

# Evolution of Network Hardware

(Ch 15 of S&G; Ch 8 of P&H;  
Class discussions)

# Telephony to Telecom to Networks

- voice communication in analog initially
- voice telephony switches to digital in the early 60's
- paved the way for computers to communicate using the telephone switching infrastructure
  - birth of ARPAnet (Advanced Research Project Agency) network...precursor to internet
- early 70's ARPAnet opened to non-defense
  - birth of internet for wide area computer comm.

# Computer/DataComm Evolution - I

- Mainframes
  - batch oriented environment
  - next step
    - data terminals connected to mainframes
  - next step (early 80's)
    - need to access mainframes remotely (say from home)
      - birth of modems
        - » send data over the telephone line: data to voice to digital signals at the exchange to send over the telephone lines to the remote machine!
        - » reverse this at the receiving end...
        - » this is still true today

# Computer/DataComm Evolution - II

- Xerox PARC designs the first “Personal Computer” (circa mid to late 70’s)
- These computers need to talk to one another
  - Xerox PARC designs the Ethernet in mid 70’s
    - birth of LAN
- Companies pick up the PC idea (early 80’s)
  - Apple’s PC
  - Sun’s first workstation
  - IBM standardizes the PC in mid 80’s
- Companies pick up LAN idea (mid 80’s)
- What was Xerox doing???

# Early LANs

- Ethernet
  - first Ethernet was 1 Mbit/Sec bandwidth
  - broadcast medium
  - Carrier Sense Multiple Access/Collision Detection (CSMA/CD) protocol
  - vampire taps to connects the AUI (Attach Unit Interface) cables from “stations” to LAN
- Token Ring
  - circulating token on the logical “ring” topology
  - station grabs the token to send the packet

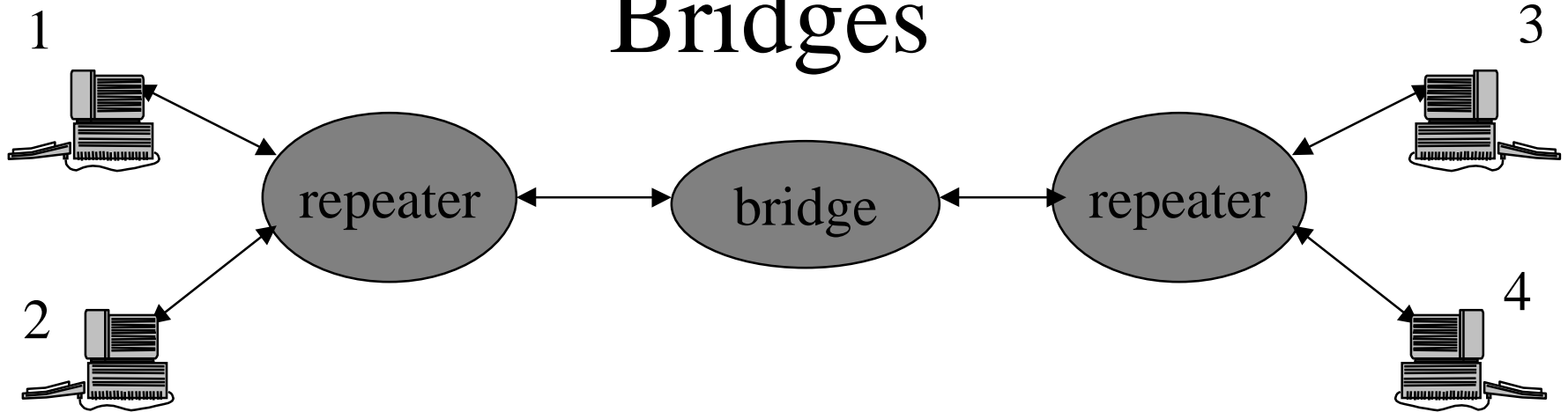
# Ethernet Evolution

- x\_base\_y
  - x stands for the available media bandwidth
  - base stands for base band signaling on the medium
  - y stands for the maximum distance a station can be from the vampire tap (i.e. length of AUI)
- 10\_base\_5 (1979-1985)
  - 10 Mbits/Sec with base band signaling with a station distance of max 500 meters
  - thick shielded copper conductor used as the medium

