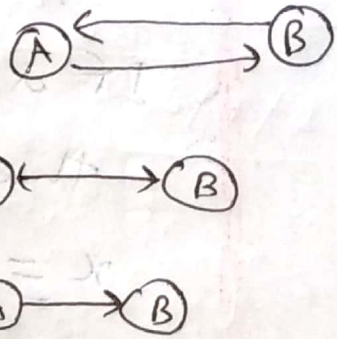
OS
OSTEP

- একটা host - এ countless applications থাকতে পারে।

Links
- Full-duplex (Bidirectional)
- Half-duplex "
- Simplex (unidirectional)



Links
- Wired
- Wireless

* একই layer এর entity, আরেকটি layer এর entity এর সাথে যোগাযোগ করতে পারবে না,
* Same layer এর দুইটির different protocol এর হবে "

function

/function ← Post condition

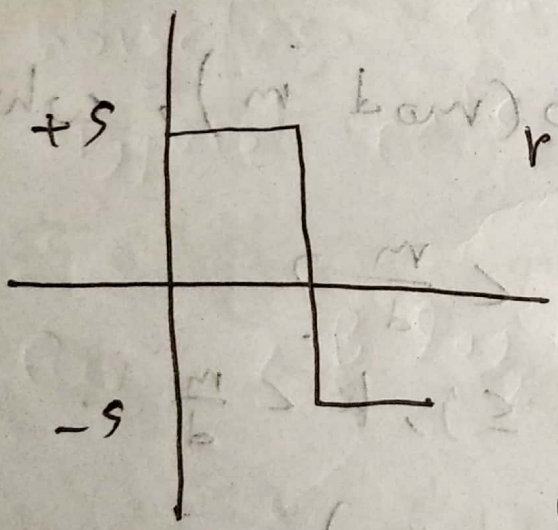
CSE – 321

17/7/23

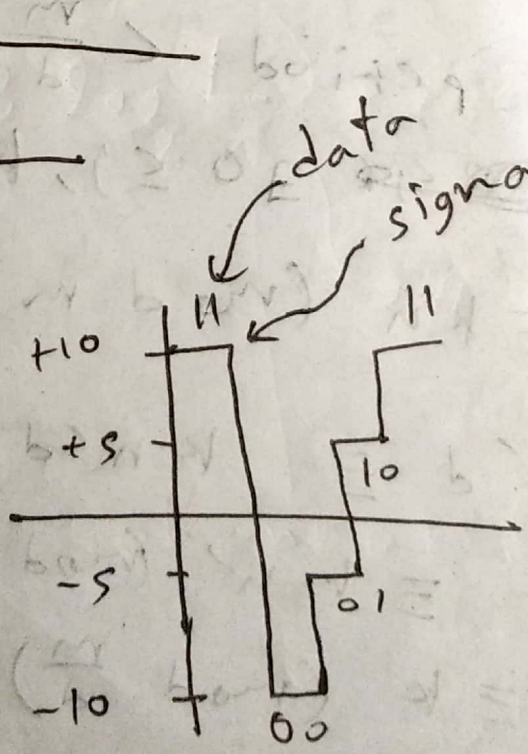
Data — signal

digital — digital

Analog — Analog



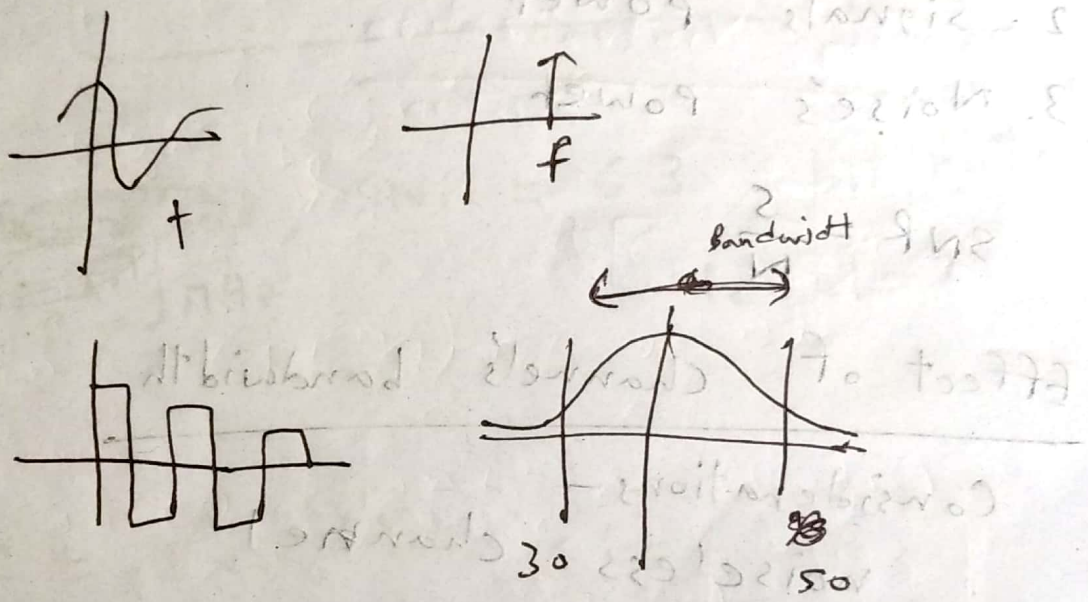
$r = \frac{2}{2} = 1$



$\frac{10}{5} = 2$

level $= x$ $\quad r = \log_2 x$

Bandwidth



i) $f_{max} - f_{min}$ (in hertz)

ii) in bits per second (in bps)

[Cause frequency বাড়লে bps ও বাড়ে, Linear relationship. এই lesson এ আমরা (ii) use করব।]

required data rate এর বেশি medium-এর capacity কম হলে data loss হবে।

Maximum data rate of a noisy medium depends on:

1. Channel's Bandwidth
2. Signal's power
3. Noise's power

$$SNR = \frac{S}{N}$$

Effect of Channel's bandwidth

Considerations –
noiseless channel
Nyquist rate

$$C = 2B \log_2 L$$

C → Capacity
B → BW
L → # of levels

Claude Shannon (Information theory এর father)

for noisy channel,

$$C = B \times \log_2\left(1 + \frac{S}{N}\right)$$

* [redacted], SNR = 63, appropriate bit-rate = ?, level = ?

B = 1 MHz

$$C = 1 \times 10^6 \log_2 (1 + 63)$$

$$= 6 \times 10^6 \text{ bps} = 6 \text{ Mbps}$$

For being safe, r = 4 Mbps (or 5 or 5.5)

$$4 = 2 \times 1 \times \log_2 L$$

$$\therefore L = 4$$

[Fraction আসলে ceiling নিতে।

Digital data ⟶ Physical Layer ⟶ Digital signal

Feed → performance measure → Actuators

→ Environment

ESE - 321.

