INTRODUCTION

I COMMUNICATION

→ EXCHANGE INFO.

BETWEEN ① MAN and MAN

② MAN and MACHINE

③ MACHINE and "

SPEECH

II EARLY COMM. SYSTEMS

① FIRE

② DRUMS

③ ETC.

FLAGS

ALL SIMILAR:

CHANGE SIGNAL IN

TIME

KIND / AMPLITUDE

CONSIST OF
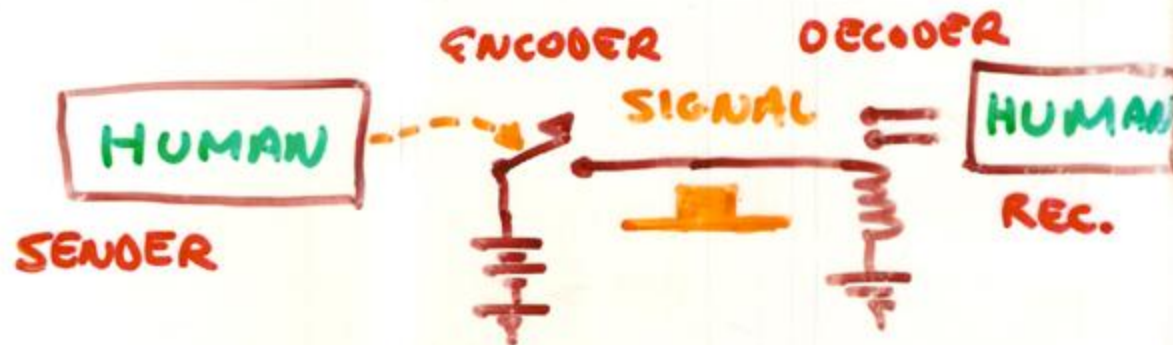
SENDER → ENCODER → SIGNAL

PATH

DECODER → RECEIVER
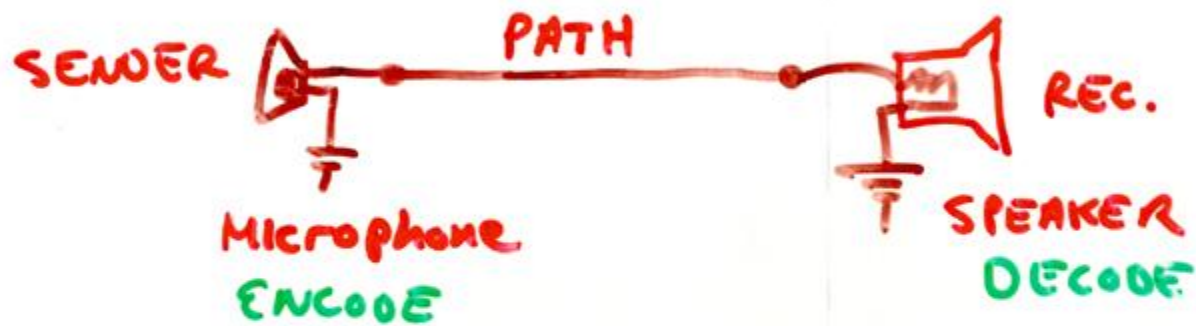
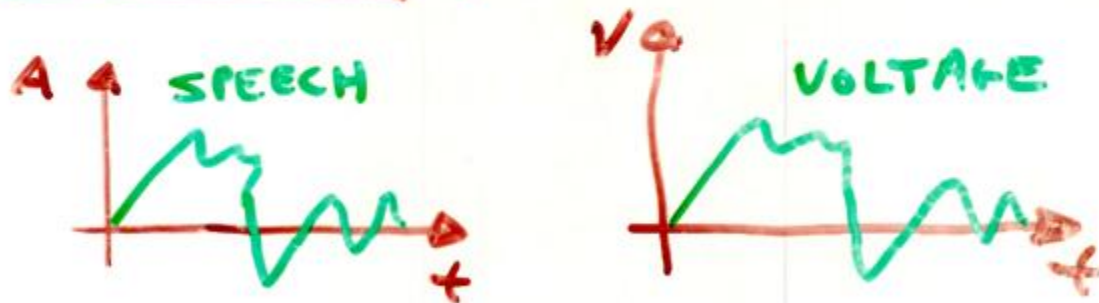# III ELECTRONIC SIGNALS

"HISTORIC SIGNIFICANCE"

① MORSE CODE - TELEGRAPH

SIGNAL: VOLTAGE LEVEL CHANGING
IN TIME   (ONE KIND)

HUMAN ENCODING & DECODING
CAN BE PROBLEM

② TELEPHONE (AUTO ENCODE)

SENDER ———— PATH ———— REC.