- 10\_base\_2 (1985-1993)
  - “thin net”, “cheaper net”
  - distance to the “station” shrinks to 200 meters
  - no more vampire taps
  - BNC connector to connect the stations to the AUI cables, the AUI cables to the medium
  - the medium is daisy-chained via the stations using the BNC connectors

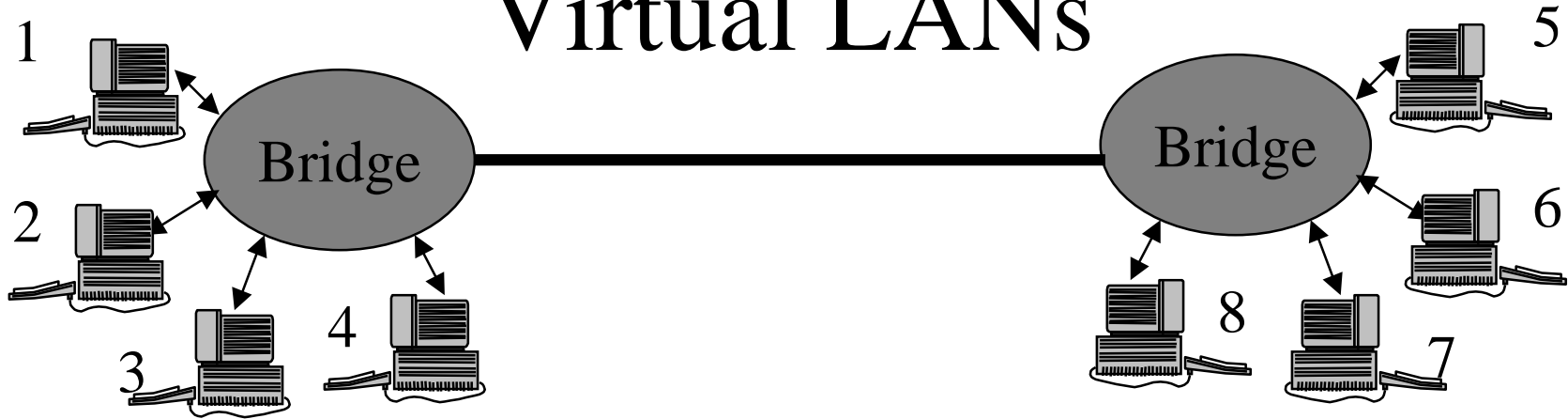
- 10\_base\_T (1993-1995)
  - AUI is a twisted pair of copper wires
  - AUIs from the stations come to a “hub” which is a multiplexor/transceiver
  - do away with the BNC connectors which are source of “connector” problems
  - use phone jack technology (RJ45 connectors) to connect AUI cables to the hub
  - hubs are connected to other hubs using the same connectors (RJ45)
  - all the hubs together form the entire medium
  - all the stations in the “same” collision domain
  - hub is also usually called a repeater

# Bridges



- advent of switched ethernet (late 1990s)
- bridges have switches inside (e.g. crossbar) that allow connecting in-links to out-links
- partitions hubs into distinct collision domains (1 & 2 talk in parallel with 3 & 4)
- bridge buffers packets that want to go on the same out-link

# Virtual LANs



- VLANs may span bridges
  - nodes 1 and 5 same VLAN; 2, 6, 7 same VLAN
  - all nodes on the same VLAN hear broadcasts from any node on that VLAN
  - VLAN limits the traffic flow among bridges
  - a hierarchical network with only bridges results in a switched ethernet with no collisions!

# NIC

- Network Interface Card
  - sits on the host station
  - allows a host to connect to a hub or a bridge
  - if connected to a hub, then NIC has to use half-duplex mode of communication (i.e. it can only send or receive at a time)
  - if connected to a bridge, then NIC (if it is smart) can use either half/full duplex mode
  - bridges learn MAC address and speed of a NIC it is talking to

# Routers

- Repeaters and Bridges understand only MAC addresses
  - traffic flow between nodes entirely based on MAC addresses
    - packet from a host station: <mac-addr, payload>
- Routers understand IP addresses
  - special board that sits inside a bridge
  - IP layer on all nodes send packets destined outside the LAN to the router
  - router sees a packet as: <ip-hdr, payload>
    - uses the ip-hdr to route the packet on to internet

# How are we connected?

- State of COC connectivity to campus backbone and internet (Nov 1999)

CoC network connectivity to the Campus Backbone

