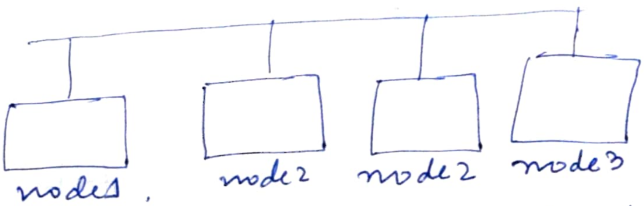
30.07.13
Tuesday.

→ Lilklider → vision of the internet → 1963 → ARPANET.

→ Robert Taylor → 1963 – 1965 [Father of Internet].
↳ First incarnation., ARPANET

→ NSF NET → 2nd incarnation.
(National Science Foundation). → 1986.



→ NSTNET NET → 3rd incarnation → commercialization

(Analog serial processing)

COMPUTER.

ENIAC (1946)

BATCH MODE (1950).

Interactene. (1960)

ARPANET (1965 – (1970)

Transistor (1947)

Microwave (1960).

Satelite (1965)

ETHERNET (1990)

INTERNET.

PACKET switching.

TV (1923)

Radio (1896)

Telephone (1876)

Telegram

COMMUNICATION

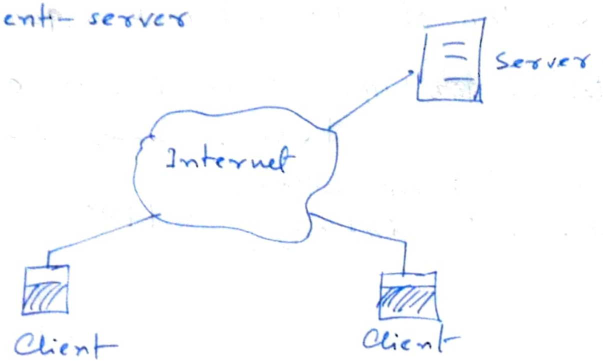
Assignment 01:

Evolution of Internet.

, before 6th August.

05.07.13.
Monday

* client- server

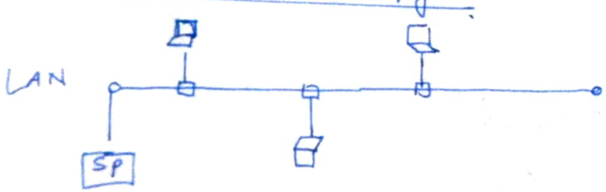


* Signal — Electrical signal
— Optical signal

* Digital signal provides more bandwidth than analog signal (Proof mathematically)
↳ Data rate = bandwidth.

* Communication Devices :
[i] Co-axial cable [ii] Twisted cable.
[iii] Microwave [iv]

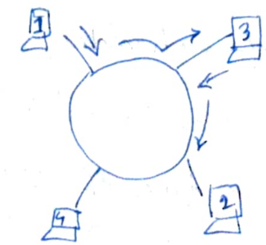
Network topology :



1) Bus topology.
↳ Ethernet protocol
IEEE 802.3

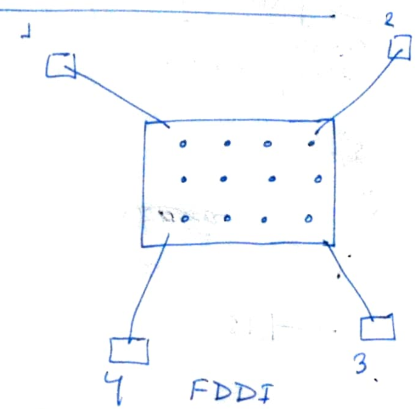
2. Ring topology:

IEEE 802.3.



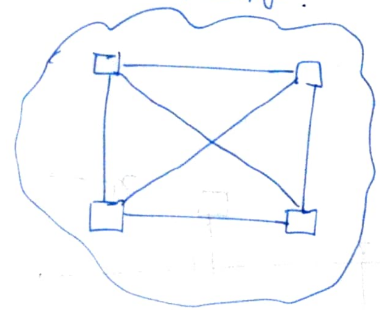
3. Fiber distribution :

IEEE 802.3



FDDI
(Fiber Distribution Data Interface)

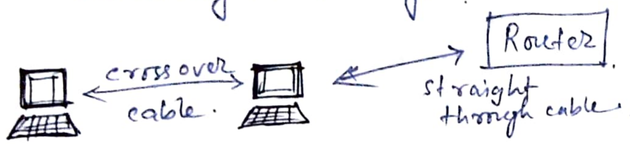
4. Mesh topology.



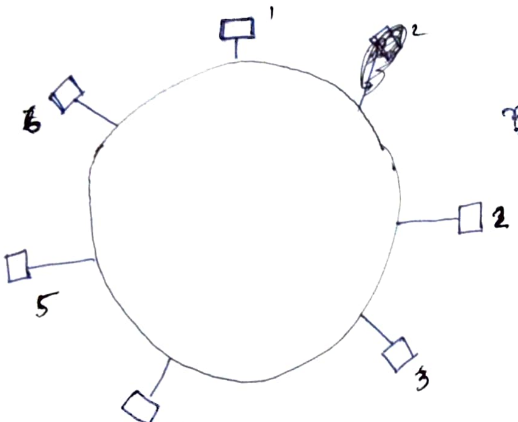
WAN Technology.

