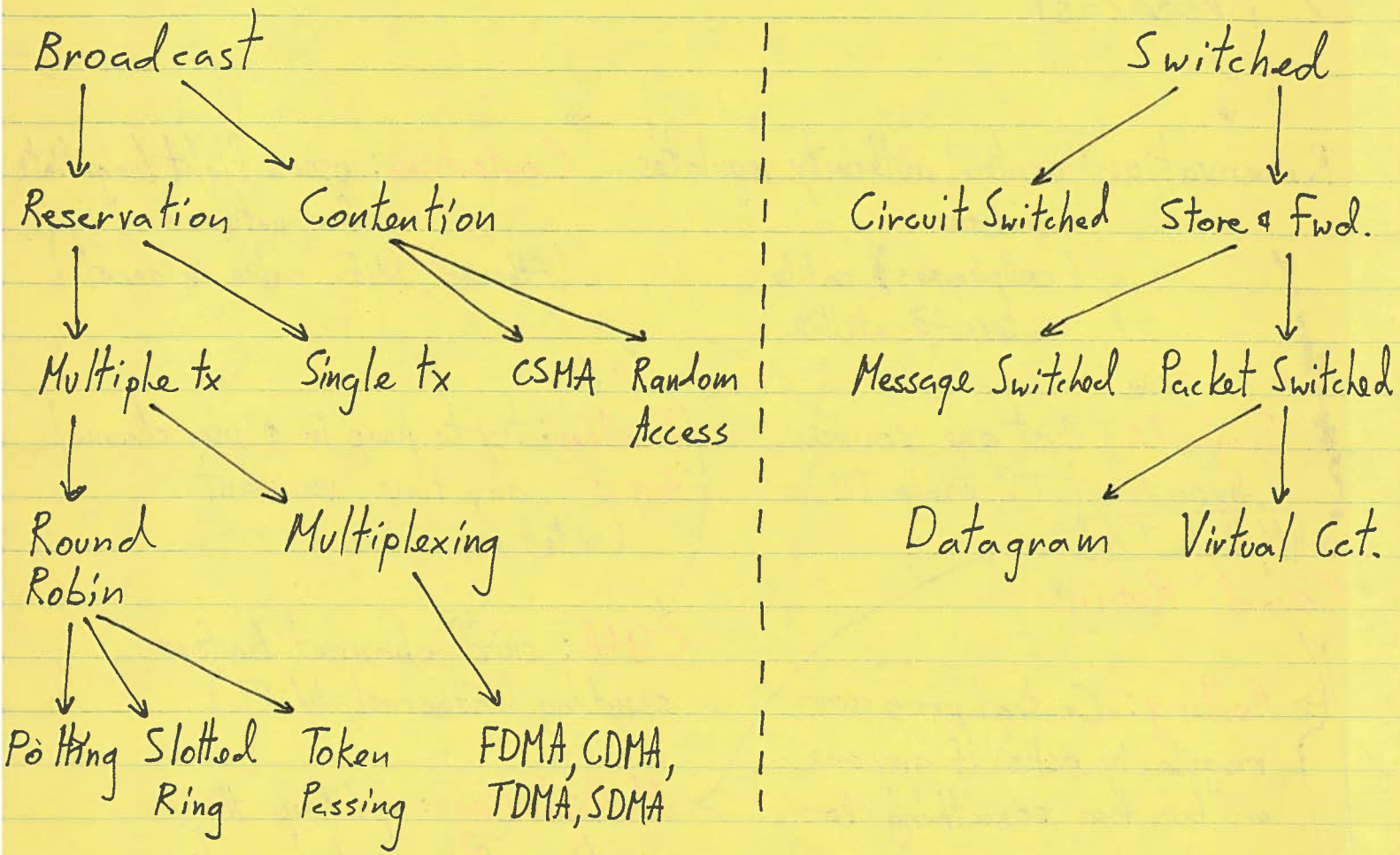
L3 Network Classification



3.1 Network Types

Broadcast: Users connect to common tx medium (cellphones WiFi, Ethernet, cable)

Switched: Collection of individual links that can be configured (switched ) as desired

(wired telephone infrastructure, ISP core networks, inter-campus networks)

