Lecture 7

Transport layer

- Packet switching
  - Datagram
    - 

    - R_1, R_2 – router knows next hop
    - ☆ – packets are forwarded independently and know final dest.
    - routing for forwarding table
    - forwarding table
      - Dest / Port
  - Virtual Circuit
    - each packet has its own VCI (not src/dest)
    - each router/switch has table for ingoing/outgoing VCIs
    - forwarding table
      - incoming/outcoming VC/interface
    - setup in advance by:
      - PVC - administrator
      - SVC } source node (carries src/dest)
      - signalling }
    - routing for outgoing link for setup msg
    - connection-oriented → RTT delay before sending
  - Source routing
    - Source host specifies path to take (switch ports) in packet header
    - Header enter: OCBA → DCBA → ptr DCBA
      Header leaving: ADCB → DCB → ptr DCBA

- Interconnecting Ethernet LANs does not change MAC
  - Hub - multiport repeater for electrical signals (when weak)
    - connected LANs are single "collision domain"
    - limit on total length and # hubs
    - cannot filter data (flood)
    - cannot find best path → inefficiency ss wastage

physical layer

  - Bridge - repeater + filter by reading MAC of src ss dest
    - 2 port device
    - each LAN is its own "collision domain"
    - no heterogeneity supported: only LANs with same protocol
    - automatically fills in forwarding table by received frames

data link

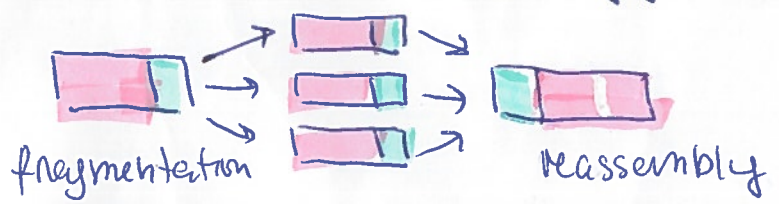
  - Switch - multiport bridge
    - has error checking before forwarding data
    - separate collision domain, same broadcast domain
    - # ports = # hosts

data link

- learning bridge
  - reduces amount of broadcast traffic on the LANs
  - when frame is received at bridge
    1. record incoming port and addr of sending host in forwarding t
    2. lookup dest addr in forwarding table
    3. if entry exists
       then {
         if dest = src port
           then { drop frame }
       else
         { forward frame to port indicated }
       else
         { forward to all ports except src port (flood) }

- Spanning-tree algorithm
  - automatically switch off some ports to reduce topology
    - no loops
    - every node unreachable
  - strategy:
    - every bridge has unique identifier
    - bridge with lowest ID is root
    - until known otherwise, each bridge thinks it is root
    - root periodically sends out config msg, which other bridges relay
    - using config msg, bridges find the shortest path to root and construct spanning tree
    - after convergence root still sends config msg
    - when link fails → tree is reconfigured
  - limitations:
    - no heterogenity supported: only same type LANs
    - scale: root bottleneck, flooding of initial packet

- Internetworking
  - IP service model
    - global addressing scheme
      - provides a way to identify all hosts in Internet
    - datagram delivery
      - packets may be lost/delayed/out of order/duplicated
    - IP can use underlying network
  - IP fragmentation, reassembly
    - network links have MTU (max. transfer unit) of frame
    - large IP datagram divided by frames within net
      - one datagram becomes several datagrams
      - reassembled only at final test
    - IP header is used to identify order



$$\text{offset} = \frac{\text{datagram bytes}}{\text{MTU bytes}}$$

IPv4

- routers / hosts have IP addr for each interface
- globally unique
- hierarchical: network + host within network

IP datagram forwarding

- strategy:
  - every IP datagram contains dest IP addr
  - each router maintains a forwarding table
  - if directly connected to dest. network (interface addr == dest addr)
    → forward to dest. host
  - if not directly connected → forward to next-hop router
  - forwarding table: Network Num / Next Hop

Subnetting

- add another level to addr / routing hierarchy: subnet
- subnet masks define var. partition of host part of addresses
- subnets are visible only within site

CIDR (Classless InterDomain Routing)

- abolishes class A/B/C for inter-domain routing
- IP ranges need only a single entry in global Internet's forwar. table
- a provider may advertise several customers networks using a single network addr to the outside world, if IP addr are chosen suitably
- with CIDR, an addr may match several forwarding entries
  → longest prefix matching

Global addresses