Announcements

- Midterm #1 regrades completed (and in my office)
  - avg. request for re-grade resulted in 2 points being deducted
- Project #2 was returned
  - submit requests for regrade by email to jow **and** hollings
  - deadline for regrade requests is Tuesday 10/28/97 11 AM
- HW #2 (due 10/28/97):
  - Chapter 5: 1, 5, 6, 7, 8, 15, 16, 21, 30, 35
- Reading
  - Today: 5.6
  - Thursday: 6.1-6.2.6

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Fragmentation

- Sometimes need to split packets into smaller units
  - limits of the hardware being used
  - operating system buffer constraints
  - protocol limits (max permitted packet is x bytes)
  - reduce channel occupancy (head of link blocking)
- Fragmentation
  - where to split it into smaller packets
    - source (requires end-to-end information on max size)
    - when it reaches boundary
  - how to represent split packets
    - need to encode fragment offset
- Reassembly
  - where to re-combine packets
    - destination (may result in poor performance)
    - at the gateway to the subnet that supports the full size

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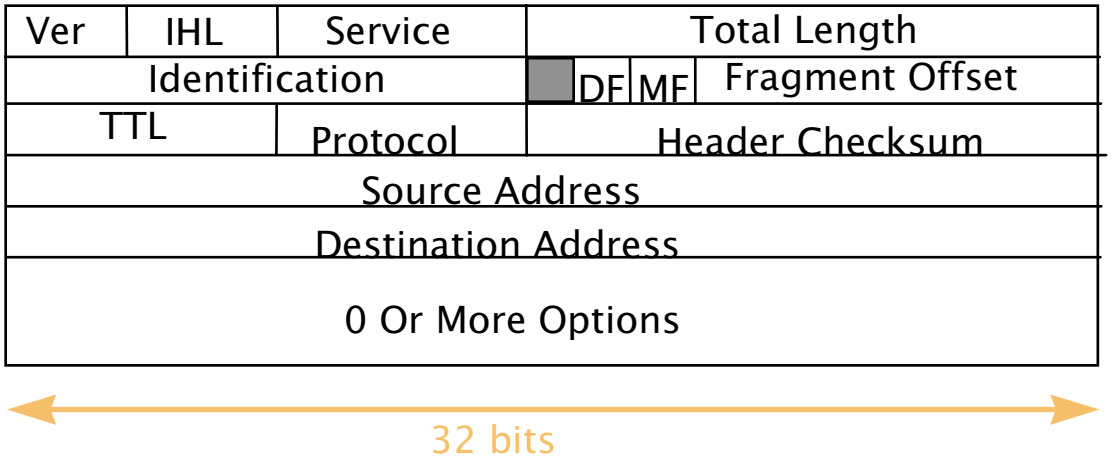
The IP Protocol

- IP Header
  - source, destination address, total length
  - version, ihl (header length in 32-bit words), ttl, protocol
  - fragmentation support: identification, df, mf, frag. offset
- Options
  - variable length
  - defined options
    - loose source routing
    - timestamp
    - record path



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Semantics of IP Addresses

- Each address has a network, subnet, and host part
  - for routing only care about network and subnets not hosts
  - what is the network and subnet part varies depending on
    - what the address is (used to be fixed class A, B, C)
    - where the address is viewed from
      - Maryland subnet viewed by world is 128.8.X.X
      - CS Dept. subnet viewed by campus is 128.8.128.X
    - subnets are not visible at higher layers
  - each routing entry is <target,network mask>
    - match dest AND mask with target
    - if multiple matches, one with most 1's in mask wins
- Some special network addresses
  - all 0's --> this host
  - 0's in network address --> host on this network

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Internet Control Message Protocol (ICMP)

- Used to configure and run an IP network
- Just a transport protocol (more or less)
- Message Types
  - destination unreachable
  - time exceeded (ttl count reached 0)
  - parameter problem (invalid header)
  - redirect (inform router of possibly bad path)
  - echo request/response (AKA ping packets)
  - timestamp request/response (timestamped pings)
  - Address Resolution Protocol
    - finding out who owns an IP address on the subnet
    - send link level broadcast with a request
      - response is IP address of destination

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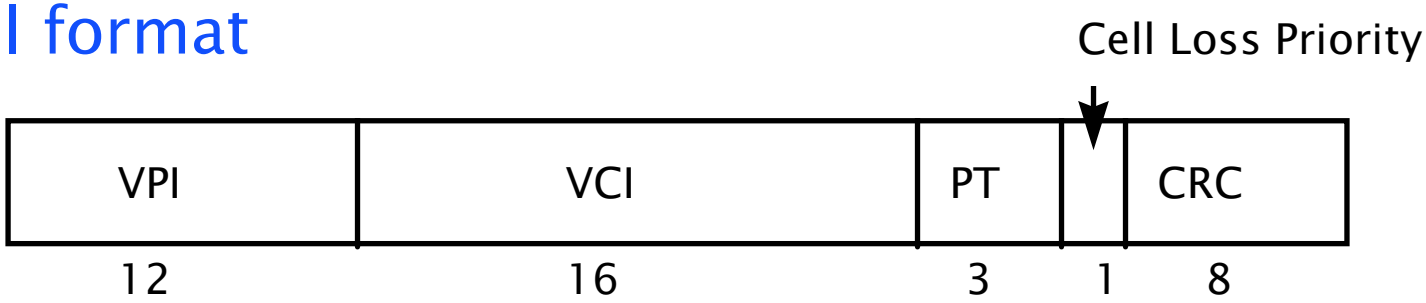
ATM Network Layer

