IP address

IPv6 : 128 bits

IPv4

- Each host connected to the Internet is assigned a unique 32-bit IP address that is used in all communications with that host
  - IP addresses do not specify an individual computer, but a connection to the Internet
    - A host might be "multi-homed"
    - IP addresses might be reused

IP address

- Each IP address has two parts: (netid, hostid)
  - netid identifies a network
  - hostid identifies a host on that network

www.iastate.edu

20.221.234.34

00010100 11011101 11101010 00100010

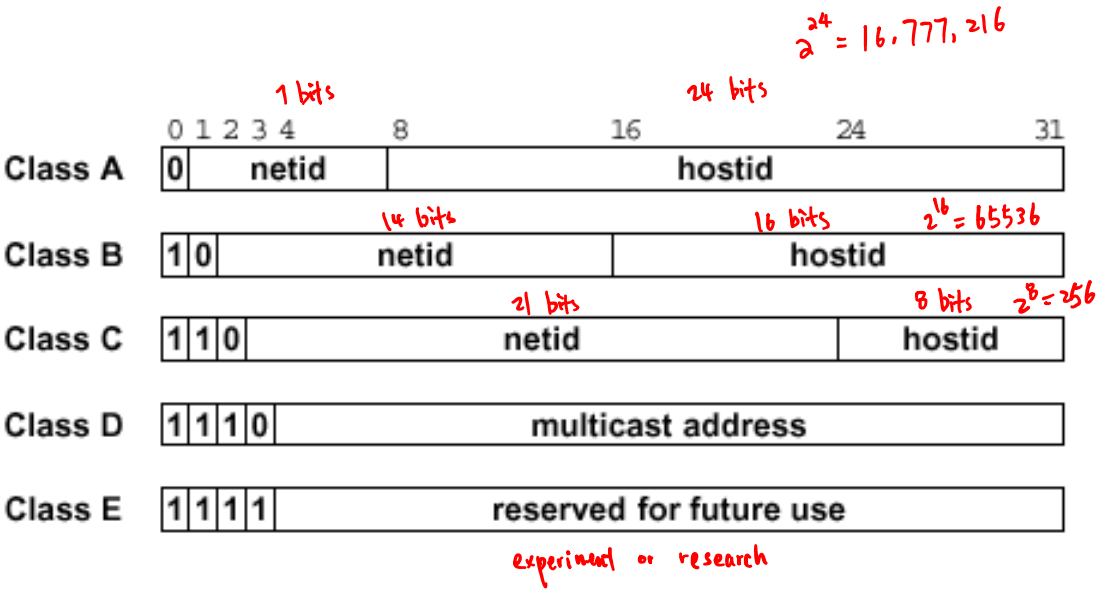
netid hostid

0 : class-A IP address

10 : class-B

110 : class-C

Classful Addressing Scheme



134. 161. 7. 207

10000110

class-B

www.uni.edu

198. 7. 223. 242

11000110

Class-C

www.drake.edu

54. 163. 225. 50

00110110

Class-A

www.uiowa.edu

Network Address

- IP addresses can be used to refer to networks as well as individual hosts
  - By convention, an address that has all bits of the hostid equal to 0 is reserved to refer to the network
  - network address = IP address AND network mask
  - Slash notation of the network mask

(netid, hostid) : network address

hostid: all 0's

20.221.234.34 / 8

20 → 00010100 → Class-A

20.0.0.0 = 20.221.234.34 "&" AND 255.0.0.0

network mask "/8"

Reserved IP Addresses

all 0s		This host[1]
all 0s	host	Host on this net[1]
all 1s		Limited broadcast (local net)[2]
net	all 1s	Directed broadcast for net[2]
127	anything (often 1)	Loopback[3]

netid

255.255.255.255

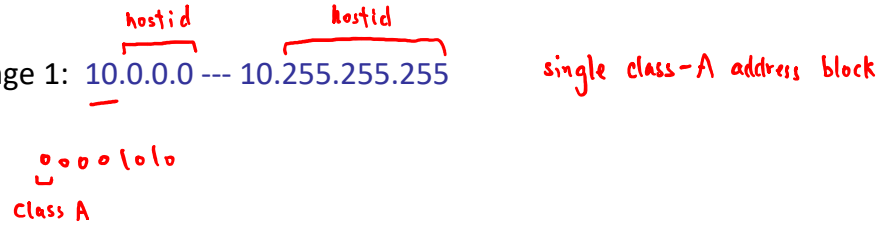
during bootup, DHCP

127.0.0.1

Notes: [1] Allowed only at system startup and is never a valid destination address.
[2] Never a valid source address.
[3] Should never appear on a network.

