Switching

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Recap

- Two node network (Point-to-point link)
  - PHY layer: Encoding
  - Link Layer: Framing, Error Recovery, Reliable Transfer
- Network with few hundred nodes
  - Link Layer: Topology and MAC
- Network with thousands of nodes?
  - Solution: Switching

1024 max hosts in ethernet

250 token ring

Outline

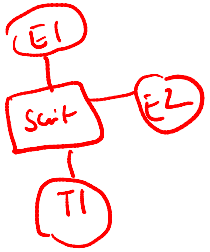
- Switching Concept
- Circuit Switching
- Packet Switching
- Types of packet switching covered elsewhere

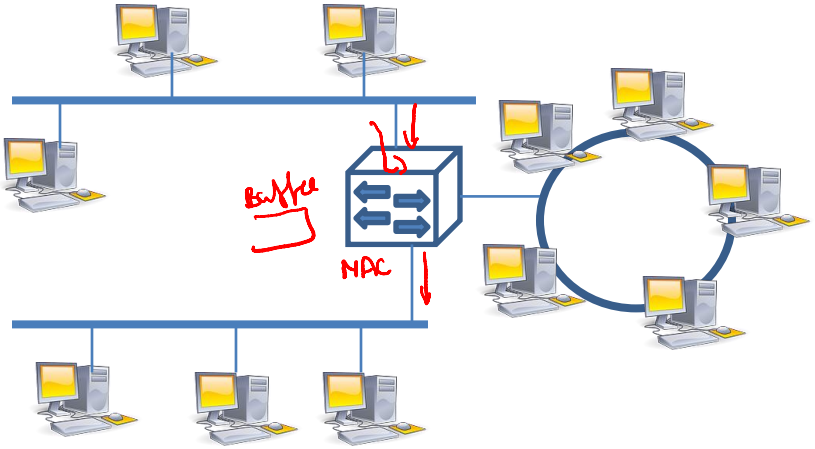
Switch Characteristics

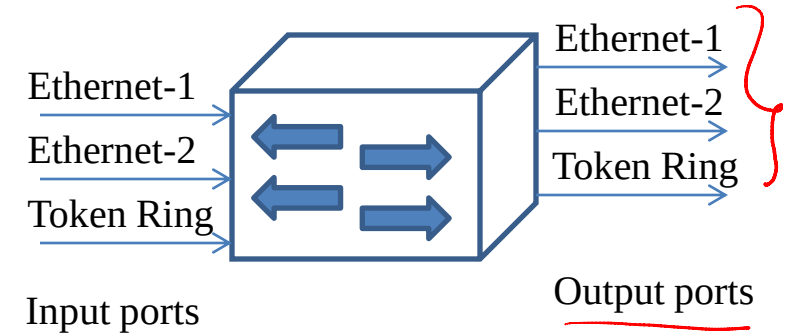
- A multi-input multi-output device
- Main Function: Transfer packets from an input to one or more outputs
- Provides star topology → more scalable
- Runs appropriate data link protocols on each link

hub is a phy layer device just repeats the input channe to out. But switch stores the packet .. bufffers it.. and while sending out, it also employs the MAC protocol on the outgoing link.

Switching







Important Functionality: Which port to forward incoming packets?

Note

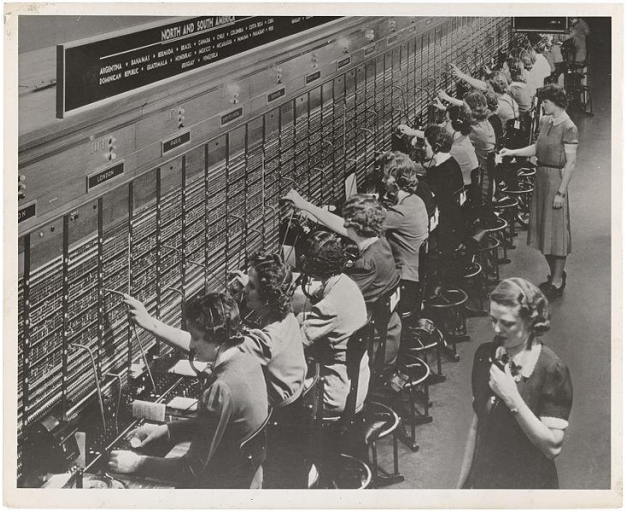
- Switching is a concept
  - Different types of switching: Circuit and Packet
- Packet switching: Possible at link-layer as well as network layer
  - Devices at link-layer are called bridges, switches (layer-2)
  - Devices at network-layer are called routers