Types of Line Cables:

* LAN: Organization of networks.
* UTP: Type of LAN cable (unshield twisted pair)
* CAT5: Line cable ← type of UTP
  - → Cross over (for same devices)
  - → Straight through (for different devices)



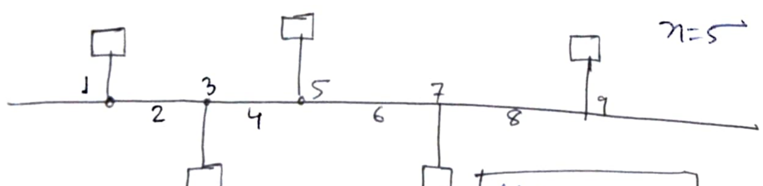
Q



$n = 6.$

Calculate the no. of links in terms of 'n' (no. of users)

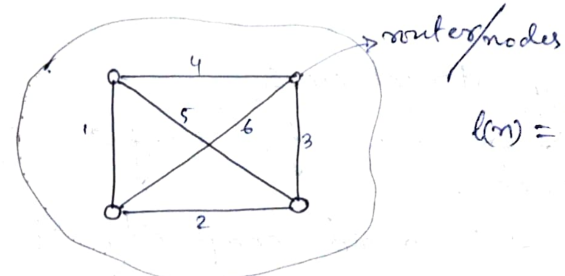
$$\boxed{r(n) = 2n}$$



$n = 5$

$$\boxed{l(n) = 2n - 1}$$

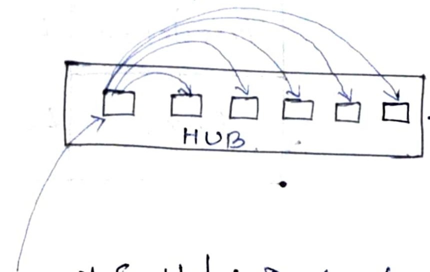
Q



$$l(n) = \frac{n(n-1)}{2}.$$

Component of internet:

* HUB: It's towards the signal.
  ↳ repeaters: enhances the signal.



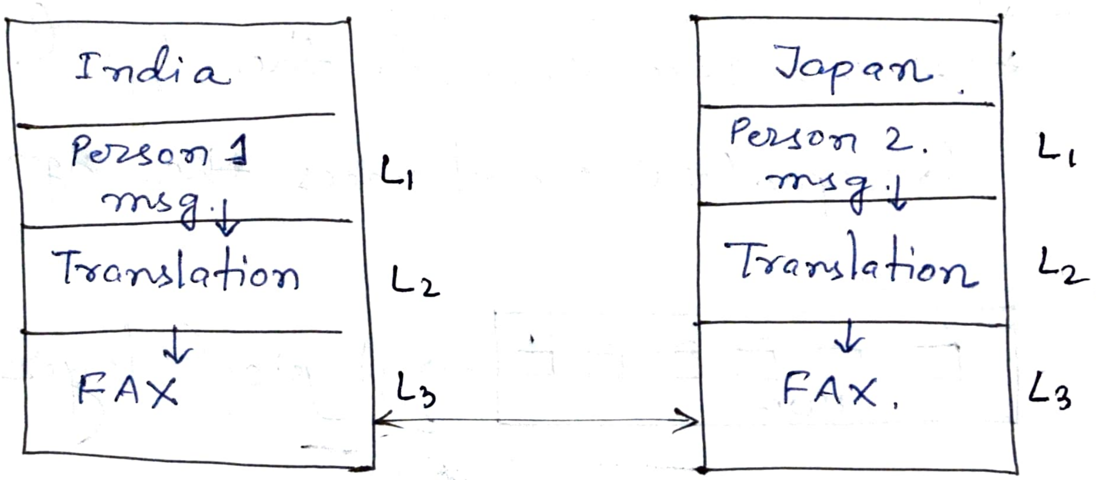
→ physical layer.

* Switch: Data Link Layer → forwarding to particular Rx (LAN)
* Bridges: Similar f(x). as switch. but for WAN. works in data link layer.
* Router: L3; Layer-3, → Network layer.

Layering Structure :

↳ needed for easy management of internet.

↳ to avoid complexity of the network.



12.08.13
Mon

OSI Layer ⇒ Open system interconnection.
by ISO body.

[7 layers] → Protocol Data Unit.
PDU

* Software (upper layer) → Application — *PDU, PPDU, SPDU
* TPDU
* Lower layer — *deals with transport → mixing of software & hardware.

7	Application.	IE, Email, FTP, TELNET
6	Presentation	representation html, JPEG, MPEG, ASCII, EBCDIC
5	Session	→Maintain timer, ie, Boss's security → logically maintains RPC (Remote Protocol call), SQL (Structured Query language)
4	Transport	Sending information, Reliable, Unreliable → (UDP) → ports. TCP (Transport Control Protocol)
3	Network	IP → routing → path finding → IP address
2	Data ~~Layer~~ Link	LLC (Logical Link Control) IEEE 803.3 → Ethernet. 803.2 ( ) (Token ring) → 803.5
1	Physical	IEEE 803.2, 5, → Addrs management → it converts IP addrs to logical Addrs (MAC) wiring

JPEG = Joint Photography Expert Group
* MPEG = Moving

01. PPDU → Bits. → no data.
02. DPDU → Frames.
03. NPDU → Packets.
04. TPDU → Segmentation
05. SPDU →
06. PPDU →
07. APDU →

Data

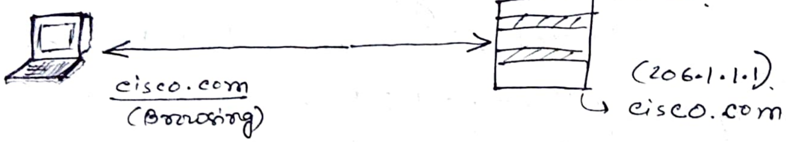
| H1 . - - - H7. |
| H2 - - - - H7 |
| H3 - - - - H7 |
| H4 - - H7 |
| H5 - - H7 |
| H6 | H7 |
| H7 | ~~APD~~ APDU. |

RPC : Remote procedure call.
Session : Logically maintains the timing.
TCP : Transfer Control Protocol
Transport : Ports management.
IP : Internet Protocol.
LLC : Logical Link Control.
Data Link : Address Management → convert to logical address.
Physical : Wiring, physical connection
PDU : Protocol Data Unit.
APU : Application Protocol Data Unit.

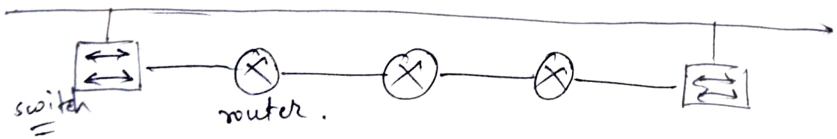
19.08.13
Mon

Mapping of an Application with OSI layer.