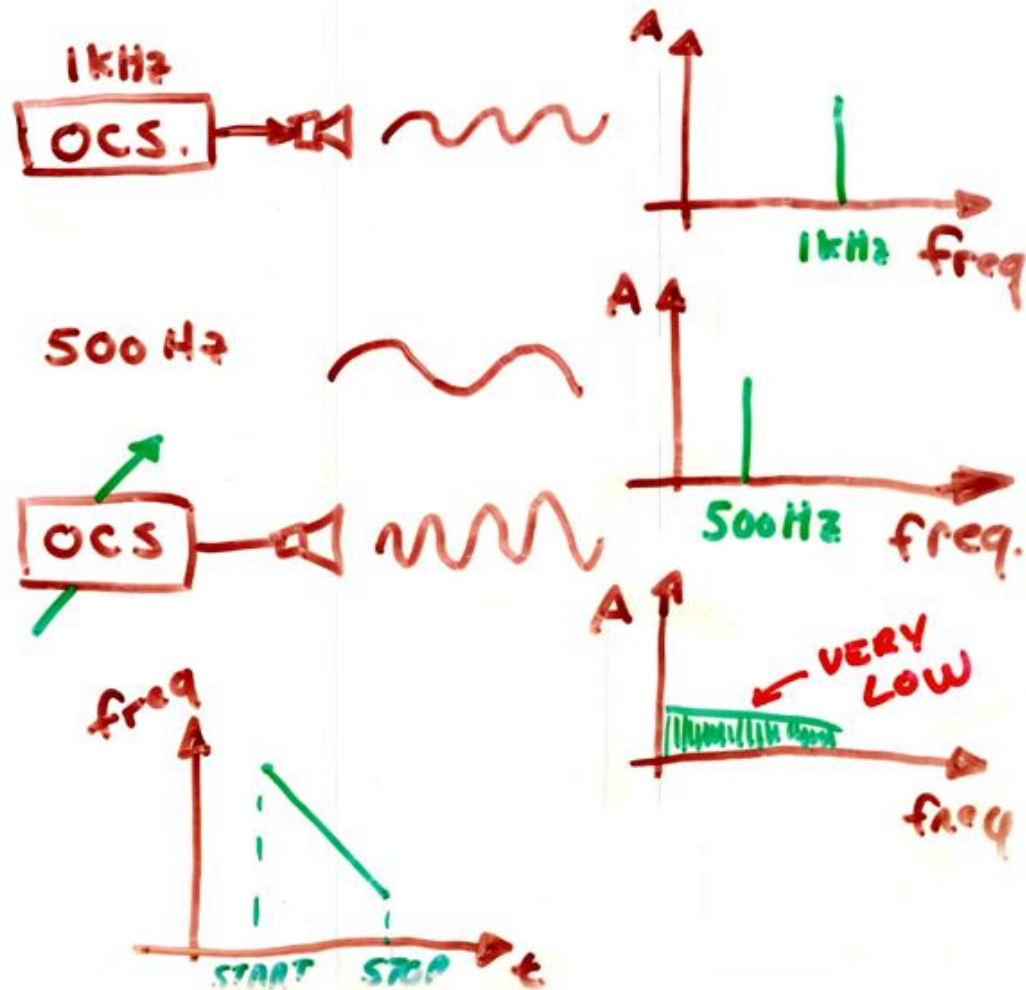Microphone
ENCODE

SPEAKER
DECODE

HOW WORK? ⇒ UNDERSTAND SPEECH

A ↑ SPEECH

V ↑ VOLTAGE

VARIATION OF AMP WITH
TIME (ONE KIND)

DECODE (BRAIN) SPEECH

by ENERGY in ① TIME
② FREQ (KIND)

1 kHz

OCS. ▷▷ ◁ ∿∿∿∿

A
|
1 kHz freq

500 Hz ∿∿∿

OCS ◁ ∿∿∿∿

A
|
500 Hz freq.

