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
  - Links Layer: Topology and MAC
- Network with thousands of nodes?
  - Solution: Switching

1024
250

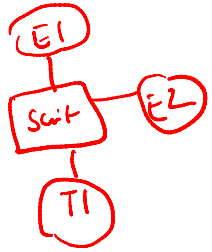
Outline

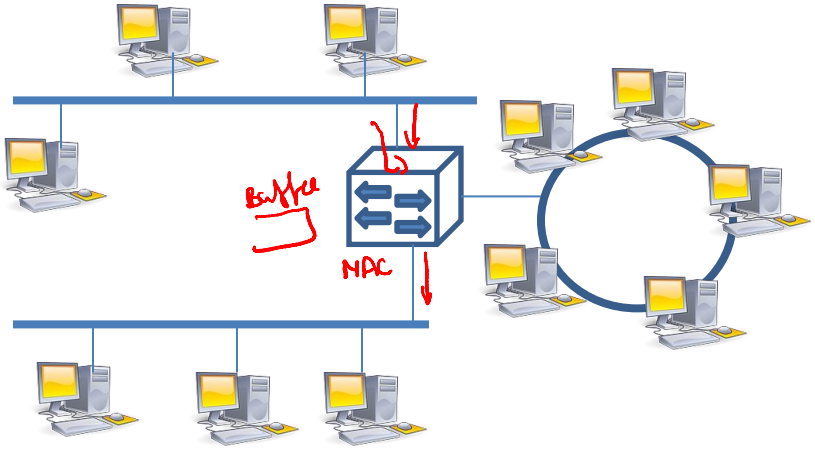
- Switching Concept
- Circuit Switching
- Packet Switching
- Types of packet switching covered elsewhere

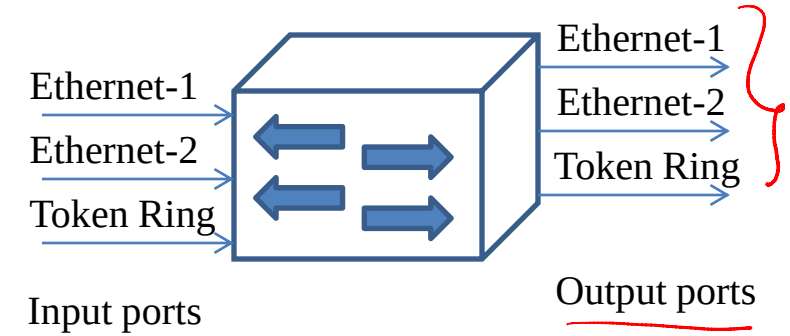
Switch Characteristics

- 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

Switching







Important Functionality: Which port to forward incoming packets?

Note

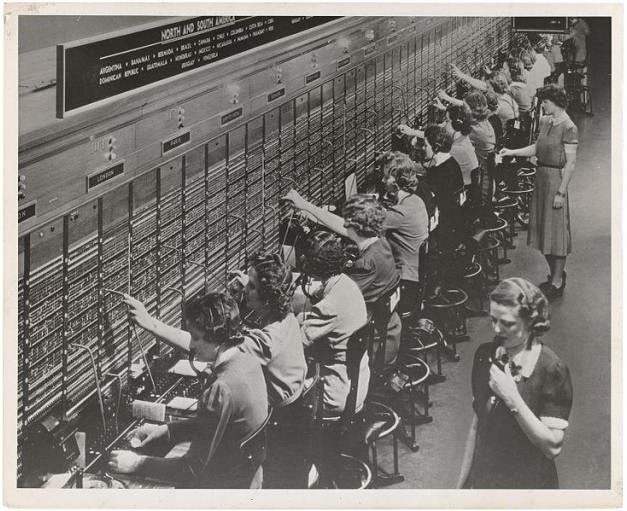
- Switching is a concept
  - Different types of switching: Circuit and Packet
- Packet switching: Possible at link-layer as well as network layer
  - Devices at link-layer are called bridges, switches (layer-2)
  - Devices at network-layer are called routers