- Connection oriented
- Cell format



- Messages
  - Setup – establish a virtual circuit
  - Call Proceeding – request seen
  - Connect – request for connection ok
  - Connect ACK – thanks for accepting
  - Release – please terminate (either party)
  - Release Ack – ok, hanging up

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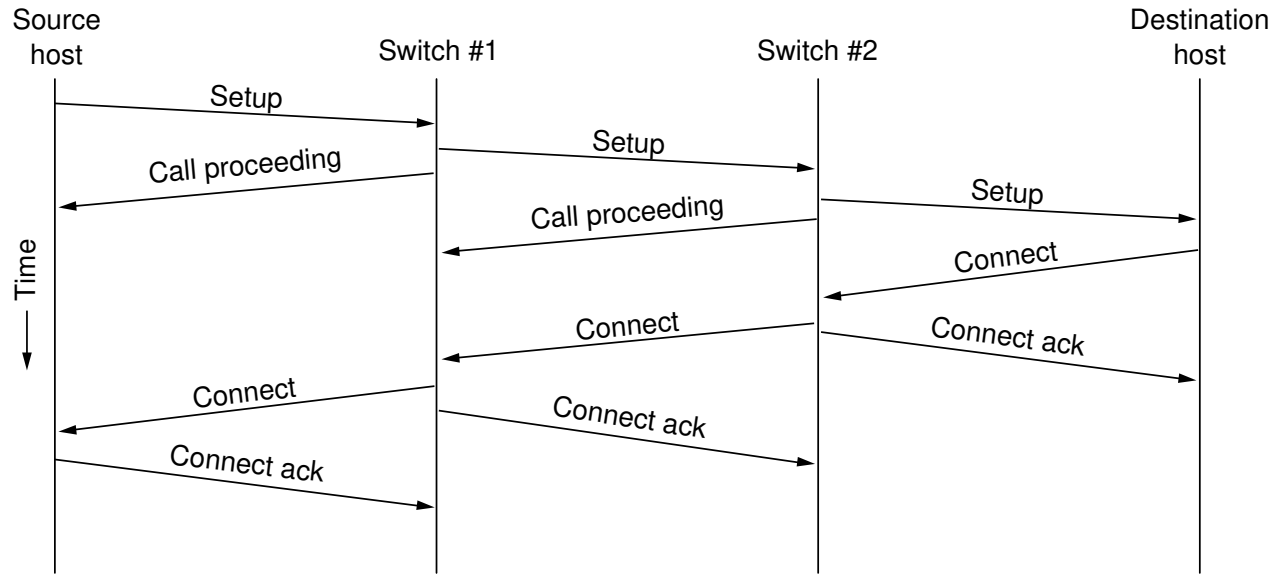
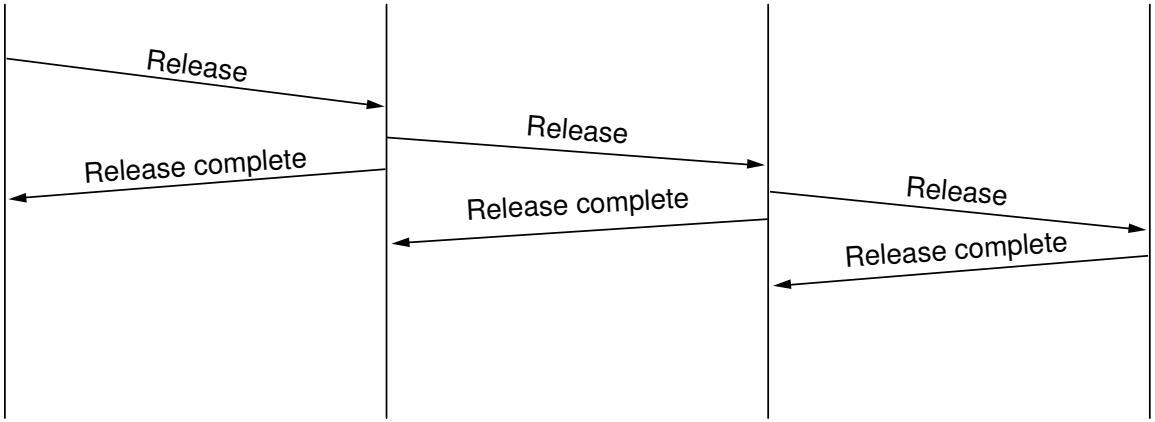
ATM Network Signaling



(a)



(b)

From: *Computer Networks*, 3rd Ed. by Andrew S. Tanenbaum, (c)1996 Prentice Hall.

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