3.2 Broadcast

Reservation: central authority regulates access (cellphones, cable internet, satellite)

Contention: users fight/negotiate for network (Ethernet, WiFi, cable internet)

Single TX: Just one source (broadcast TV, cable TV)

Multiple TX

Round Robin

Polling: Central processor regularly asks if anyone on bus has something to say

Slotted Ring: Everybody gets some unique pre-defined time-slot for transmission

Token Passing: When m/c has "token" it is allowed to tx, passes token on after finished (inter campus networks, metro sized C.O./L.E networks)

Random Access: try to jump in & use channel any time you want (satellite, cable)

CSMA: sniff channel before sending (Ethernet, WiFi)

Multiplexing: split up the medium into subchannels

FDMA: Users @ diff freqs.

TDMA: Users @ diff times

CDMA: Users with diff. "languages"

SDMA: Users @ diff. locations

(cellphones, bluetooth satellite)

3.3 Switched

Circuit Switched: complete a physical connection between ~~a~~ endpoints for duration of session
- time-division switching?
  - mux's multiple users on one line (in trunk)
  - user has reserved CHANNEL TIME (if you send nothing, channel empty)

PRO: great, reliable link, super for QoS
CON: not efficient for bursty traffic

Store-and-Forward / Cut-Through Switching: sending data in hops between intermediate stations

S.F.: gathers whole information sequence before sending it on

C.T.: starts forwarding information sequence before ~~it~~ all appears (o.k. for virtual circuit networks)

Message Switching

complete message sequence

PROs:
- easy to keep track of message (not split up)
- easy to know what resources to allocate (e.g. which message to send first)

CONs:
- significant storage
- error control a problem as message length ↑

Packet Switching

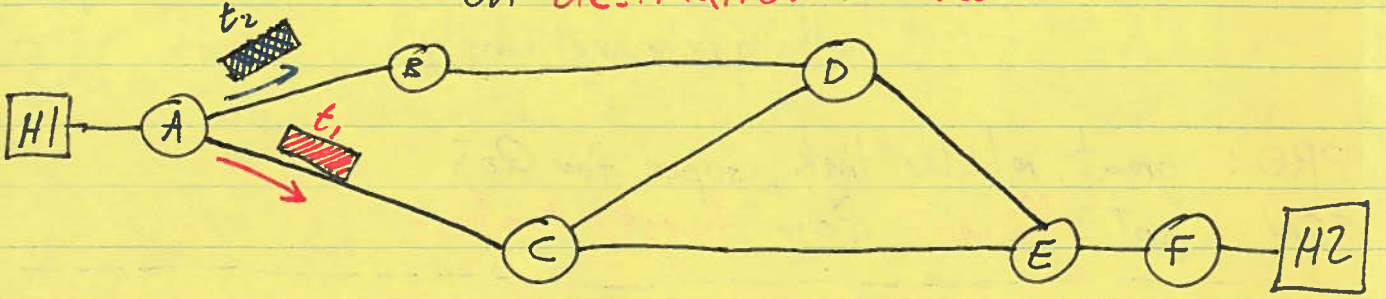
chop up message into small chunks

PROs:
- easy to handle errors
- lower storage requirements

CONs:
- dealing with delays & out of order packets

3.4 Packet Switching

datagram network: - no pre-set route for packets
- network nodes (routers) studies quality of connections & runs algorithms to decide where to send packets based on **destination address**



H1 sending packets at:  time
to H2

- routes taken depend on state of **routing tables**

e.g. A's routing tables at...

