

# Announcements

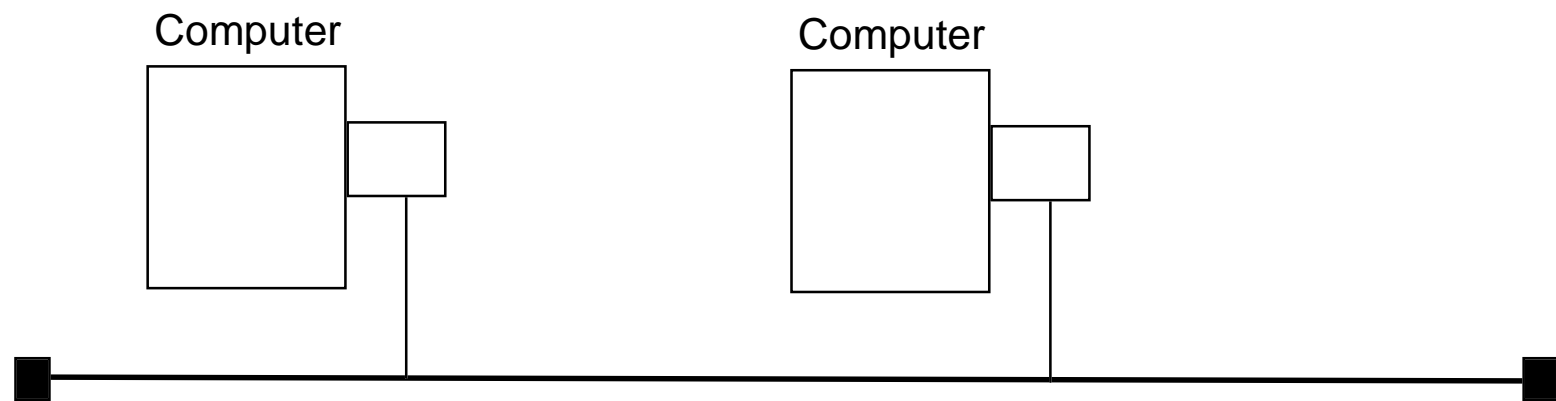
- Reading Chapters 15
  - problems: 15.1, 15.2, 15.5, 15.8

# Sending Data

- Data is split into *packets*
  - limited size units of sending information
  - can be
    - fixed sized (ATM)
    - variable size (Ethernet)
- Need to provide a destination for the packet
  - need to identify two levels of information
    - machine to send data to
    - comm abstraction (e.g. process) to get data
  - address may be:
    - a globally unique destination
      - for example every host has a unique id
    - may unique between hops
      - unique id between two switches

# Ethernet

- 10 Mbps (to 100 Mbps)
- mili-second latency
- limited to several kilometers in distance
- variable sized units of transmission
- bus based protocol
  - requests to use the network can collide
- addresses are 48 bits
  - unique to each interface



# Hub based Ethernet

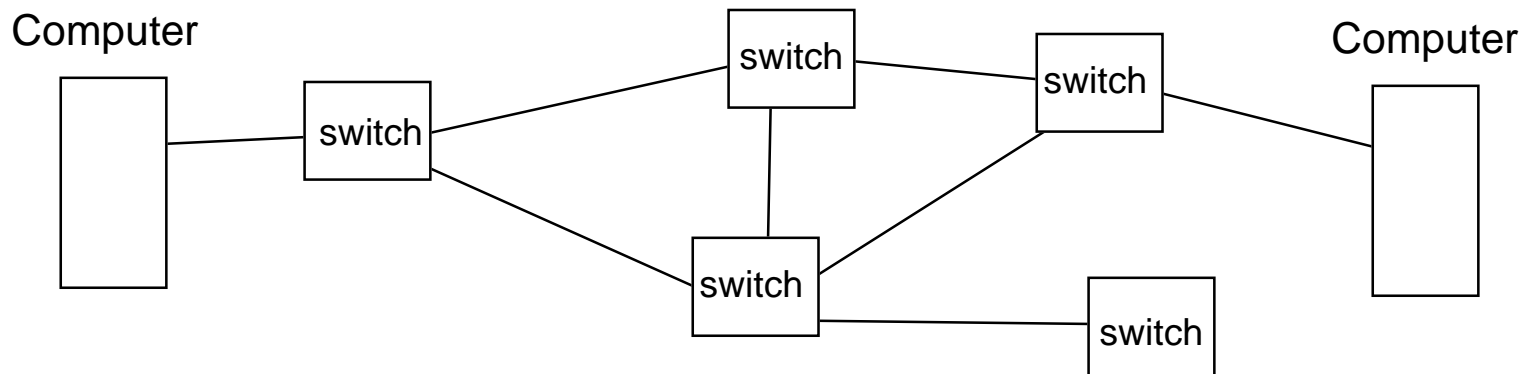
- Logically it is still a bus
- Physically, it is a star configuration
  - the hub is at the center of the network
- Hubs provide:
  - better control of hosts
    - possible to restrict traffic to only the desired target
    - can shutdown a host's connection at the hub if its Ethernet device is misbehaving
  - easier wiring
    - can use normal telephone wire to connect links (called 10 base-T)
- 100 Megabit Ethernet
  - is only available with Hubs
  - requires different hubs than 10base-T

