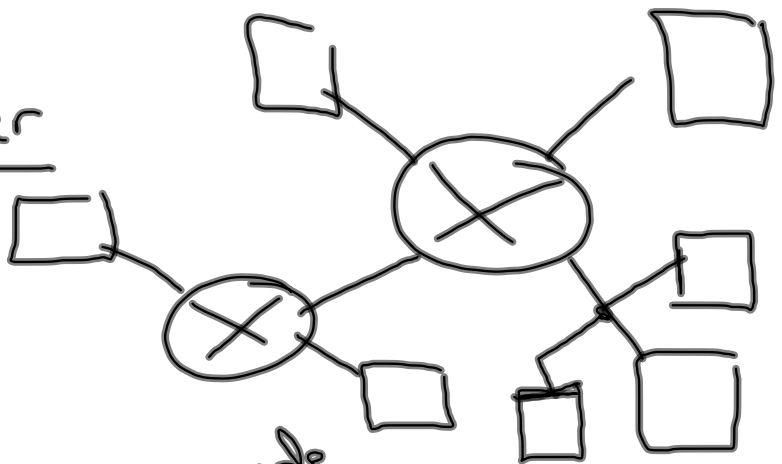
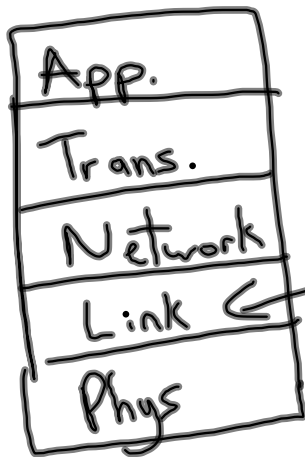
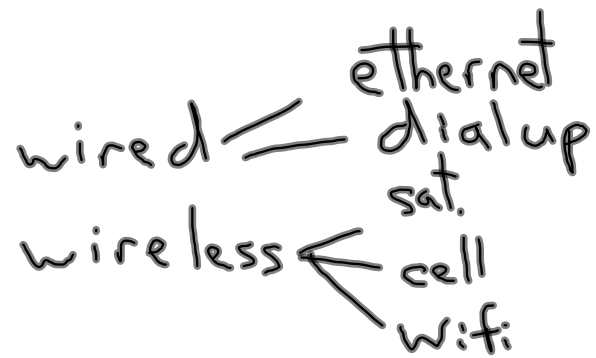


# Link Layer



node to node

## Links



LAN - local area net.

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Frames - grouped data

## Services

- frames
  - link access
- } Media Access Control  
(MAC) addresses  
(48 bits)
- reliable delivery
  - flow control
  - error detection/correction
  - communication duplex
    - half
    - full

Adapter : Network Interface Card (NIC)

- framing
- error checking

# Error Checking

even parity

← make # of 1's even

01011001

rcv.

00011001

2D parity check

1	0	1	1	0	1	0
0	1	0	1	0	0	0
0	1	0	0	1	1	1
1	1	0	1	0	0	1
0	1	1	1	1	0	0

rcv

1	0	1	1	0	1	0
0	1	0	0	0	0	0
0	1	0	0	1	1	1
1	1	0	1	0	0	1
0	1	1	1	1	0	0

CRC: Cyclic Redundancy Check

D: data

choose a generator pattern,  $G$   
( $r+1$ ) bits

choose  $r$  bits (called  $R$ )

$\langle D, R \rangle$

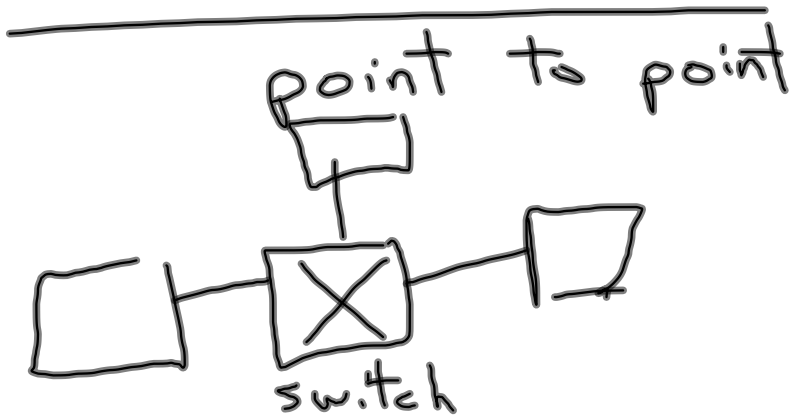
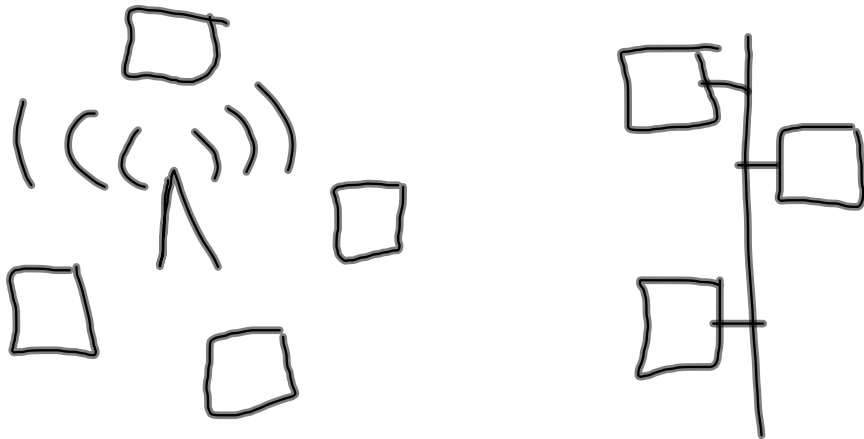
s.t.  $\langle D, R \rangle$  exactly divisible  
by  $G$  (mod 2)

send  $\langle D, R \rangle$

detect error bursts of  
 $r$  bits

# Multiple Access

broadcast media



---

collisions

## Multi-access Protocol

channel rate  $R$  bps

ideal  
- only 1 device  $\rightarrow$  it can  
send @  $R$  bps

- when  $N$  nodes transmit  
each can send @  $\frac{R}{N}$  bps

- no coordinating

---

## Types of MAC protocols

Channel partitioning

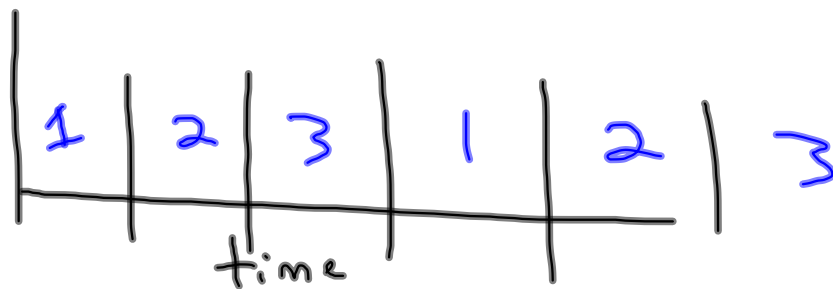
Random Access

"Take turns"

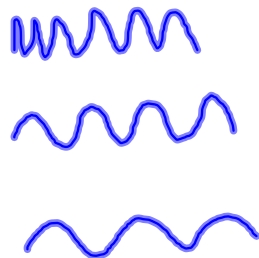


# Channel Partitioning

TDMA - time division



FDMA - freq. div



## Random Access

CSMA: carrier sense  
multiple access

- listen before transmitting

CSMA/CD (collision detection)

- if collision, wait random  
Time