t_1

packet destination	output line
A	–
B	B
C	C
D	B
E	C
F	C

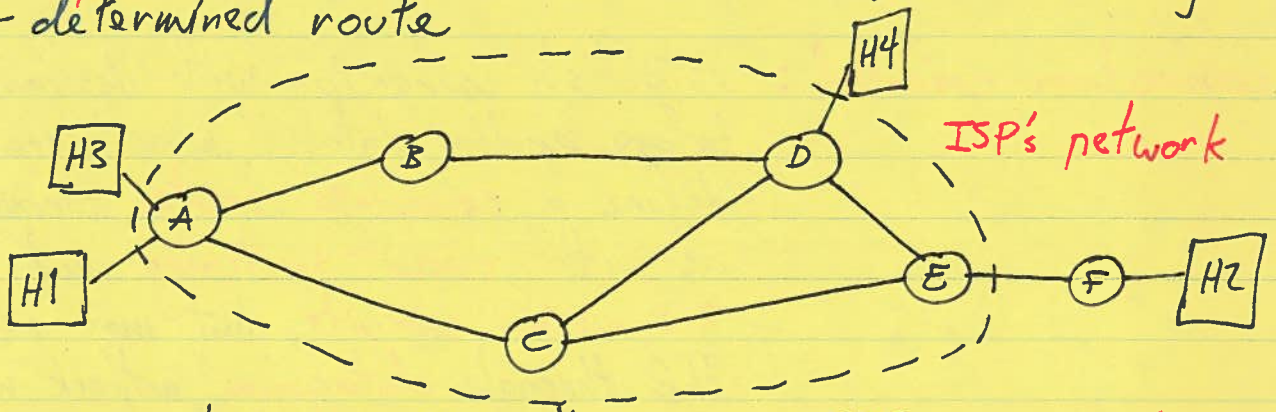
t_2

packet destination	output line
A	B
B	C
C	B
D	B
E	B
F	B

virtual circuit network: pre-decide the route that packet takes
- guaranteed QoS... unless router crashes and then thing can go quite bad as an efficient back-up plan for route may not exist

- "Layer 2/3 virtual circuits"
- configure router tables to look for messages with route identity (VCI: virtual circuit identifier) & pass along pre-determined route

e.g.



- say we want to use the path A→C→E~~→F~~ for H1 & H3 TO H2
- ISP must set up... "From" → which line going into router

A table

From	VCI	To	VCI
H1	1	C	1
H3	2	C	2

C ~~B~~ table

From	VCI	To	VCI
A	1	E	1
A	2	E	2

E table

From	VCI	To	VCI
C	1	F	1
C	2	F	2

note H1 traffic on ~~a~~ virtual circuit labelled 1
H3 " " " " " 2
} routers look at packet VCI to determine next hop (good for cut-through)

- if H3 wanted to contact H4?
- set up another virtual circuit path with a unique identifier say...

A → C → D with VCI 3

A's table			C's table			D's table		
H3	3	C 3	A	3	D C	C	3	H4 3

we'll mention "Layer 4 virtual circuit" (i.e. TCP) next

3.5 Connection Service

- 2 broad connection service types

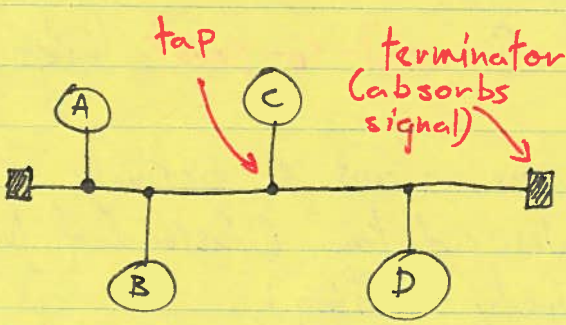
connection-oriented: establish connection with destination before sending data (may literally define a complete route through network as with circuit-switching and layer 2/3 virtual circuits, but may also do this through datagram network with appropriate protocol like TCP... layer 4 virtual circuit)

connectionless: allow message to be launched into network prior to identification of route to destination or any confirmation of destination's availability

connection-oriented	connectionless
TCP (internet)	IP (internet)
ATM (internet, MAN)	UDP (internet)
virtual circuits (internet)	HTTP (internet)
telephone	Ethernet
cell phone	WiFi

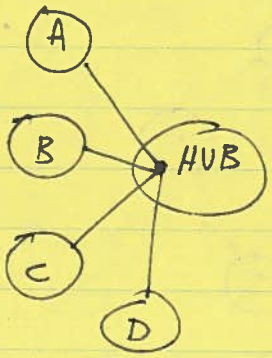
3.6 Broadcast Network Topologies

Bus



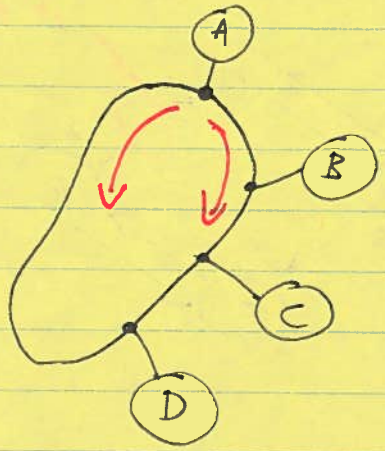
("multidrop")

e.g.