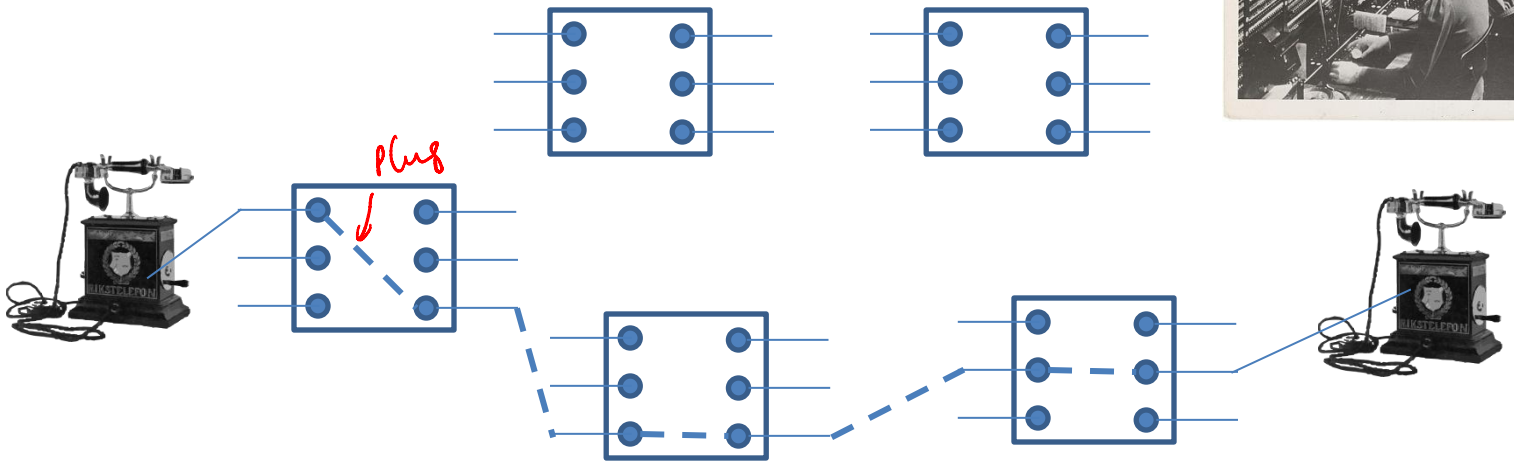
Circuit Switching

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
- 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

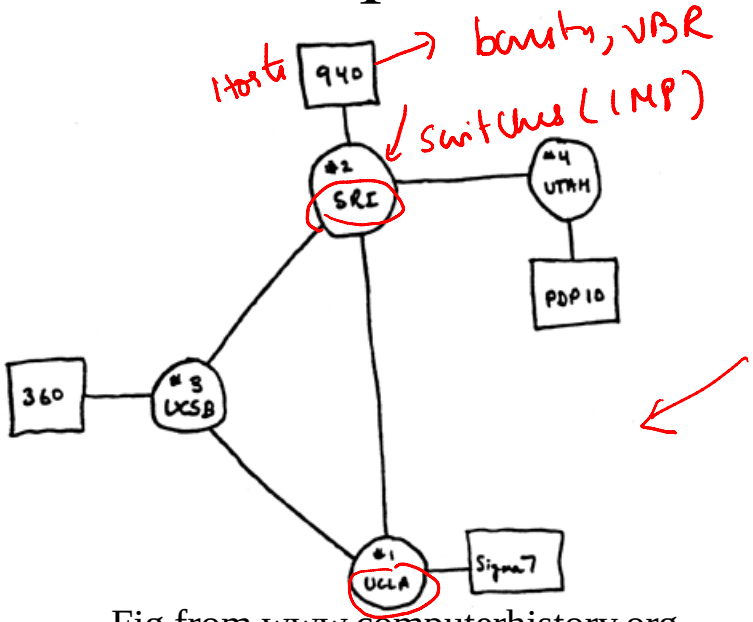
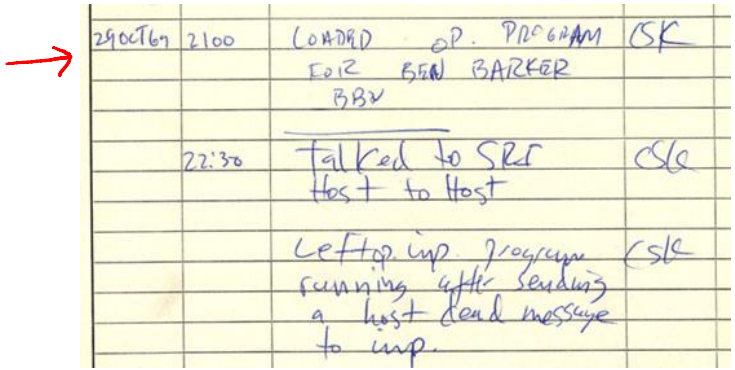


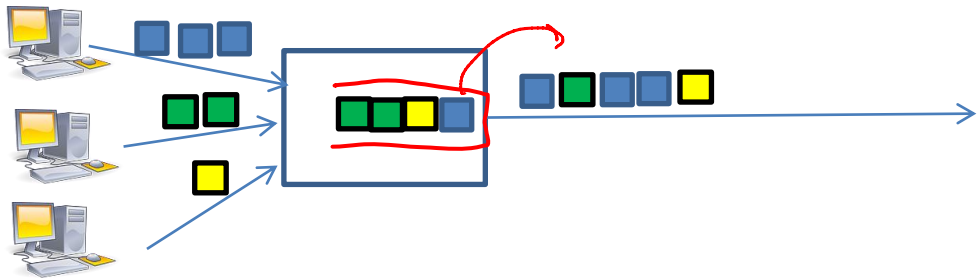
Fig from www.computerhistory.org



First ARPANET IMP log

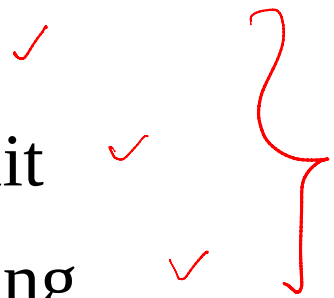
Statistical Multiplexing

- 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)



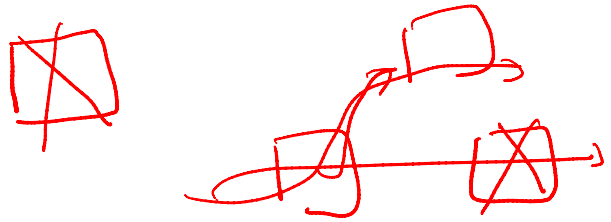
Forwarding

- 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
  - 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