A
← VERY LOW
∥∥∥∥∥∥
freq
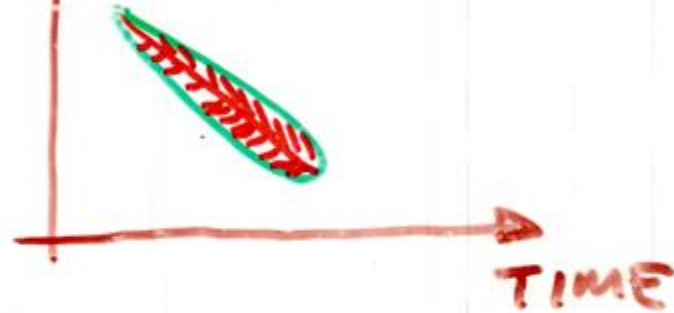
freq
|
START STOP t

3D GRAPH

FREQ

TIME

SPEECH
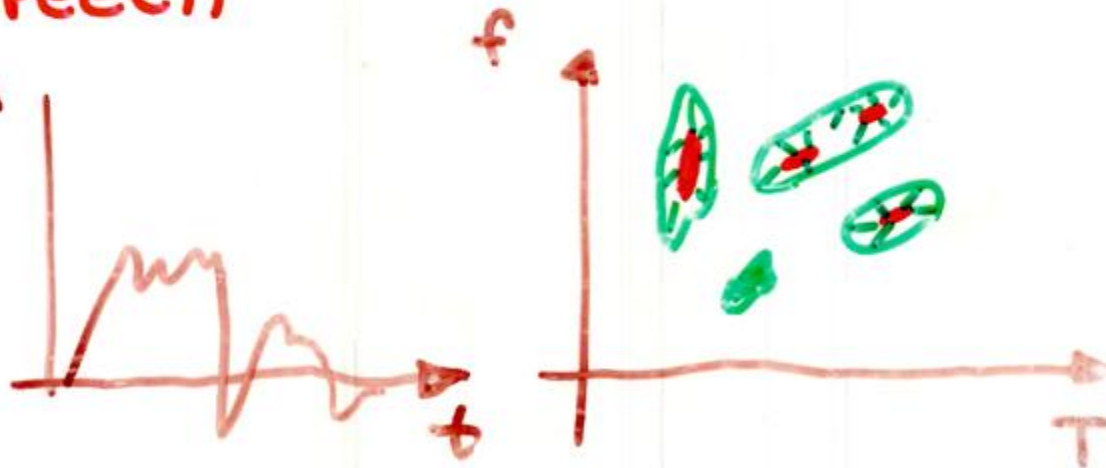

A

f

t

f

T
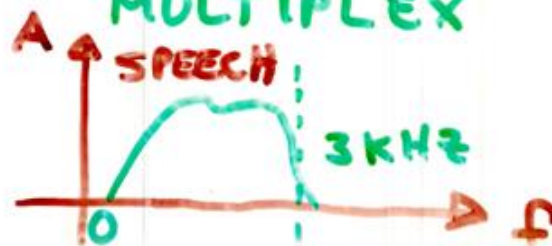
VARIATION IN TIME - FREQ - AMP

IV FREQ. DIFFERENCES
ALSO USED TO SEPARATE
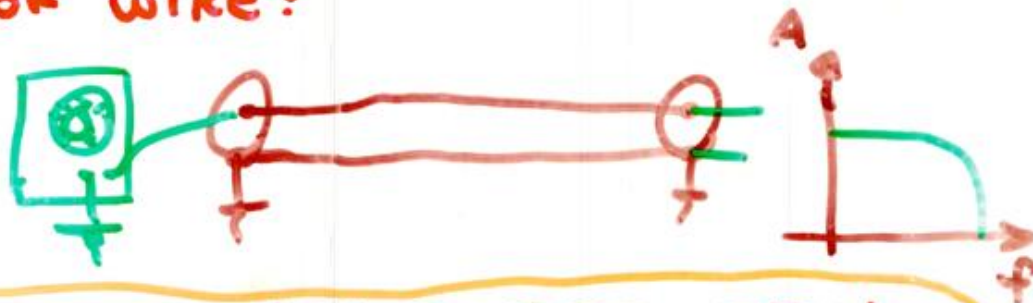SIGNALS.