Client   Server   cisco.



7. # Application: Browsing → IE.   [H7 | M]
6. # Presentation: html → http:\\cisco.com   https:....   [H6 | H7 | M]
5. # Session: start & End of session
4. # Transport layer: Selection of port based on application.
   e.g; IE 80, Email: 25, FTP: 21.
   S: 109 → will be changing router to router.
   D: 80
3. # Network: Assign IP Address/ Logical address.
   S: 10.1.1.1 → Again it'll be changing.
   D: 206.1.1.1
2. # Data link: Logical Address to MAC Address.
   10.1.1.1 → " "
   206.1.1.1 → " "
1. # Physical
   [H1 | H2 | . . . | H7 | M] (Header)



cmd commands:

i. ipconfig /All
ii. c:>> netstart
iii. Ping
iv. ftp
v. tftp.

Shows

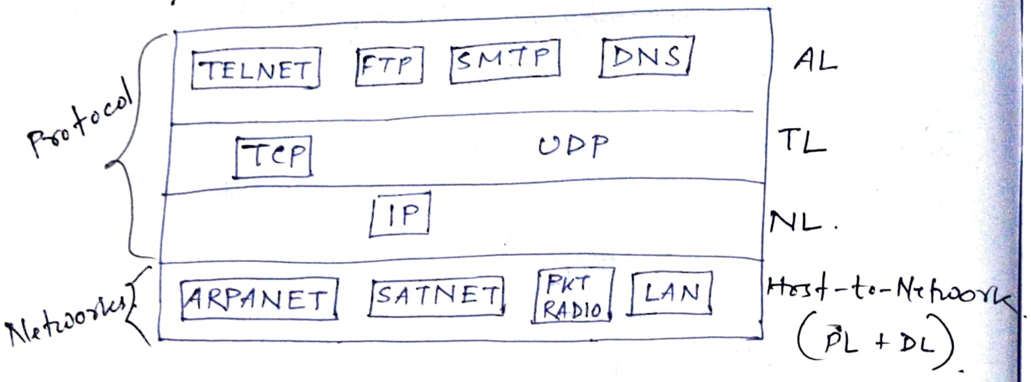
APPL:	IP:	MAC:	status
Cisco.com	S/D	S/D	closed
" : "	"	"	Started.

TCP/IP

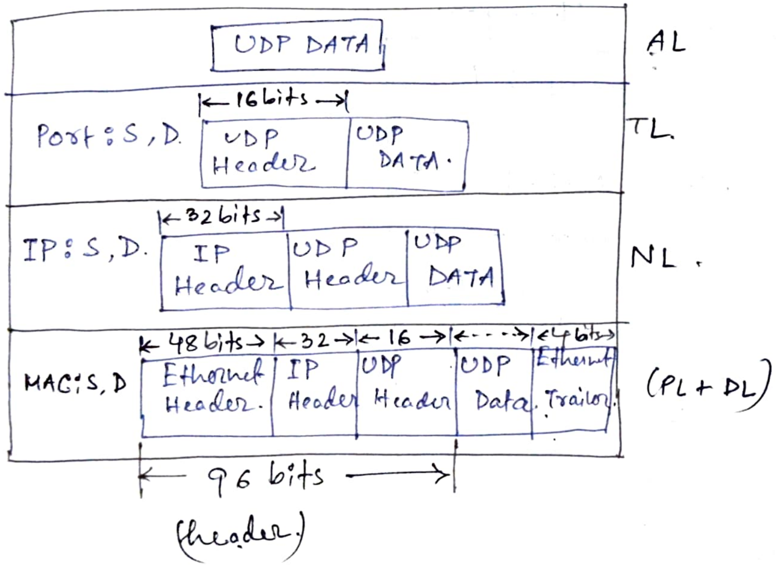
- Application Layer
- Transport.
- Internet Layer.
- Host-to-net & Data link + Physical layer.

21.08.13
Wed

TCP/IP Protocol:



Encapsulation of UDP Header:



Physical Layer:

1. Data Communication: Mix of Analog + Digital.
2. └ [i] Communication Media.
   - [ii] Modulation
   - [iii] Multiplexing & Switching.
   - [iv] Terminal Device.
   - [v] Communication Protocols & Standards.

[i] ex: STP (Single Twisted Pair)
UTP (Unshield Twisted Pair)]→ wiring.

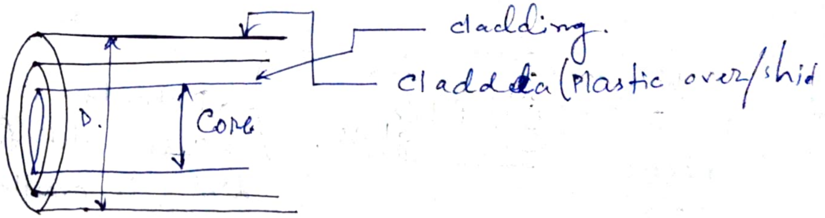
Copper wire = 10baseT — LAN Cable.

(STP).

Co-axial cable.

Optical fiber:

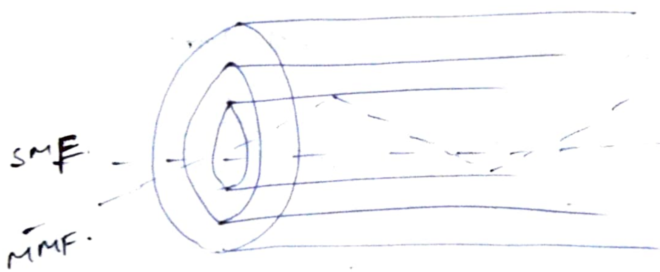
Total internal reflection.

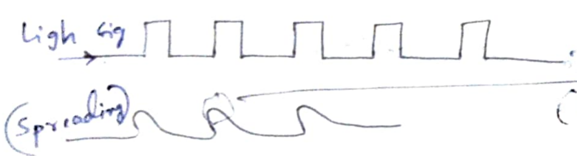


D = 2–125 µM.

