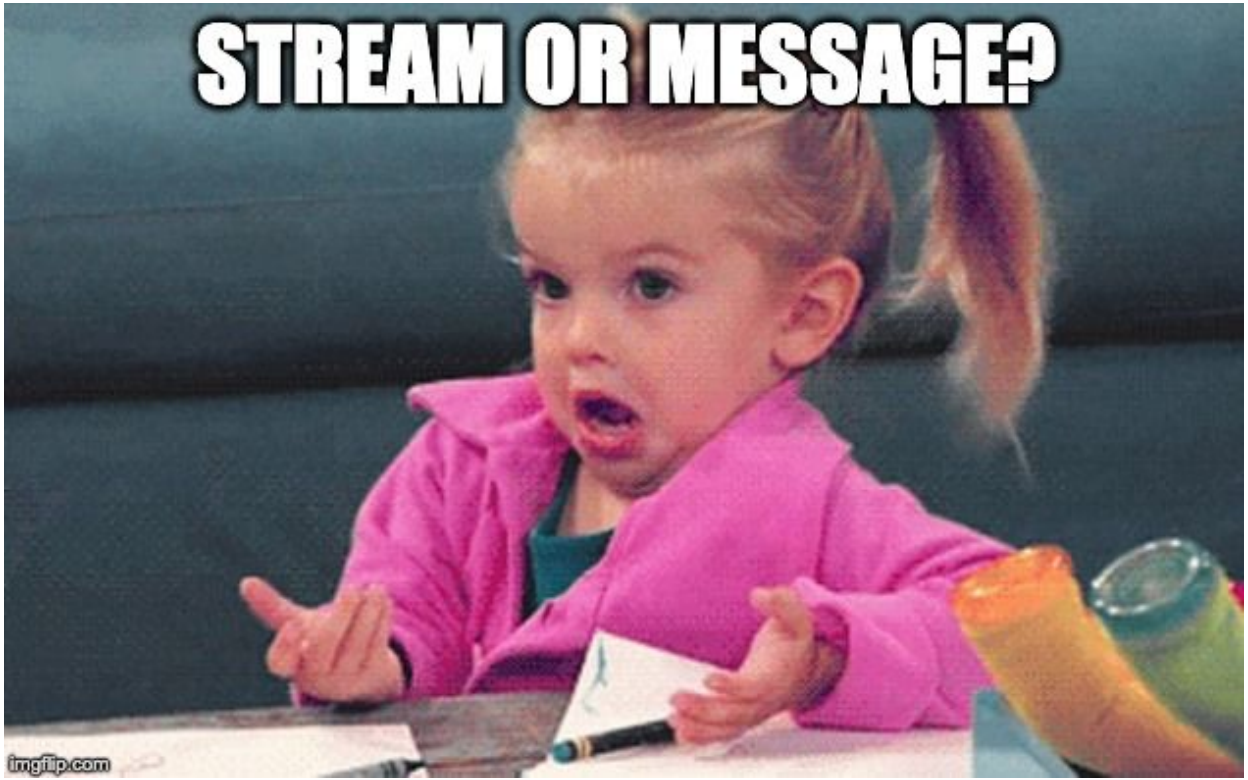
Stream paradigm

- Transfer a sequence of bytes
- Connected oriented
- 1-1 communication (between two applications)
- Bidirectional
- No meaning attached to data
- No boundaries inserted in data
- Reliable

Message paradigm

- If sender places N bytes in a message, a receiver will find exactly N bytes in the incoming message
  - Boundaries are preserved by messages
- Connectionless
- Allow unicast, multicast, or broadcast
- Unreliable

Which one is better?



Socket (or socket API)

- Originally part of BSD Unix
- Now standard in the industry
- Almost every OS includes an implementation
- Two socket types
  - SOCK_STREAM
    - Reliable, byte stream-oriented, based on TCP
  - SOCK_DGRAM
    - Unreliable datagram, based on UDP

Socket [TCP]

- TCP provides reliable, in-order, byte-stream transfer between client and server application processes
- Connection oriented
- 1-1 communication between two application processes
- What do you use to identify an application process?
  - How to address a machine in the Internet?
  - How to address a process in a machine?

