# CSc 450/550
# Computer Networks
## Internet Protocol

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# Review

- Application layer
  - HTTP, DNS
  - client-server model
  - request-reply transaction
- Transport layer
  - TCP, UDP
  - connection management
  - flow, error, congestion control

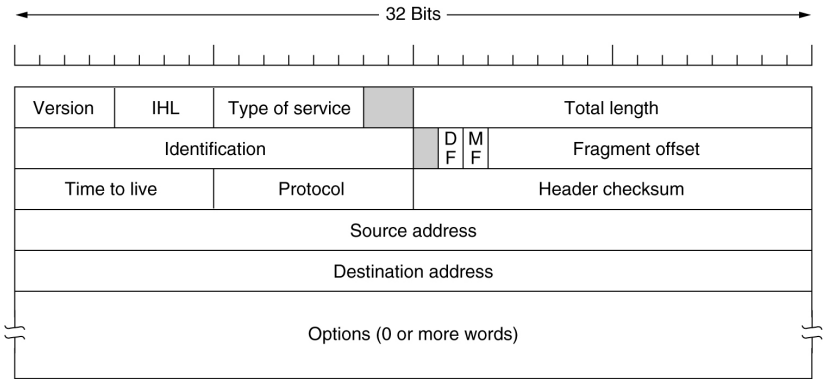
# The Internet Protocol

- Service provided to transport layer
  - packet delivery
    - addressing and routing
  - best effort
    - lost, duplicated, reordered, corrupted
- Service provided by link layer
  - frame delivery
    - point-to-point link
    - shared medium



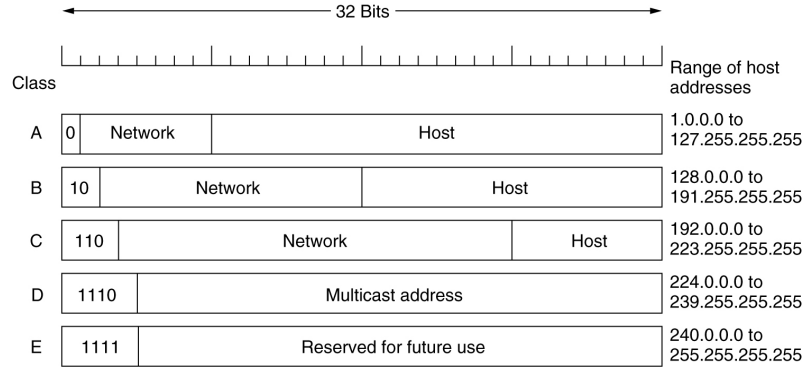
# IP header

- IPv4



# IP address

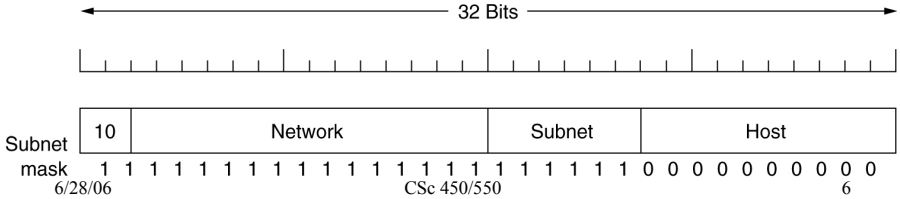
- Address classes






# IP address: more

- Problem with "address classes"
  - too big a Class A network
  - too (many) small Class C networks
- Classless address
  - CIDR: classless inter-domain routing



# UVic's IP space

- UVicNet
  - Class B: 142.104.0.0/16
- UVic EngNet
  - network address: 142.104.96.0
  - network mask: 255.255.224.0
    - 142.104.96.0/19
  - subnet test
    - net_add & net_mask ?= host_add & net_mask
    - host_A_add & net_mask ?= host_B_add & net_mask

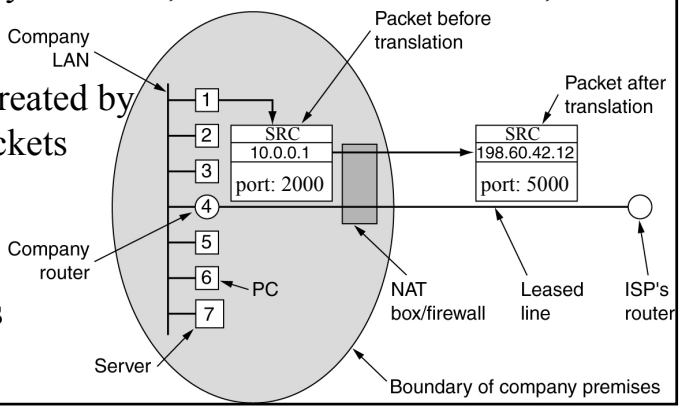


# Obtain an IP address

- Static configuration
  - e.g., on UVic campus
  - e.g., /etc/sysconfig/network-scripts/ifcfg-eth0
- Allocated by service provider
  - e.g., at home
  - DHCP: dynamic host configuration protocol
    - obtain IP add, net mask, default gateway, DNS, etc
    - authentication often needed

# Network address translation

- "Not enough IP addresses!"
  - not efficiently allocated, more connected devices, etc
- NAT/NAPT
  - translation created by outgoing packets
- Problems
  - NAT solves
  - NAT creates






# Header fields

- IP header checksum (16-bit)
  - TCP/IP-style checksum
  - cover IP header (and option) only
- Protocol ID (8-bit)
  - TCP(6), UDP(17); /etc/protocols
- TTL: time-to-live (8-bit)
  - decrement by each router
  - drop if TTL=0

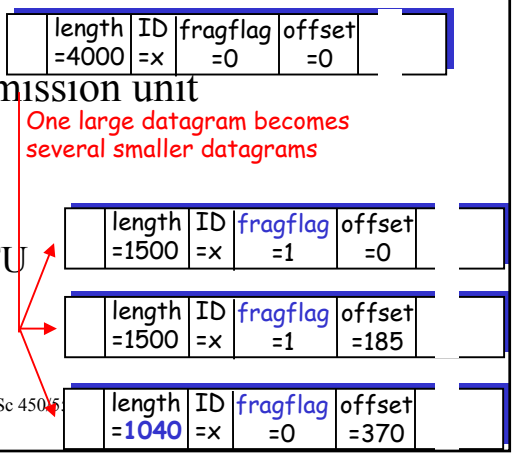
# Header field: more

- Total length (16-bit)
  - byte counter
- IHL: IP header length (4-bit)
  - 4-byte counter
- Identification (16-bit)
- Fragment offset (13-bit)
  - 8-byte offset
  - DF: don't fragment; MF: more fragment(s)



# Fragment and reassemble

- IP packet length
  - $2^{16}$-1 bytes
- MTU: maximum transmission unit
  - Ethernet: 1500 bytes
- Fragment
  - when total length > MTU
- Reassemble
  - only at destination
- PMTU discovery



# Type of service

- ToS: type of service
  - precedence (bit 7-5)
    - 0: normal traffic
    - 7: network control traffic
  - flags: Delay, Throughput, Reliability
- New definition: DiffServ Code Point
  - per-hop behavior (bit 7-2)
- The other two bits



# This lecture

- IP
  - IP addressing
    - address class, classless, NAT
  - fragmentation and reassemly
    - MTU, “total length”, offset
- Explore further
  - /sbin/ifconfig

# Next lecture

- Routing algorithm
  - read CN Section 5.2