"Optical fiber"

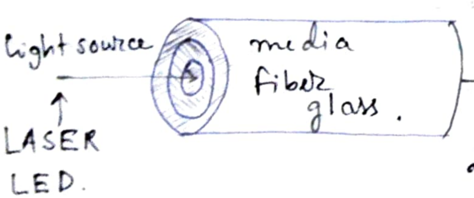
Single Mode	Multimode
1. One light signal.	Multiple light signals.
2. core 8–9 μm.	core 62.5/50μ/100μm.
3. Wavelength 1300 to 1550 nm. $f = c/\lambda$	frequency 160 – 500 MHz.
4. For long distance comm.	For short distance.
5. Less Chromatic ~~Distance~~ Dispersion.	5. More Chromatic Dispersion





Solitons.
(Pulses without spreading)

22.08.13.
Thursday



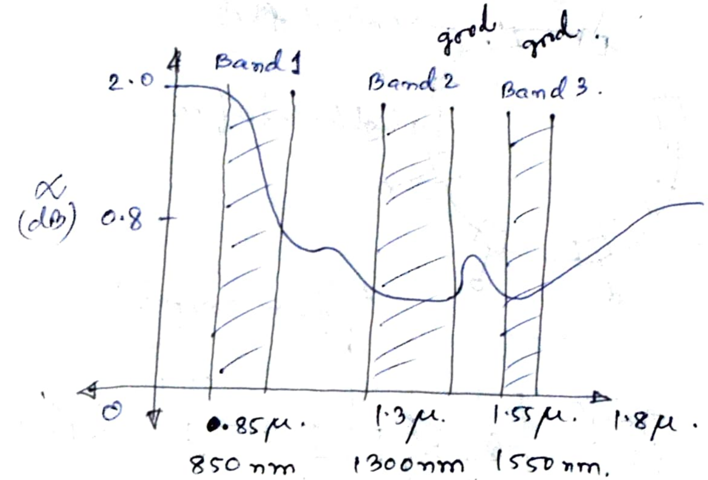
→ Detector.
* Here light fall on photo diod & it emitts electricity.

α = Attenuation = $10 \log_{10} \frac{P_t}{P_r}$

P_t → transmitting power

of (Photodiode)

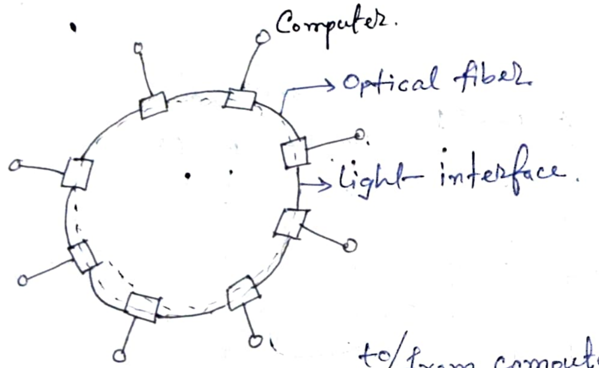
P_r → Receiving power

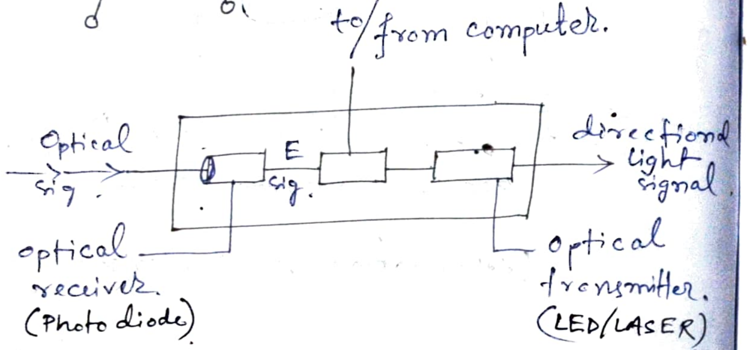


[Attenuation vs. wavelength graph].

	LED	Semiconductor LASER.
Data rate	Low	High.
Fiber type	Multimode	Single or Multimode.
Distance	short	Long.
Life time	Long life.	short life.
Temp & Sensitivity	Minor	Substential.
Cost	Less	More.

Use of Fiber Network:

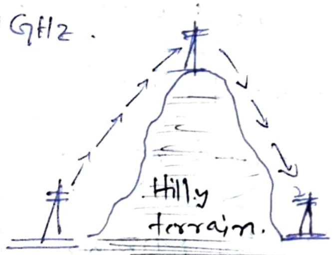




Radio & Microwave :

100 KHz — 1 GHz.

Here the problem in transmission is LOS (Light of sight)

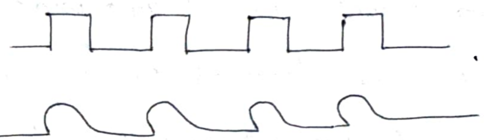


Satelite Communication.

↳ 20 — 40 GHz

↳ Propagation delay. (250 – 300 μs)

Solitons;



solitons are the signal without spreading & so its called as 'original' signal.

Signal & Channel Properties :

Bandwidth, Data rate . Baud rate, bit rate, S/N, BER, Constellation, signal level.

27.08.13.
Tue

Signal & Channel properties:

Channel → Medium.

* signals flows through the channel.

Bandwidth: Range of frequencies that can pass through the medium.

Data rate: signals per unit time is called data rate.

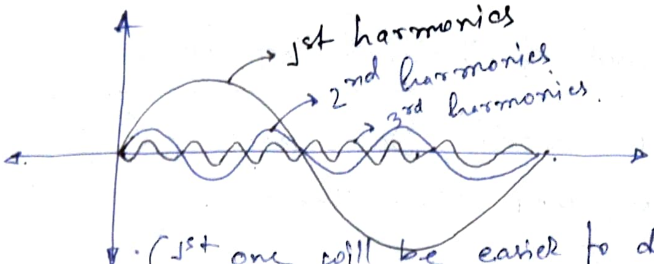
[i] Data rates $\propto$ Bandwidth.

[ii] Data rate depends on signal types – Analog or Digital.