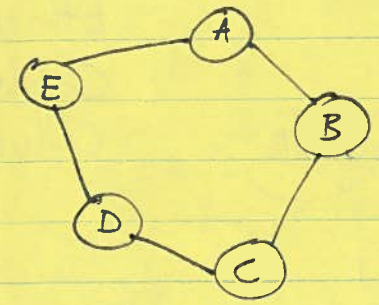
Ethernet
Cable
Cellular

Passive Ring

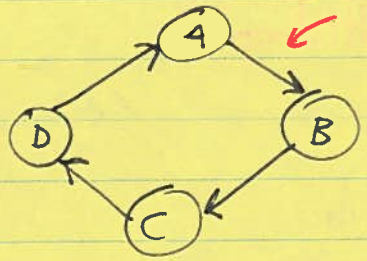


- just launch message in and let it fly bi-directionally
- each node sniffs channel for signal
- long ringing in network (signal going round & round)
- use token to organize comms.
- not very popular

Active Ring

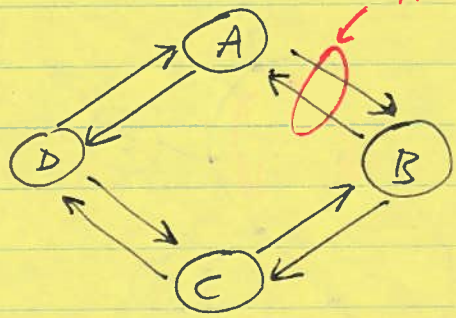


- ring of point-to-point links
- everyone stops & actively examines data (instead of just passively sniffing)
- unidirectional (cheap) →



if this line breaks B is cut-off

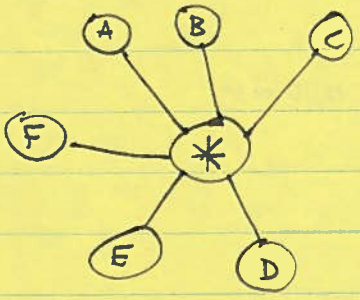
- bidirectional (more robust) →
  - common in fiber optic trunks (MAN/WAN)



if this line breaks can still send to B

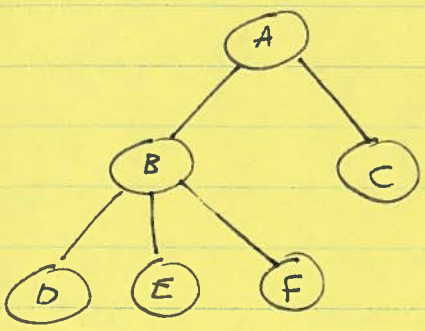
3.7 Switched Network Topologies

Star / Hub



- the telephone network
- special central node (unlike the broadcast HUB each node only sees one other node at a time)
- vulnerable to failure

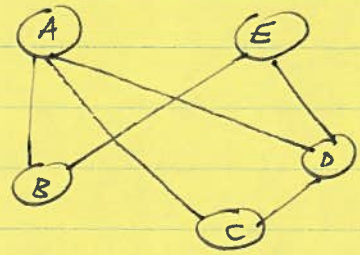
Tree



- only one possible path between any two nodes
- routing is easy
- see this in campus networks where IP subnets exist as a tree

- star is special case of tree with only 2 hierarchical levels

Mesh



- if add more links to tree such that node is connected to MORE THAN 1 higher level node
- WAN, main trunk networks

- fully interconnected mesh usually too expensive

3.8 Size Classification

LAN	0-5km	1-200 nodes	campus has collection of LANs
MAN	1-100km	1-500 nodes	connect up a bunch of campuses in city/region
WAN	1000s km	10^4 +	Internet backbone, Tier 1