PROBLEM: MANY TELEPHON
SIGNALS BUT ONE WIRE?

ONE WIRE

ANS. MULTIPLEX TELEPHONE

FDM — FREQUENCY DIVISION
MULTIPLEX

SPEECH

3KHz

CONSERSATION:
#1   #2   #3   #4

4KHz   8KHz   12KHz

#3
#2
#1
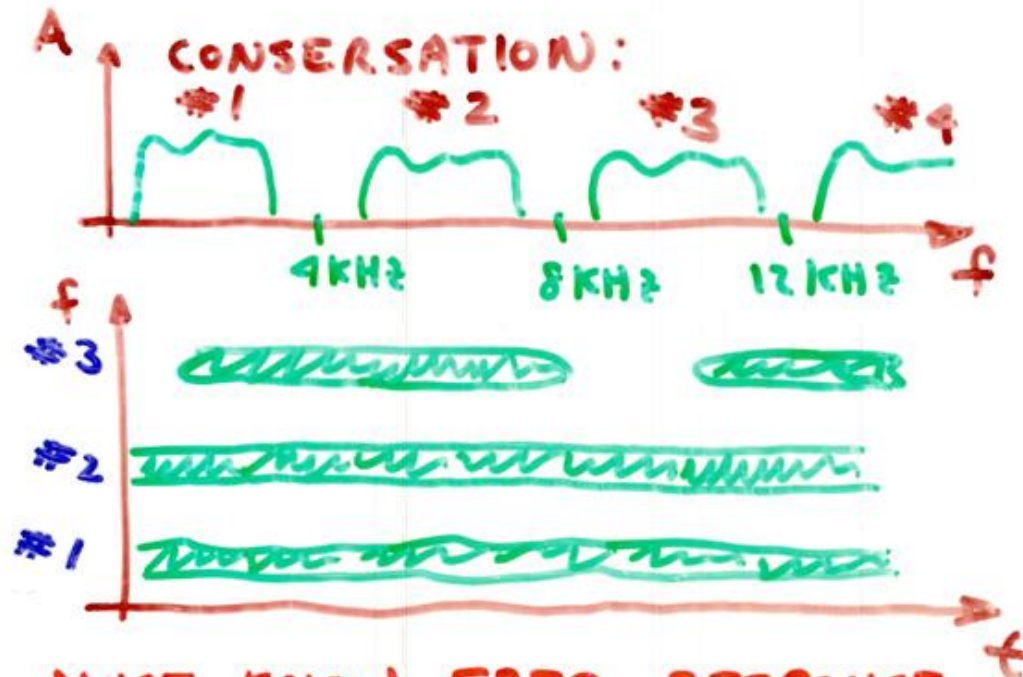
MUST KNOW FREQ. RESPONSE OF WIRE:

RELATIONSHIP BETWEEN TIME/AMPLITUDE AND FREQ. IMPORTANT!

PROBLEM : WHAT IF DON'T
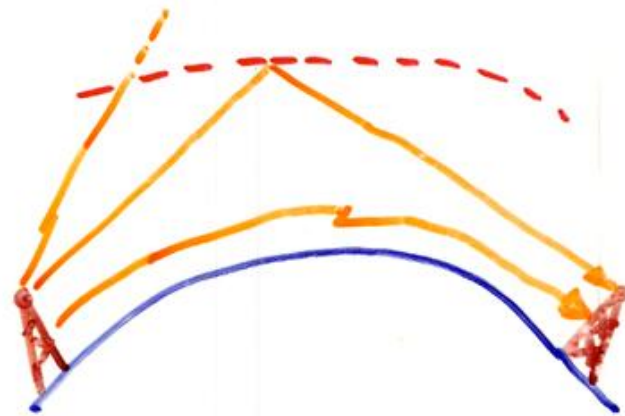HAVE WIRE ?