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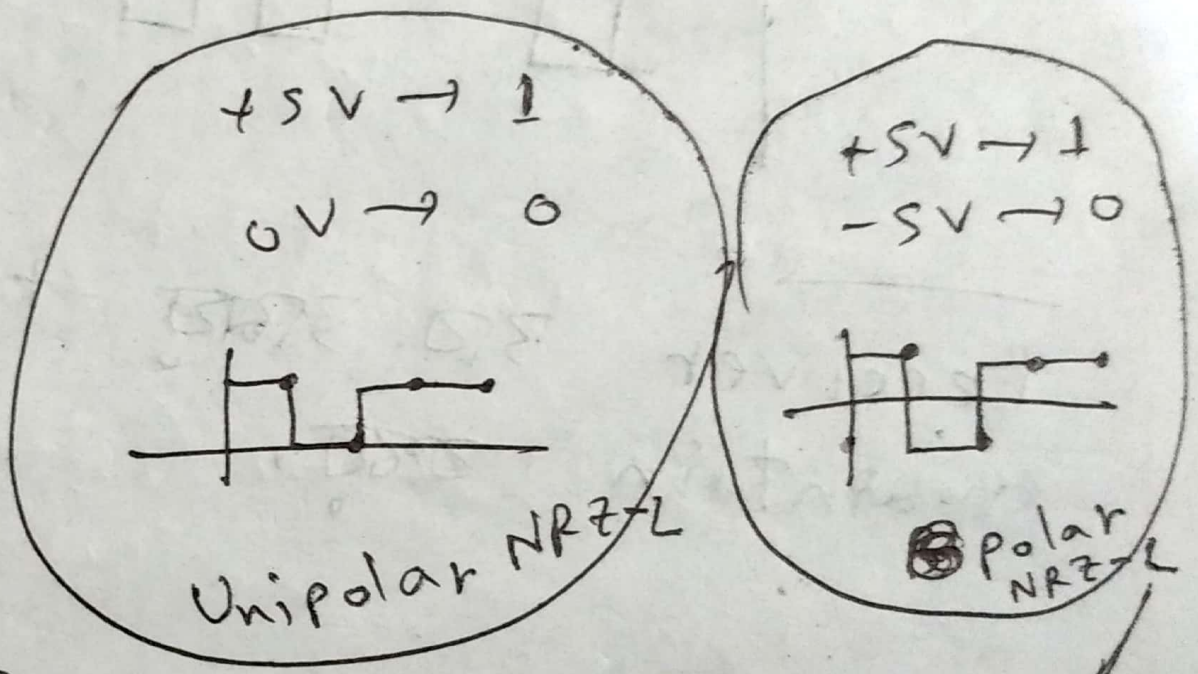