IP address

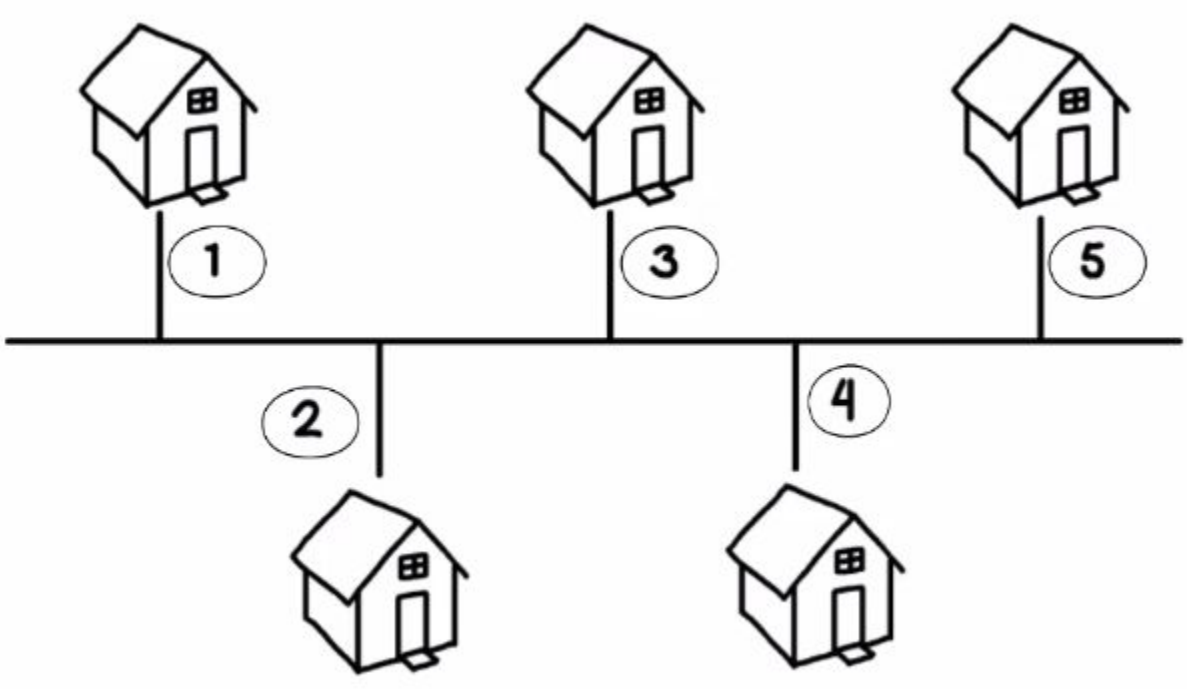
What is an IP address?

- Layer 3 logical address assigned by administrator
  - Uniquely identify specific devices on a network
  - Used for routing packets
- IPv4 and IPv6 address
- Hierarchical addressing structure
  - Network and host portion

IPv4 address format

- 32 bits binary number
- Divided into 4 octets (8 bits or 1 byte)
  - 00001010.00000001.00001000.00000010
  - 10.1.8.2
- Network address portion (network ID)
  - Identify a specific network
- Host address portion (host ID)
  - Identifies a specific host on a network

Street analogy

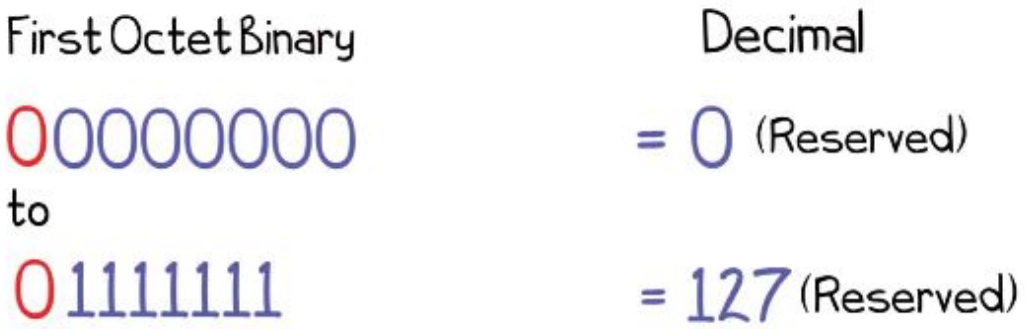


Address classes

- Divide IPv4 address into 5 classes
  - Class A, B, C: used for unicast
  - Class D: used for multicast
  - Class E: reserved for future or experimental use
- Class A, B, C
  - Accommodate different sizes of networks
  - Determined by the Internet Assigned Numbers Authority (IANA)