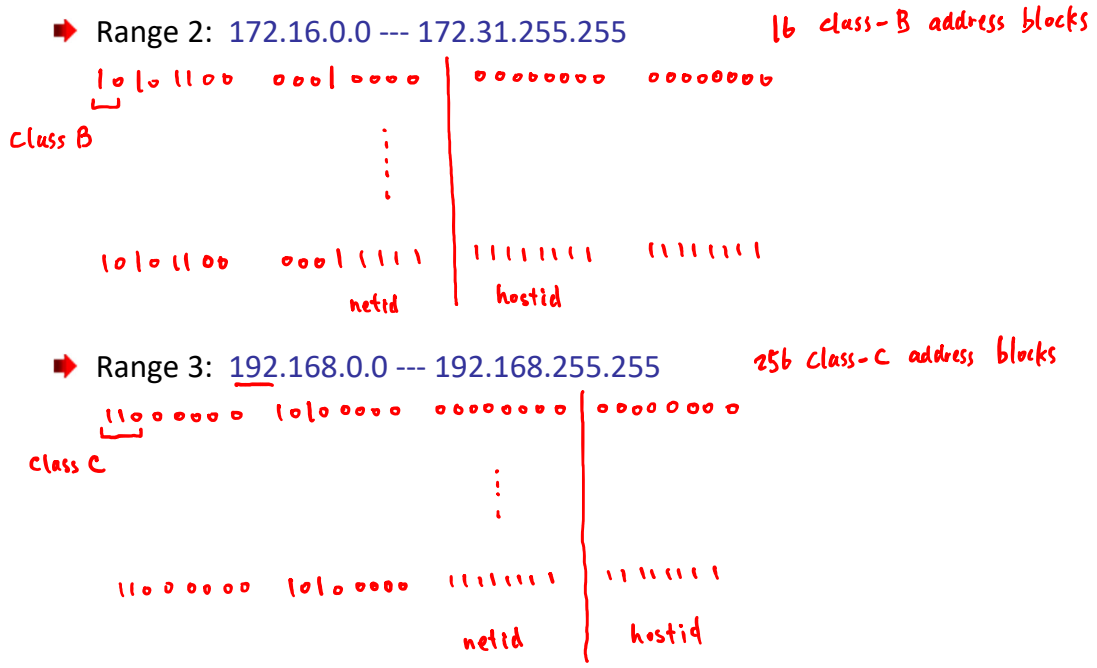
Private IP Addresses

- Specific ranges of IP addresses for private networks
  - Use is restricted to private internets that do not connect directly to the Internet
  - These addresses are considered unregistered, and routers in public Internet discard packets with these addresses
  - Range 1: 10.0.0.0 --- 10.255.255.255