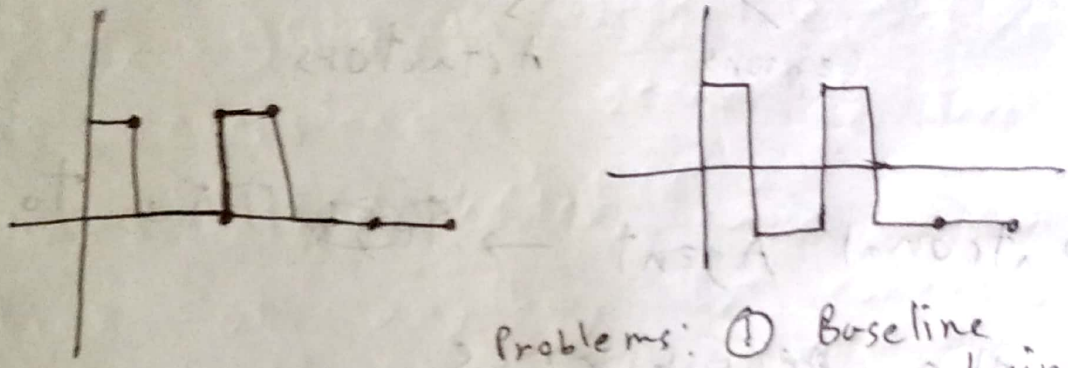
For binary data,

$$C = 2B$$

L means Line

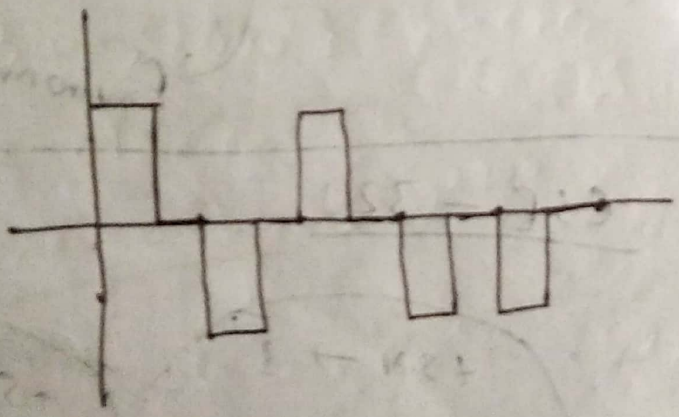
1 0 1 0 0

Non-return to zero - NRZ



Problems: ① Baseline wandering
② Lack of self-synchronization
③ DC voltage

Polar RZ

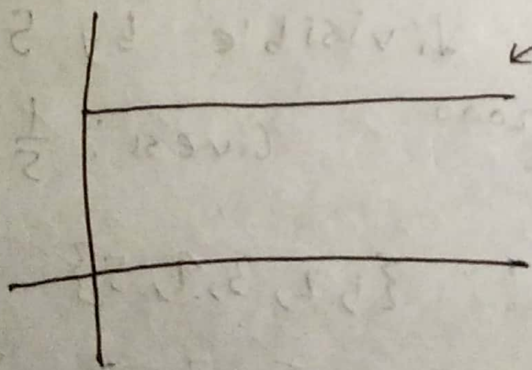


Receiver এর সমস্যা running average maintain করতে।

+5 -5 +5 -5
1 0 1 0

→ 5 → 0 → 1.67 → 0

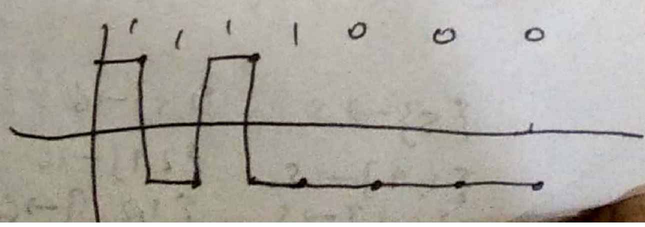
Unipolar এ ideal case average 2.5 আর Bipolar এ 0. Receiver running average (baseline) এর সাথে received signal কে compare করে। বড় হলে 1, ছোট হলে 0. পরপর অনেকগুলো 1 বা 0 থাকলে Baseline সরে যায়, আর error এর সম্ভাবনা হয়। (Baseline wandering)



signal এর শুরু বুঝা যায় না, Synchronization Problem, [আলাদা channel এ clock পাঠানো যায়, but তা অনেক expensive]

NRZ-I → inverted

1 1 1 1 0 0 0



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DC voltage → একটানা same bit send করলে average একই থাকে, এটা constant voltage বোঝায়, যেটা DC characteristics. এটা noise বোঝায় বাড়িয়ে দেয়।