└ Analog → Data rate $\propto \log_2$(no of constellation point)

└ Digital → Data rate $\propto \log_2$ (no of levels)

[iii] Data rate depends receiver sensitivity.



(1st one will be easier to detect)

[iv] Temperature $\propto$ resistors.

[v] Bandwidth of a signal $\propto$ BW of a medium.

$\underbrace{\text{Bandwidth of a signal}}_{\text{Data rate}}$ $\propto$ $\underbrace{\text{BW of a medium}}_{\text{(Limited)}}$

Let's say 8bits/sec | ↓ | ↓ | ↓ |

16bits/sec | ↓ ↓ | ↓ ↓ | ↓ ↓ | ; it will be hard to ...

* data rate ↑ signal will be distorted. bandwidth is limited.

03.09.13
Tue

[] MDR (Maximum Data Rate) for binary sig (chnl)

↳ Based on Nyquist equation.

$$\boxed{MDR_{(channel)} = 2 \times BW}$$; for binary sig level. (BAUD rate)

↳ Multiple signal level:

$$MDR = 2 \times BW \times \log_2(\text{signal level})$$

[*] For real system ← System with noise (noisy chnl)

↑ "shannon's theorem"

↳ $$\boxed{MDR = BW \times \log_2(1 + S/N)} \quad \text{—— (i)}$$

$$\boxed{S/N_{(dB)} = 10\log\left[\frac{P_{sig}}{P_{noise}}\right]}$$

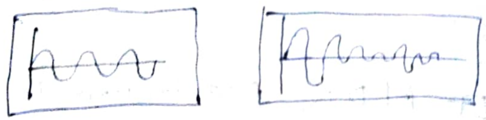
if ⇒ $P_s = P_n$; then from equn (i);

⇒ $MDR = BW \times \log_2(1 + \cancel{\log 1})$

$= 0$

Signalling: can be Analog & Digital.

Periodic   Non-periodic.



Example:

Voice sample

↳ Audio CD → Analog.

↳ MP3 → Digital.

* Analog signal always refers to low BW.
* Digital " " " " high "

* Dig. sig's bw depends upon the no. of signal levels.

↳ [?] two different levels. ; where 1 = +1V, 0 = -1 V.

let's say 1 1 0 0 1 1 0 1

Orig. sig : (+1, +1, -1, -1, +1, +1, -1, +1)

|←t→|←t→|←t→|←t→|←t→|←t→|←t→|←t→|

$t = 0.1\ \mu s = 10^{-7}$ sec.

∴ BW = [no of bits transmitted per second]

=

05.09.13

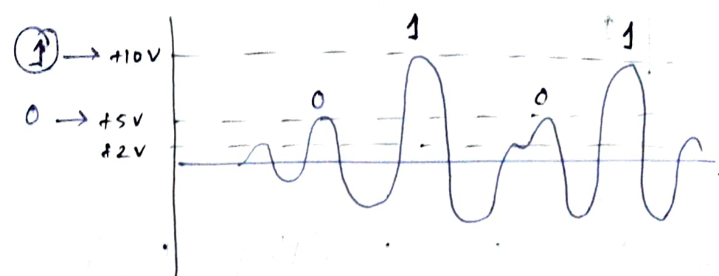
See the Mobile comm copy for this day's class note

11.09.13.
Wed

Coding Mechanism:

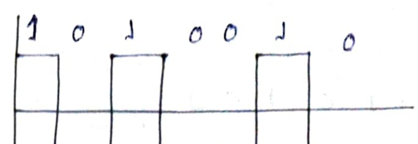
Representation of signal → Shift keying

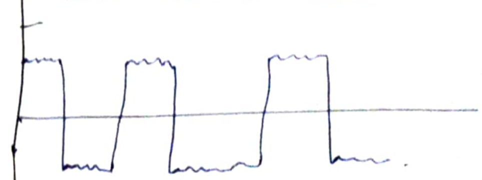
ASK, FSK, PSK.



Sequence = 0 1 0 1.

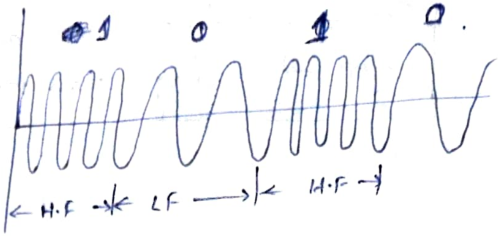
Digital





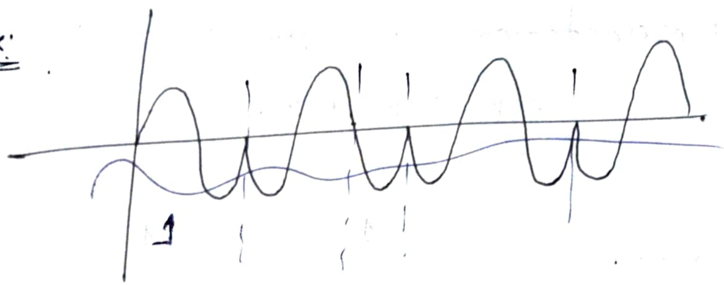
(noisy version)

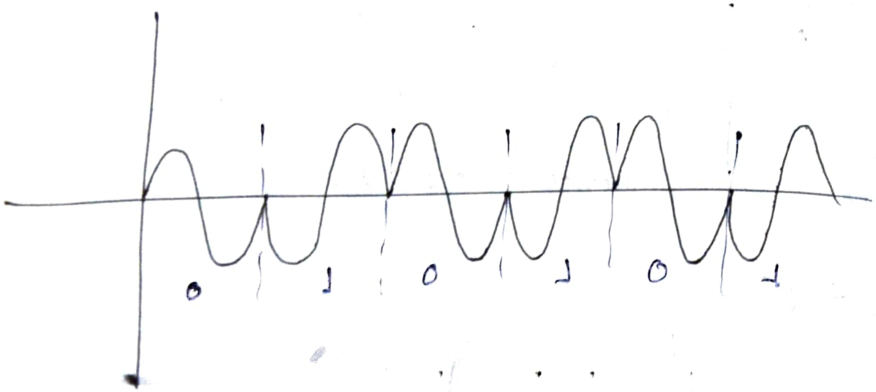
FSK:



Sequence : 01010.