ANS: ELECTRICAL SIGNALS
RADIATE !

INDUCTION:

TRANSFORMER

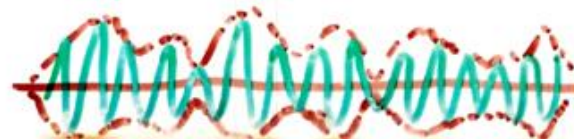TRUE RADIATION:

GOHZ
PICKUP

DIF. SINWAVE FREQ HAVE DIFFERENT PROPAGATION CHARACTERISTICS:

CAN MODULATE THESE AC SINWAVES (RADIO) TRANS- MIT INFORMATION.

CARRIER

VOICE MODULATED

MUST KNOW RELATION
BETWEEN MODULATED
WAVEFORM AND FREQ.
CONTENT.

- HOW MANY SIGNALS
- RECEIVER BANDWIOTH
- ETC.

VII FREQ ⟹ SINUSOIDAL FREQ

FREQ OF NATURAL SYST.

MASS

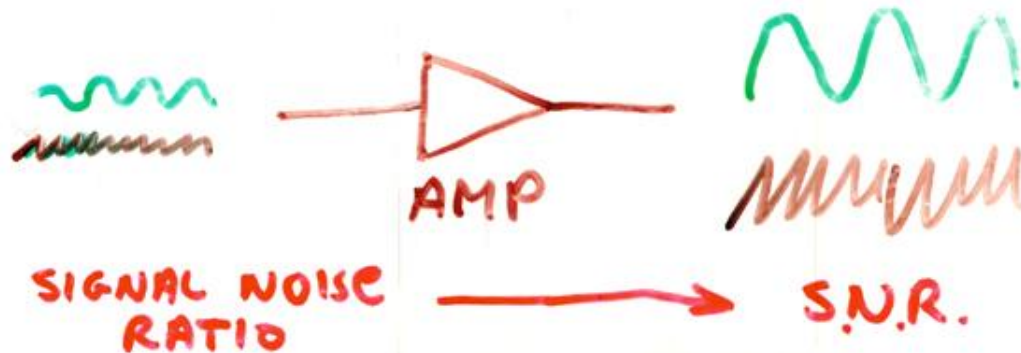COULD DEVELOPE SYST.

BASED ON SQUARE WAVES

VII LIMITATIONS (ALL SYS.)

① NOISE

② Interference } CAN ELIM.

③ Distortion

SIGNAL NOISE RATIO → S.N.R.

AMP

④ BANDWIDTH

– LIMITS RATE OF INFORMATION TRANS.

SIGNAL CAN CHANGE ONLY SO FAST

INFORMATION CAPACITY
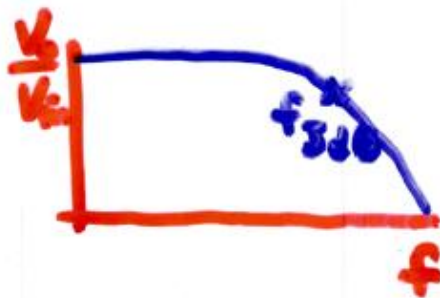
$$C = W \log_2\left(1 + \frac{P_T}{P_N}\right) \quad \text{Bits/Sec}$$

Bandwidth

$P_T = $ Tx Power

$P_N = $ Noise Power

$$\frac{P_T}{P_N} = SNR$$

T_m

$$f_{max} = \frac{1}{T_M}$$

$\frac{V_o}{V_c}$

f_{3dB}

f

Noise

VIII SUMMARY

COM. SYS. INVOLVE:

1. GENERATION OF SIG.
2. ENCODE SIGNAL $\begin{cases} \text{DIGITAL} \\ \text{ANAL.} \\ \text{ETC} \end{cases}$
3. TRANSMIT OVER PATH
   by WIRE OR RADIATION
4. DECODE SIGNAL.

ENCODING $\Rightarrow$ TIME, AMPLIT. & FREQ

RELATION   TIME—AMPLITUDE

FREQ — AMPLITUDE

IMPORTANT