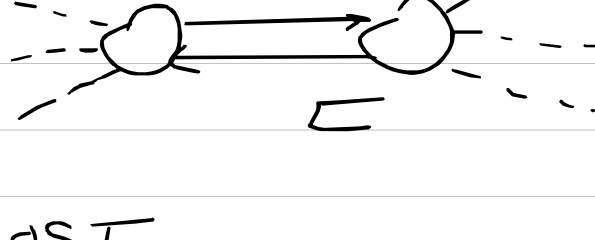
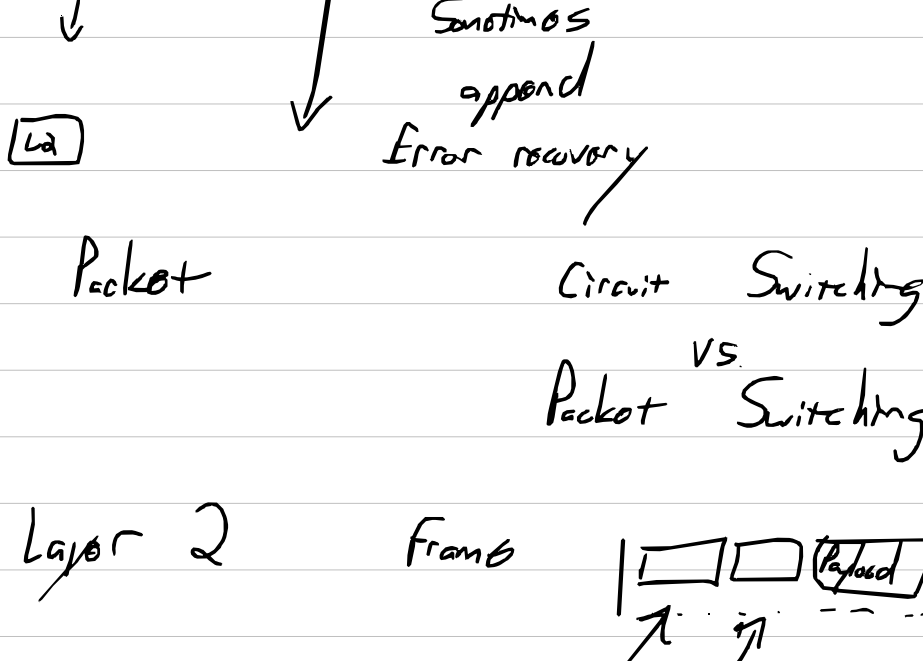


Lecture 3 - Link layer

Last lecture



Recall OSI



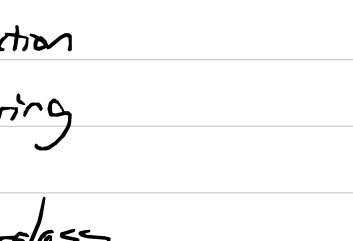
Packet

Circuit Switching

Packet vs Switching

Layer 2

Frame



Preamble

Head

Today Links

Direction

Sharing

Wired vs. Wireless

Distributed (Unlicensed)

vs.

Centralized (Licensed)

LAN



Bus

Shared

Split

Frequency

TDMA

FDMA

Multiple Access

When Shared

Distributed

or

Centralized

Each node competes

Non-deterministic (generally)

→ Potentially deterministic

Bus



CSMA/CD → Detect

CA → Avoid

Carrier Sense

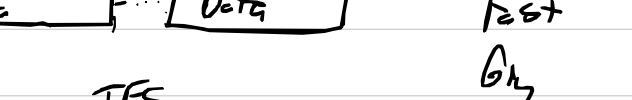
Collision

Wired

802.3

Ethernet

Hub



CSMA/CD



IFS

Ethernet

Fast

10 Gb/s

100 Gb/s

10,000

10,000

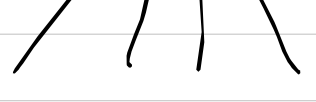
Radius ↓ to account for propagation / collision detection

Possible wiring

Switch

Store & Forward

Star



Layer 2

MAC Address

6 Bytes

Hex

— : — : —

Broadcast

All 1's

Switch

Self Learning

Simple/Dumb

Managed

Web Interface

Layer 2 MAC

VLAN Logically Partition

Fiber

Optical

Less aimed

SFP

SMF

MMF

Light

WDM

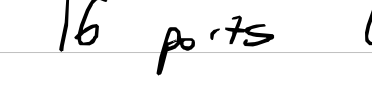
— Red

— Violet

— Green

→ Fiber

≡ Bundles of Fiber



Optical Electronic

Crossbar

pps

mbps

16 ports GbE

Perfect switching

Any no any

Datacenter N/W

Most computers will struggle >> 1 Gb/s

Switch

L2

Sometimes

"pick" up

Router

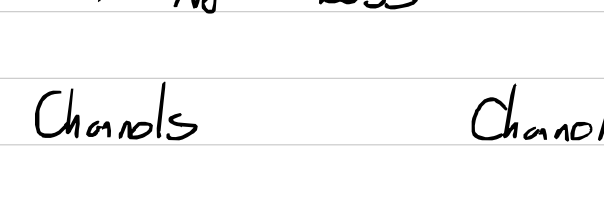
L3

WiFi

Cellular

↓

802.11



Unlicensed

→ No Boss

2.4

Channels

Channel width

5

6

Frequency

vs.

Speed

vs.

Path Loss

Path Loss

Wired

vs.

Wireless

CSMA/CA

Slotted

ALOHA

Exp.

Backoff

Wireless → Lousy

BER ↑

L2 Ack for all data

sender

Recv

DIFS

SIFS

DIFS

SIFS

MRR

Fast

Fast

Slow

Inf Theory



Sudoku

802.11

1 Mb/s

802.11 a

5

b

24

g

2.4

24+

n

5

+ 6 GHz

GE

↓

ac

WiFi Version 5

ax

6

20

320 MHz

2.4

1, 6, 11

5

More

WLAN

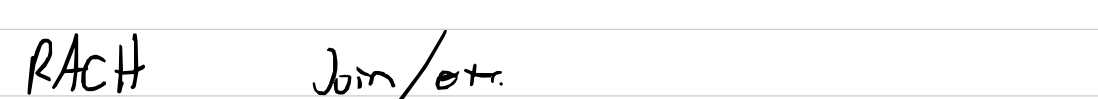
6

Lots & lots

Cellular

→ 3G PP

4G LTE



RAN

Loss of

procs

Roaming

Ugly

Licensed / Scheduled

RACH

Join/exit

Micro, femto, pico cell vs. Macro cell

Sharing of the pie

Uplink vs. Downlink

NB-IoT w/ 5G

Challenges / Changes

Wired / Ethernet

WiFi

Cellular