# Ethernet Collisions

- If one host is sending, other hosts must wait
  - called Carrier Sense with Multiple Access (CSMA)
- Possible for two hosts to try to send at once
  - each host can detect this event (cd- Collision Detection)
  - both hosts must re-send information
    - if they both try immediately, will collide again
    - instead each waits a random interval then tries again
- Only provides statistical guarantee of transmission
  - however, the probability of success is higher than the probability of hardware failures and other events

# ATM (Asynchronous Transfer Mode)

- 155Mbps and up
- fixed sized unit of transmission called a cell
  - cells are 48 bytes plus 5 bytes header
- switch based protocol
- for both local area and wide area networking
- addresses are VCI
  - virtual circuit ids



# TCP/IP Protocol

- Name for a family of Network and Transport layers
  - can run over many link layers:
    - Arpanet, Ethernet, Token Ring, SLIP/PPP, T1/T3, etc.
- IP - Internet Protocol
  - network level packet oriented protocol
  - 32 bit host addresses (dotted quad 128.8.128.84)
  - 8 bit protocol field (e.g. TCP, UDP, ICMP)
- TCP - Transmission Control Protocol
  - transport protocol
  - end-to-end reliable byte streams
  - provides ports for application specific end-points
- UDP- user datagram protocol
  - transport protocol
  - unreliable packet service
  - provides ports for application specific end-points

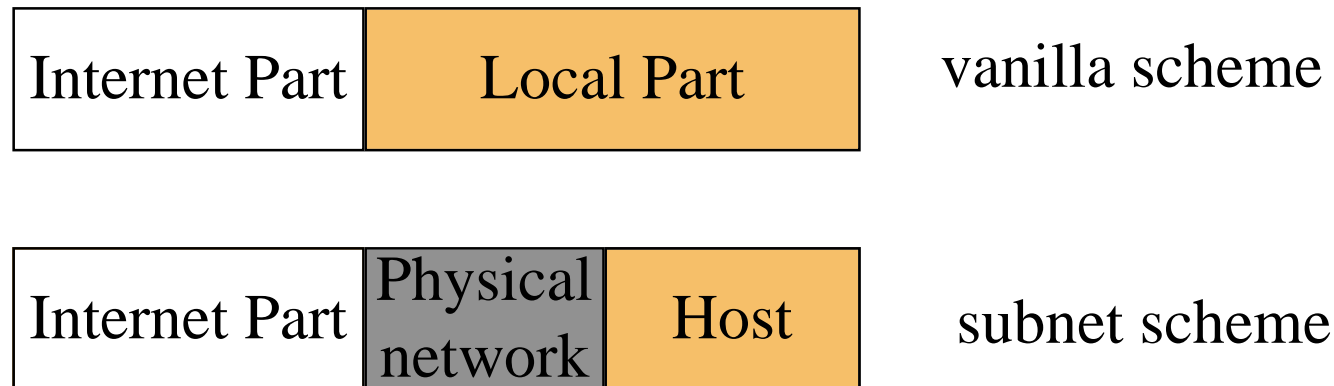
# TCP/IP History

- Arpanet was the origin of today's Internet
  - started in 1969 to connect universities and DoD sites
  - early example of packet switched network
  - original links were 64kbps and 9.6kpbs
- Current TCP protocol
  - started in use Jan 1, 1983
  - This was a *flag day*
    - all systems had to change to the new protocol at once
    - with the modern Internet this would be **hard** to do



# Subnet Addressing

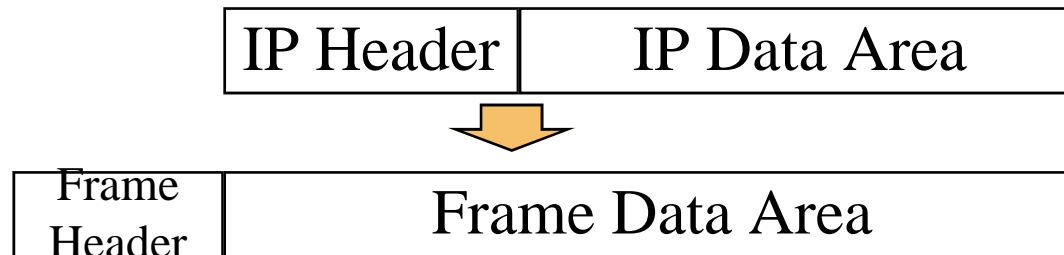
- Single site which has many physical networks
  - Only local routers know about all the physical nets
  - Site chooses part of address that distinguishes between physical networks
- subnet mask: splits the IP address into two parts
- Common Class B site mask 255.255.255.0
  - use 3rd byte to represent physical net
  - use 4th byte to represent host



# Encapsulation

How do we send higher layer packets over lower layers?

- Higher level info is opaque to lower layers
  - it's just data to be moved from one point to another



- Higher levels may support larger sizes than lower
  - could need to *fragment* a higher level packet
    - split into several lower level packets
    - need to re-assemble at the end
  - examples:
    - ATM cells are 48 bytes, but IP packets can be 64K
    - IP packets are 64K, but files are megabytes