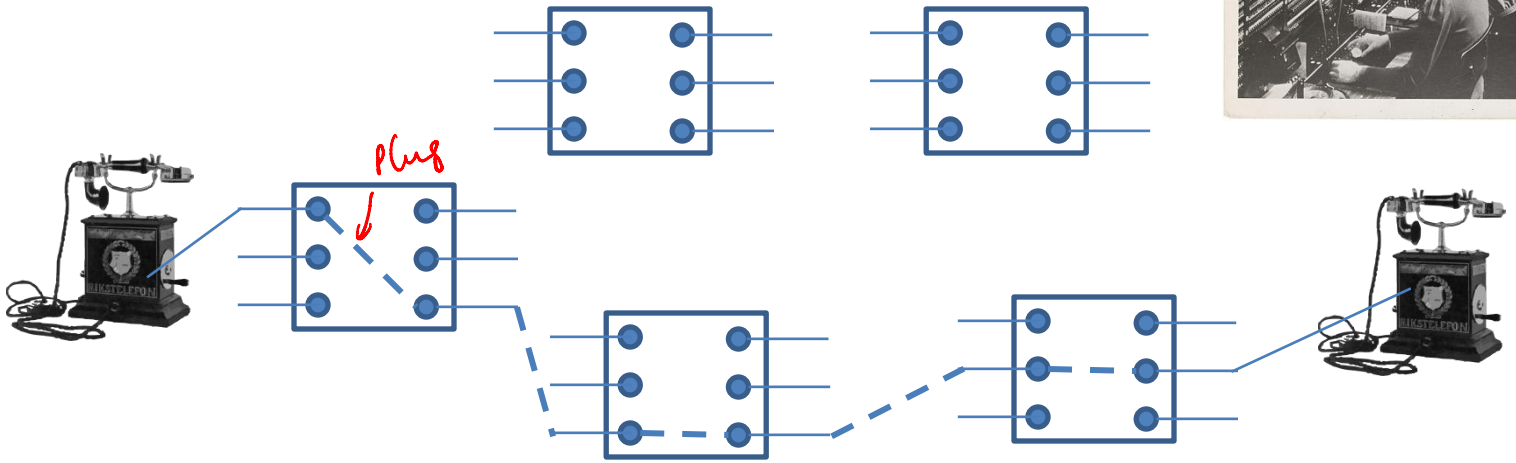
Circuit Switching

1890's

- Origins in Telephone Network
  - Manual to automatic
  - Electromagnetic to electronic

Strowger



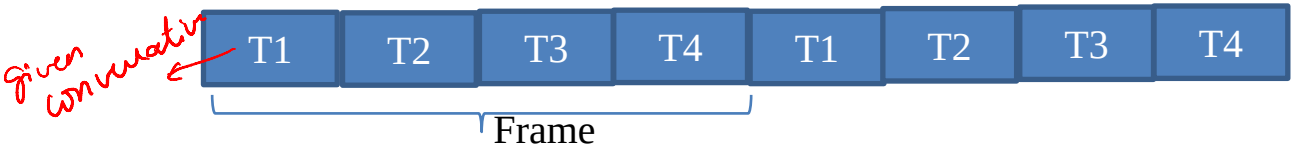


Circuit Switching

- Transmission involves two phases
- First Phase: Configuration of state along path from source to destination
- Second Phase: Information flow along set path
  - Frames carry no information on route to take

Multiplexing

- Multiplex many conversations onto single physical link
- Choices: FDM, WDM (optical fiber), TDM
- E.g. TDM



  - Number of nodes N, Capacity = R
  - Each user gets R/N bps
- How is forwarding done?
  - Map incoming port, time slot to outgoing port, time slot (mapping set up during call set up)

Pros and Cons

- Pro: Assured resources once call established
  - Works well for CBR traffic

voice telephone

- Con:
  - Wastage of resources
    - Unused slots are wasted in case of bursty, variable bit rate traffic
  - Per-connection state

Packet Switching

- Emerged in 1960's
- World's first packet switched network : ARPANET

The traffic that computers generate is Bursty, Variable Bit rate so C.K.tswitching is not useful