Class A

- Network portion: first 8 bits
  - Start with a binary 0
- Host portion: remaining 24 bits
- Binary range 0.0.0.0 to 127.255.255.255

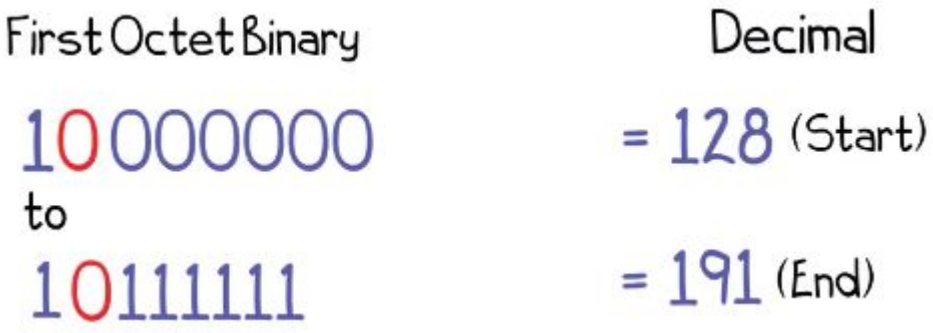


Class A

- How many class A networks?
- How many IP address within a class A network?

Class B

- Network portion: first 16 bits
  - Start with binary 10
- Host portion: remaining 16 bits
- Binary range 128.0.0.0 to 191.255.255.255



Class B

- How many class B networks?
- How many IP address within a class B network?

Class C

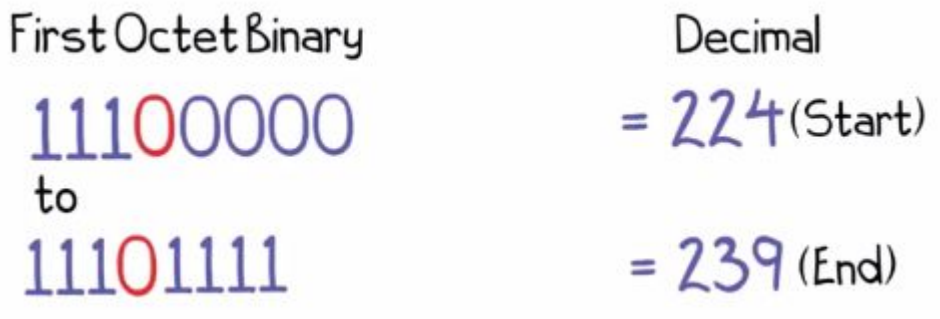
- Network portion: first 24 bits
  - Start with binary 110
- Host portion: remaining 8 bits
- Binary range 192.0.0.0 to 223.255.255.255

Class C

- How many class C networks?
- How many IP address within a class C network?

Class D

- Multicast
- Start with binary 1110
- Binary range 224.0.0.0 to 239.255.255.255



Class E

- Reserved
- Start with binary 1111
- Binary range 240.0.0.0 to 255.255.255.255

Is this effective allocation of IP addresses?

Network mask

- Used to determine network and host portion
- Network portion
  - Bits that have corresponding mask bit set to 1
- Host portion
  - Bits that have corresponding mask bit set to 0
- E.g. IP address 10.1.1.1, network mask 255.0.0.0

10.1.1.1 = 00001010.00000001.00000001.00000001

255.0.0.0 = 11111111.00000000.00000000.00000000

Network mask

- Class A, B, and C networks have default mask
  - Class A: 255.0.0.0
  - Class B: 255.255.0.0
  - Class C: 255.255.255.0
- What about less obvious network mask?