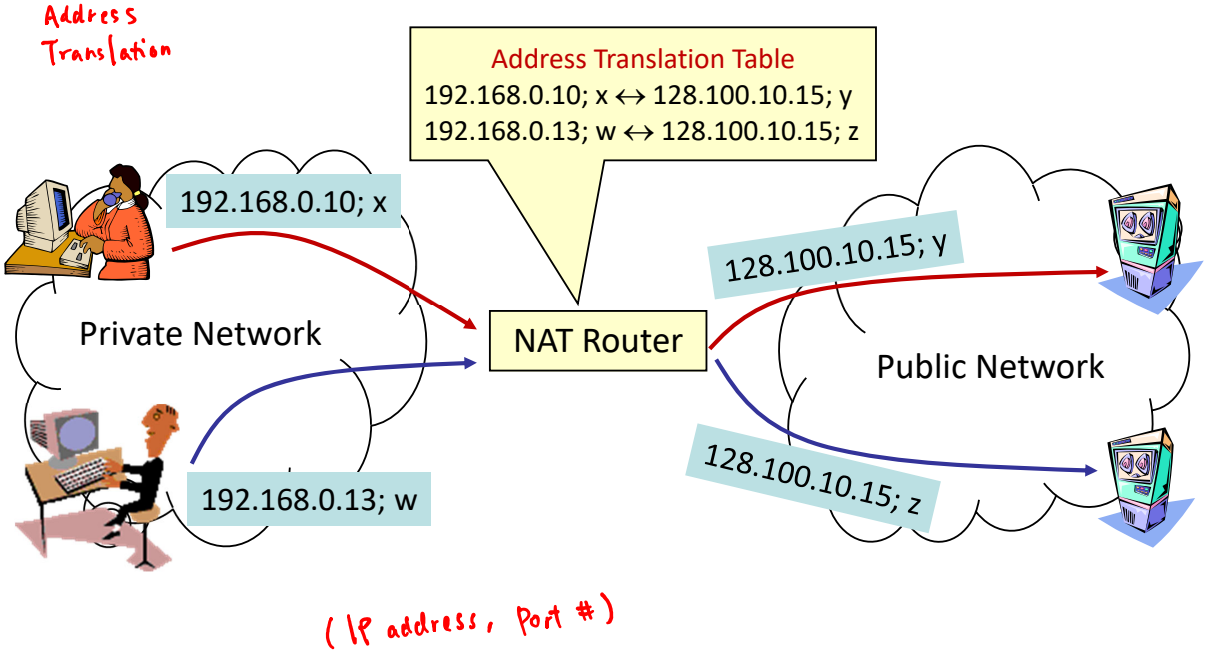
Private IP Addresses

- Specific ranges of IP addresses for private networks
  - Range 2: 172.16.0.0 --- 172.31.255.255
  - Range 3: 192.168.0.0 --- 192.168.255.255



NAT Operation

Network Address Translation



(IP address, Port #)

NAT Operation

- NAT (Network Address Translation) is used to convert between private and global IP addresses
  - Hosts inside private networks generate packets with private IP address & TCP/UDP port number
  - NAT maps each private IP address & port number into shared global IP address & available port number
  - Address Translation Table allows packets to be forwarded unambiguously

Summary

- IP addresses that can **not** be used to represent an **individual** host in the **public** domain:
  - Class D , Class E
  - network address
  - reserved addresses : bootup addresses
    broadcast addresses
    loopback
  - private addresses

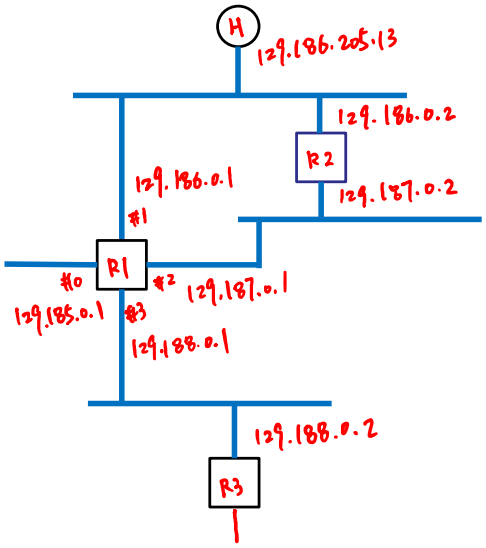
Routing Table

- IP layer in each host and router maintains a routing table

Destination	Network Mask	Next-hop Router	Network Interface	... ... Metric
...	...	...	...	... ...
...	...	...	...	... ...

Quality

IP Packet → extract dest. IP address from packet header AND Network Mask $\stackrel{?}{=}$ Destination



Routing Table @ R1

Dest.	Mask.	Next-hop	Interface
129.186.205.13	/32	129.186.205.13	#1
129.186.0.0	/16	129.187.0.2	#2