PSK:

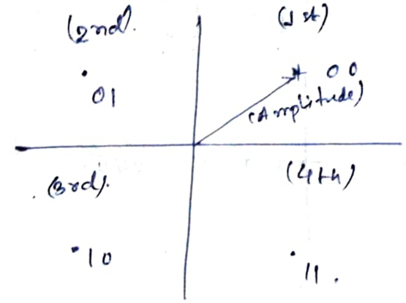




Sequence = 0 1 0 1 0 1

QPSK → 4 phases ⇒ $2^x = 4 \Rightarrow x = 2$ bits to represent a signal.

~~QAM →~~



0 0
0 1
1 0
1 1.

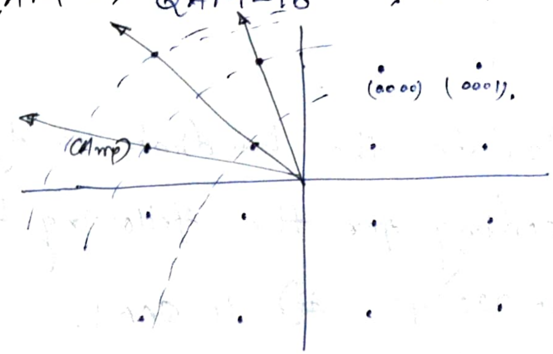
(Constellation Pattern).

$$\left[\begin{array}{cccc} 45^\circ, & 135^\circ, & 225^\circ, & 315^\circ \\ 00 & 01 & 10 & 11 \end{array}\right]$$

QAM → QAM-16 : 16 phase/signals.

$2^x = 16$

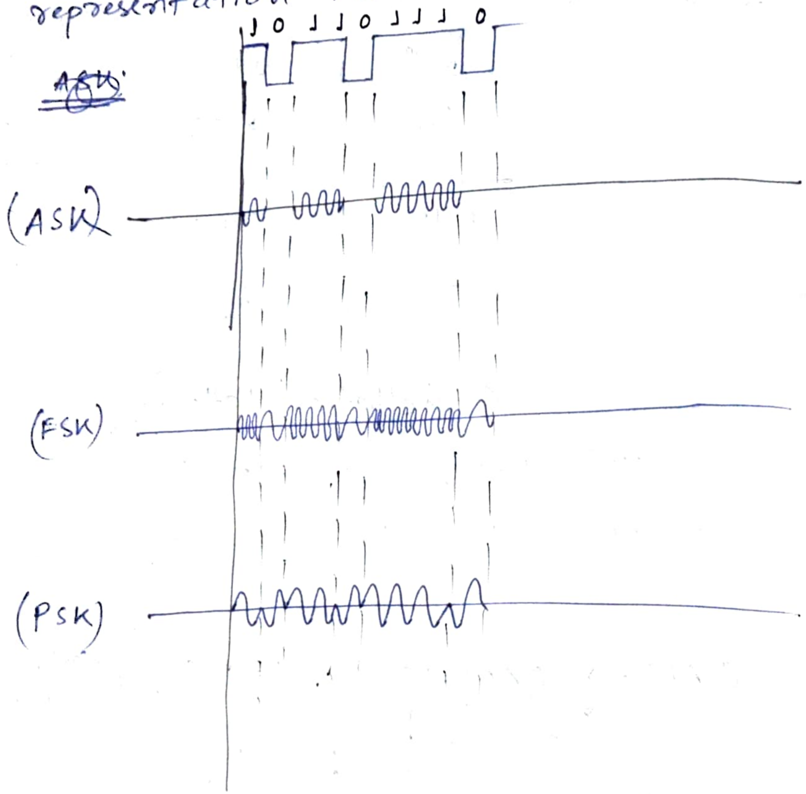
$\therefore x = 4$ bits. → 1 signal



* This channel is more noisy than QPSK.

Ex: sequence 1 0 1 1 0 1 1 1 0

representation in



1. $\boxed{\#Q}$ Calculate the baudrate & type the encoding for the following bit rates;

i) 36,000 bps, ~~ii)~~ 4 QAM.

ii) 8000 bps, 32 QAM.

$\boxed{2. Q}$ What is the maximum data rate for a communication channel having a 100KHz ~~baudrate~~ bandwidth and operating at S/N ratio of 20 dB.

⇒ 1. Soln:- $BR = \frac{R}{\log_2 N}$; for 4 QAM $N = 4$.

(i) $= \frac{36000}{\log_2 4} = 18,000$

(ii) $\frac{8000}{\log_2 32} =$

2. Soln.

$MDR = BW \times \log_2(1 + S/N)$ → $10\log\frac{S}{N} = 20$

$S/N = (10)^2 = 100$

$= 100 \times 10^3 \times \log_2(1+100)$

$= 665.8211$ kbps.

12.09.13.
Thu

Multiplexing Scheme :

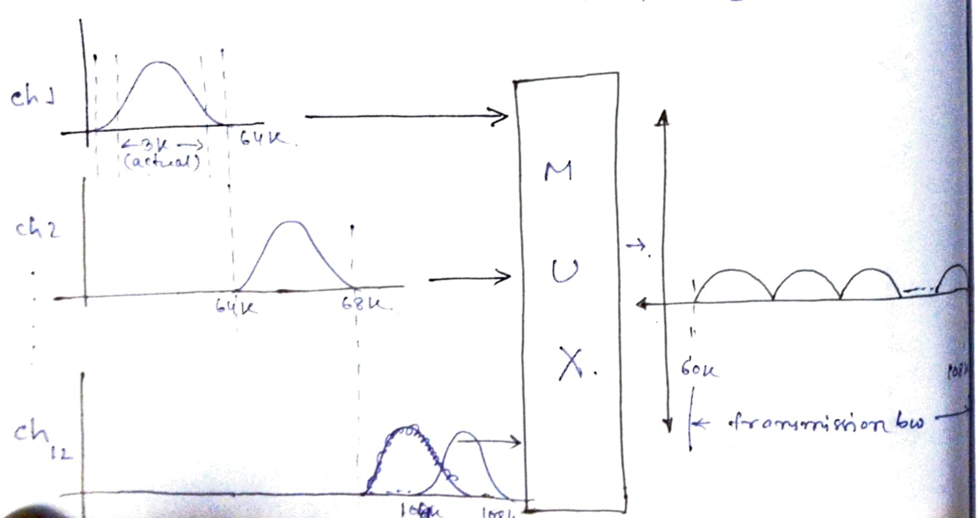
→ Multiple channels through a single physical link.