11111111.11111111.11000000.00000000 = 255.255.192.0

CIDR

- Classless Inter Domain Routing
- Introduced in 1993 to replace classful IP addressing
- /X notation: number of 1s in network mask
  - E.g. 10.1.1.1/8
  - IP address: 10.1.1.1
  - Network mask: 255.0.0.0
- Variable length network mask

CIDR is more efficient

Special address - directed broadcast address

- Host sends data to all devices on a specific network
- Binary 1s in the entire host portion of the address
- E.g
  - Network 172.31.0.0
  - Directed broadcast 172.31.255.255

Special address - local broadcast address

- Communicate with all devices on local network
- Address is all binary 1s
  - Aka 255.255.255.255

Special address - local loopback address

- Used to let a system send a message to itself for testing
- Canonical loopback address: 127.0.0.1
  - Any of 127.x.x.x can be loopback address
  - Huge waste of IP addresses :(

Private address

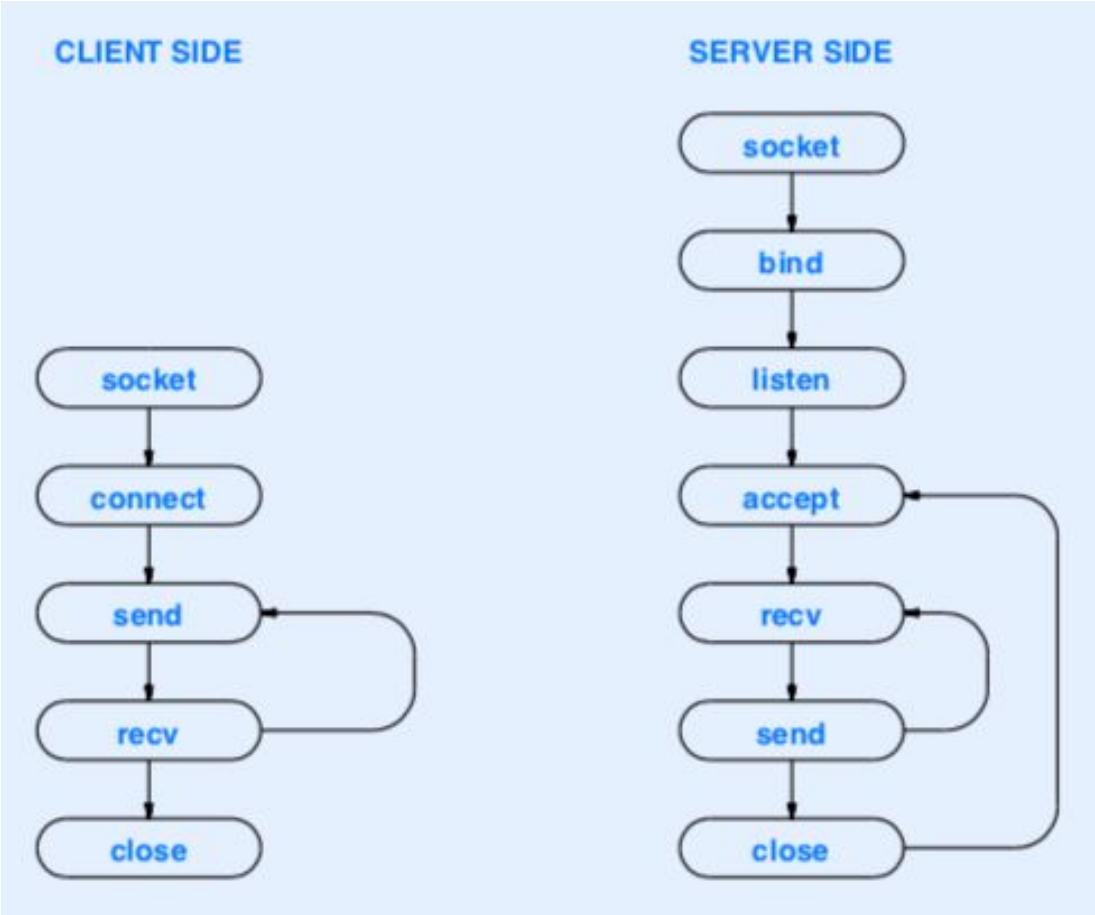
- RFC1918
  - Private IP address
  - Non routable on the Internet
- 10.0.0.0 to 10.255.255.255
- 172.16.0.0 to 172.31.255.255
- 192.168.0.0 to 192.168.255.255
- 1 class A, 16 class B, 256 class C

Port number

Port number

- Identify application process within a host
- 16-bit integer
- Well known ports [0-1023]
  - E.g. DNS (53), HTTP (80)

Socket


CLIENT SIDE
SERVER SIDE
socket
bind
listen
accept
recv
send
close
socket
connect
send
recv
close

Where is the code?

Summary

- What is socket
- IP address
  - Classful address
  - Network mask
  - CIDR
  - Special IP address
- Socket programming


READY FOR HW 1?
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