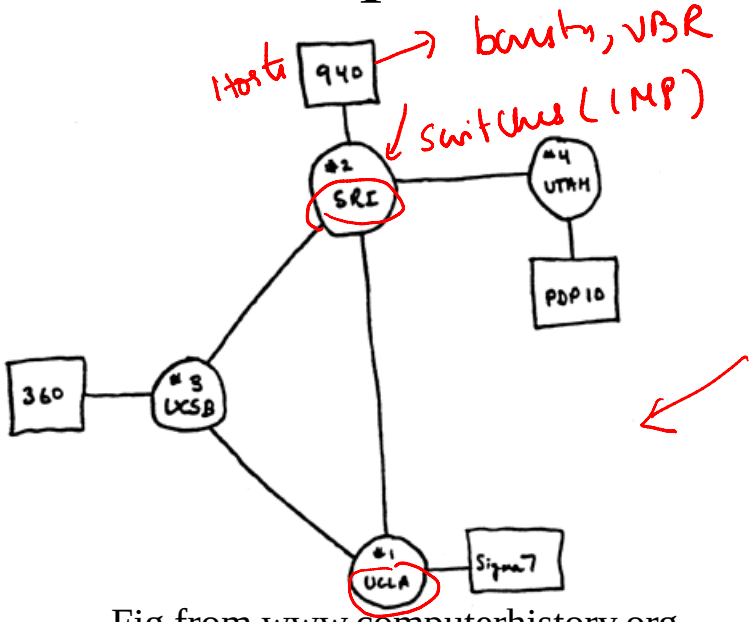
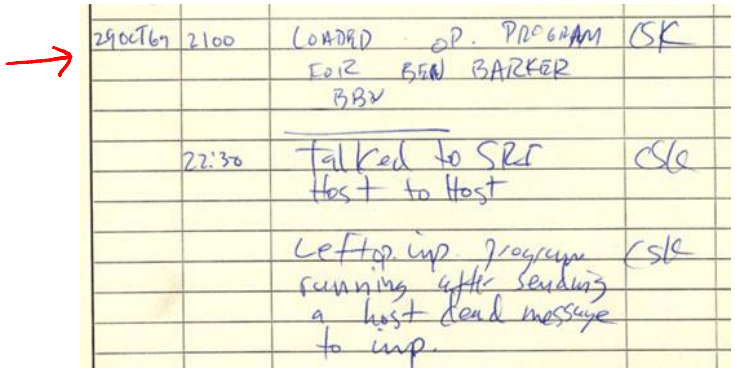


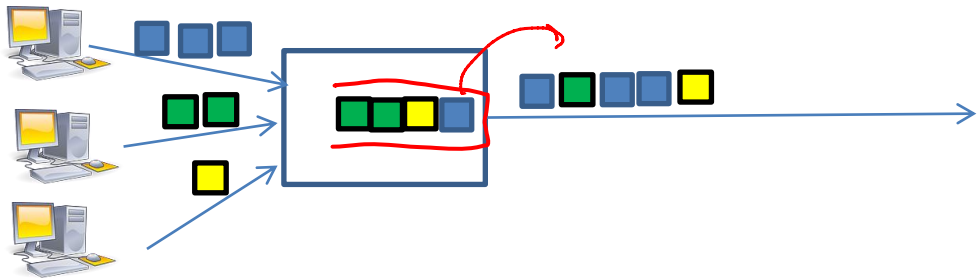
Fig from www.computerhistory.org



First ARPANET IMP log

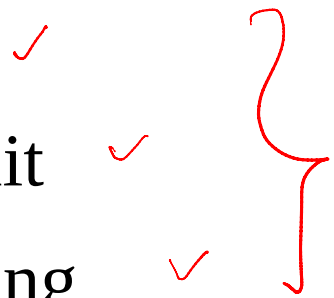
Statistical Multiplexing

- Physical link is shared among users
- Sharing is on demand and not fixed
  - Fairness handled by limiting amount of data (**packets**)
  - **Store and forward** mode of operation
  - Packets from different flows are interleaved
    - Packets served predominantly in a FIFO basis
    - Potential of packet loss (Buffer overflow)



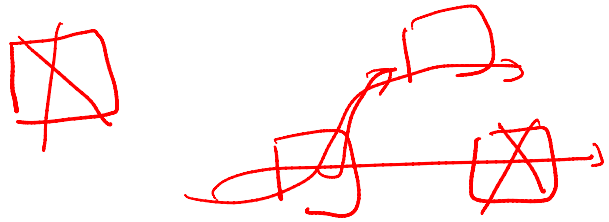
Forwarding

- How are packets forwarded to the right port?
  - Packets carry information (in headers)
- Different types of packet switching
  - Datagram
  - Virtual Circuit
  - Source Routing



Pros and Cons

- Pros
  - Less wastage of resources
  - No call set-up delay and per-connection state maintenance (first packet can be sent right-away). Virtual Circuit is an exception
  - Highly fault-tolerant



- Cons:
  - No guarantee for resources no bandwidth gaurantees
  - Out of order delivery
  - Per packet overhead → information
  - Store and forward introduces delay and losses (per packet)

Example

* A user alternates between periods of activity & inactivity
* Active 10% of the time (90% inactive)
* Requires 100 KBPS during active time

Circuit Switching

What should the link capacity be?

Assume (10 users)

10 x 100 Kbps = 1 Mbps

Packet switching

Suppose (35 users)

Prob (11 or more active at any time)

= 0.0004

0.9996 10 or less users active

10 x 100 Kbps

1 Mbps

Summary

- Switching helps interconnect hosts/networks in a scalable fashion
- Two Types: Circuit and Packet Switching
  - Tradeoffs involved
  - Internet employs packet switching
- Ahead: Types of packet switching