* FDM → Analog telephone system.
* TDM
* CDMA.
* WDM] → optional.
* BWDM

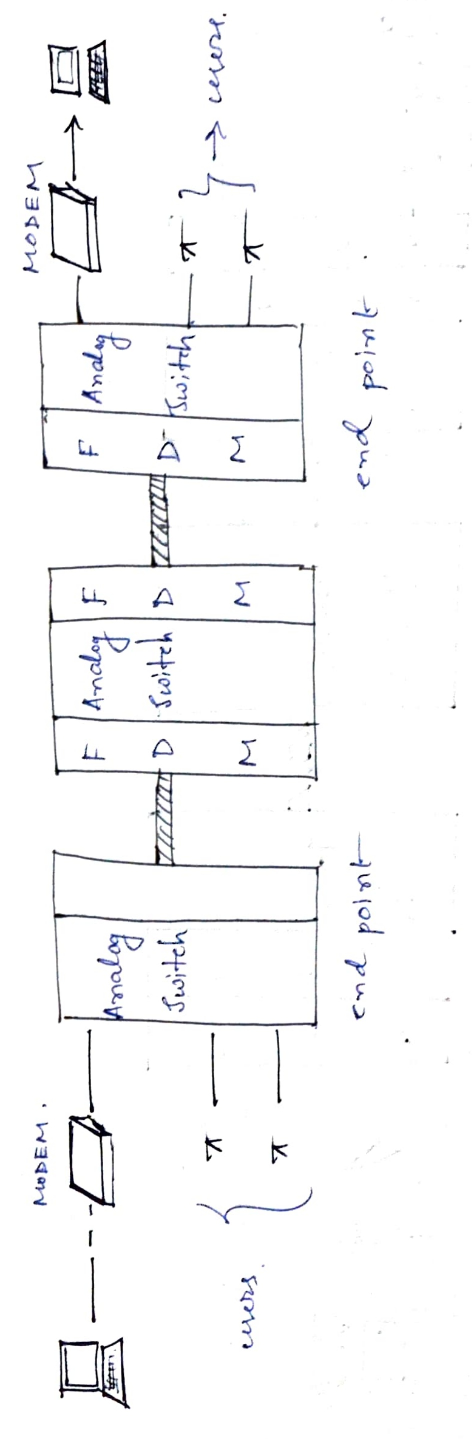
FDM → Analog telephone system
↳ 12 ch. each having a diff frequency.

→ 4000 Hz. each.

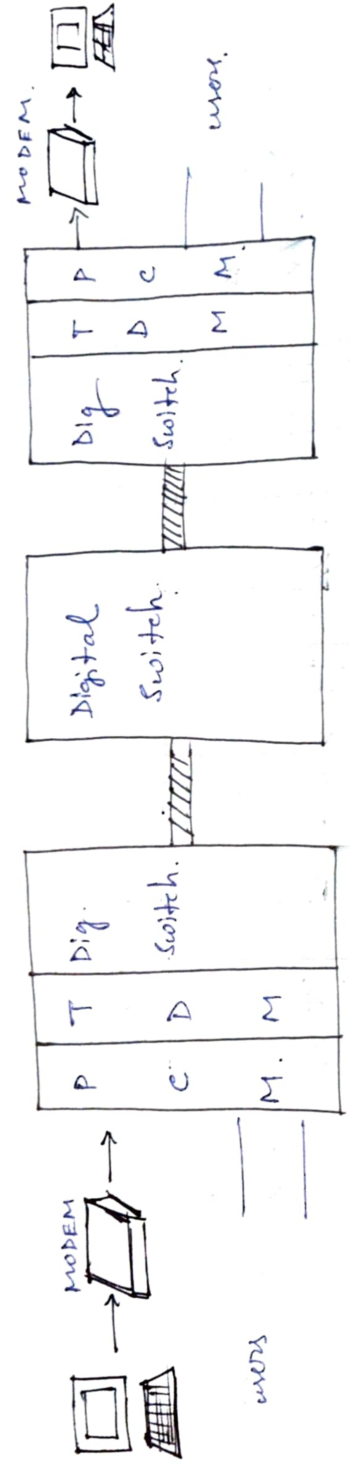
→ Transmission bandwidth 60 kHz to 108 kHz.



BLOCK DIAGRAM OF FDM SYSTEM



BLOCK DIAGRAM OF TDM SYSTEM.



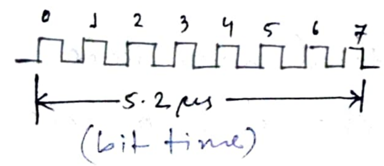
(T1 System)

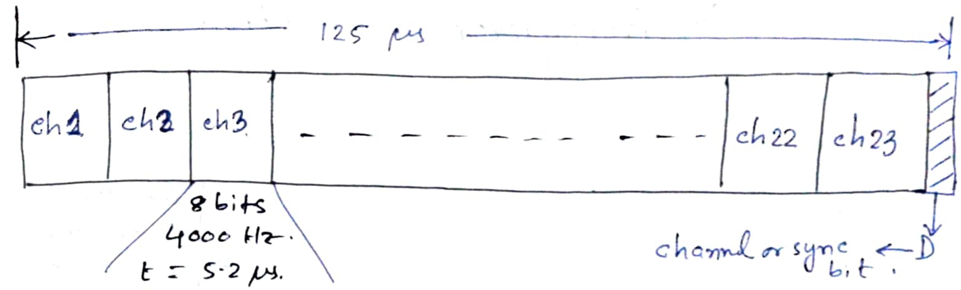
TDM → Digital telephone system.

Specifications:

[i] 24 channels (23B + 1D), 125 μs.
→ Barrier.
↳ [used for signalling]

[ii] 1 channel bw : 4000 Hz, 8 bits, t = 5.2 μs.





Total Data rate: 2 × BW × No. of bits.

$= 2 \times 4000 \times (23 \times 8 + 1) = 1.544$ Mbps

channel Data rate: $2 \times 4000 \times 8 = 64000$ bps.

Transmission BW = $4000 \times 24 = 96000$ Hz.

Assignment

E1 system:

Specification:

$\boxed{i}$ 32 ch. [30B + 1D + 1 (time & Alarm)] (8bit each; 8bit; 1 bit)

$\boxed{ii}$ 1 ch. has 8 bits., $t = 5.2\,\mu s$.

$\boxed{iii}$ 1 channel bandwidth : 4000 Hz.

Calc: i) total data rate.

ii) channel data rate.

iii) Transmission bandwidth.

16-09-13: Monday

CDMA: 40 years old technology.

+ Applied to cellular telecomm.
+ Data rate: 9600 kbps.

+ Data bit + ~~original~~ digital code = S (transmitted sig)

Data bit → original sig. '1' or '0'

Bipolar coding: checks the orthogonality

inner product of signals = 1 or 0.

$$c_i c_j = \frac{1}{n}\sum_{k=1}^{n} C_{i,k} C_{j,k} = \begin{cases} 1, & \text{if } i=j \\ 0 & \text{if } i\neq j. \end{cases}$$

"vector code"

$C = \boxed{c_i,\ \bar{c_i}}$ ($c_i \to 1$, $\bar{c_i} \to 0$)

Digital code. ↓ PN code.

Sequence of code for n-channel.

Transmitted signal: $S = C_1 + C_2 + C_3 + \cdots + C_n$ ($C_1 \to$ ch1, $C_2 \to$ ch2, $C_n \to$ chn)

Retreiving the signal:

getting c_i from S.

$\Rightarrow c_i \cdot S = c_i \cdot (C_1 + C_2 + \cdots + C_n)$ (c_i or $\bar{c_i}$)

$$= \begin{cases} +1 & c_i = C_i \\ -1 & \bar{c_i} = C_i \\ 0 & \text{when chanl. is idle/silent} \end{cases}$$

wednesday
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Ex:

channel	Vector code to transmit "1" (c_{ij}, c_i)	Vector code to transmit "0" ($\bar{c}_{ij}$, $\bar{c}_i$)	data bit (Actual Data)
ch 1 (c_1)	(+1, +1, +1, +1)	(−1, −1, −1, −1)	0
ch 2 (c_2)	(−1, −1, +1, +1)	(+1, +1, −1, +1)	1
ch 3 (c_3)	(−1, +1, −1, +1)	(+1, −1, +1, +1)	Silent
ch 4 (c_4)	(−1, +1, +1, −1)	(+1, −1, −1, +1)	0

($j \rightarrow$ columns, $i \downarrow$ rows; vector codes c_1, c_2, c_3, c_4)

[i] Check the orthogonality.

Trx → [ii] Compute the encoded & row signals to be transmitted.

Rx → [iii] Retreive the original signal.

Sol:

[i] Orthogonality check:

$\boxed{\text{for } i \neq j}$

$$\underset{i\ \ j}{c_1 c_3} = \frac{1}{4} \sum_{k=1}^{4} c_{i,k}\, c_{j,k}$$

$$= \frac{1}{4} (+1, +1, +1, +1)(-1, +1, -1, +1)$$

$$= \frac{1}{4} (-1 + 1 - 1 + 1) = 0$$

Similarly,

$$c_2 c_4 = \frac{1}{4} (-1, -1, +1, +1)(-1, +1, +1, -1)$$

$$= \frac{1}{4} (+1 - 1 + 1 - 1) = 0$$

$\boxed{\text{Now for } i = j}$

$$c_1 c_1 = \frac{1}{4} (+1, +1, +1, +1)(+1, +1, +1, +1)$$

$$= \frac{1}{4} \times 4 = 1.$$

$$c_2 c_2 = \frac{1}{4} (-1, -1, +1, +1)^2 = 1.$$

$$c_3 c_3 = c_4 c_4 = 1.$$

∴ proves orthogonality.

[ii] Encode/transmitted signal: c_1, c_2, c_3, c_4.

c_1 = '0' (see data bit in table) → (−1, −1, −1, −1)

$c_2 \rightarrow 1 \rightarrow (-1, -1, +1, +1)$

$c_3 \rightarrow$ silent $\rightarrow (0, 0, 0, 0)$

$c_4 \rightarrow 0 \rightarrow (+1, -1, -1, +1)$

Now row signal: $S = c_1 + c_2 + c_3 + c_4$ (row wise addition)

$$\boxed{\begin{array}{l} c_1 \rightarrow (-1, -1, -1, -1) \\ c_2 \rightarrow (-1, -1, +1, +1) \\ c_3 \rightarrow (0, 0, 0, 0) \\ c_4 \rightarrow (+1, -1, -1, +1). \end{array}}$$

$$= (-1, -3, -1, +1)$$

14 Retreiving data:

for ch 1 = $c_1 \cdot s = \frac{1}{4}(+1, +1, +1, +1)(-1, -3, -1, +1)$

$= -1$; which refers to '0'

data bit
(Actual Data)

for ch 2 = $\frac{1}{4}(-1, -1, +1, +1)(-1, -3, -1, +1)$

$= \frac{1}{4} \times (1 + 3 - 1 + 1) = \frac{1}{4} \times 4$

$= 1$; which refers to "1" (data bit)

for ch 3 = $\frac{1}{4} c_3 \cdot s$

$= 0$; which refers "silent". (data bit)

for ch 4 = $\frac{1}{4} c_4 \cdot s$

$= -1$, which refers '0' (data bit)