$$r = \frac{\text{data}}{\text{signal}}$$

NRZ → $r = 1$

$C = 2B \log_2^2$

$N = 2B$

$\therefore B = \frac{N}{2}$

N signals for N data

Bandwidth requirement for NRZ-L

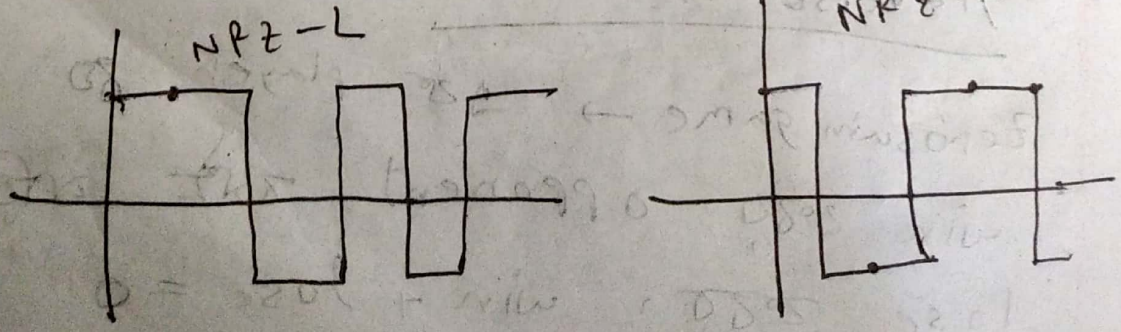
Bandwidth requirement যত বেশি, তত ভালো

NRZ-I

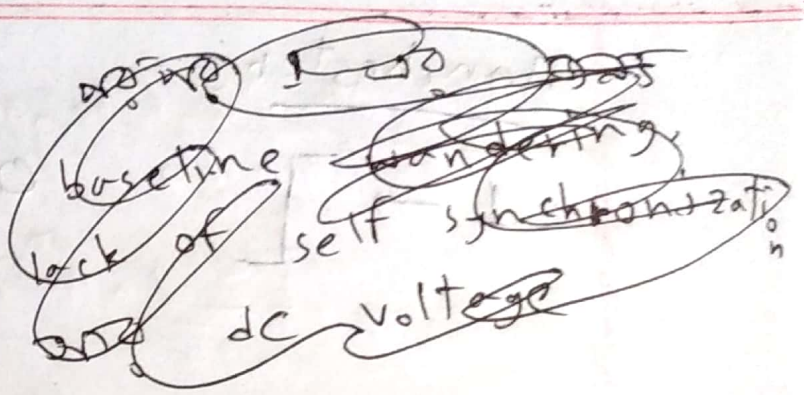
1 1 0 1 0 1

1 → transition

0 → same voltage



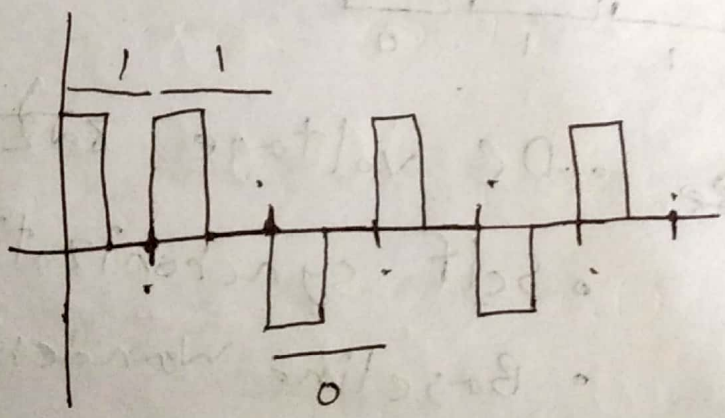
Bandwidth requirement = $\frac{N}{2}$



Baseline wandering বলতে 1 এর জন্য ভুল হওয়াকে, আর বলতে 0 এর জন্য হওয়াকে, যদি Problem দুটোও হয় বলতে।

(10101

RZ



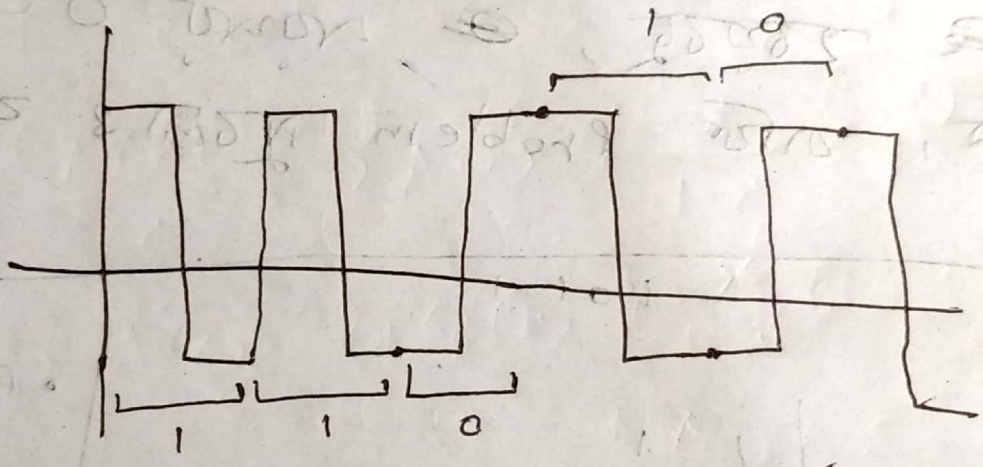
- Synchronization - এর problem ও দূর হয়।
- $r = \frac{1}{2}$, $B = N$. Requirement অনেক বেশি। (যা না চাইনিস)

- Baseline wandering আছে।
- DC voltage নাই। (Same voltage অনেকক্ষণ থাকে না।) So, problem দূর হয়।

Manchester

1 → ⌊‾⌋ 0 → ⌈‾⌉

1 | 0 | 0 | 1



- DC voltage নাই।
- Self synchronization আছে।
- Baseline wandering নাই।
- $r = \frac{1}{2}$, $B = N$

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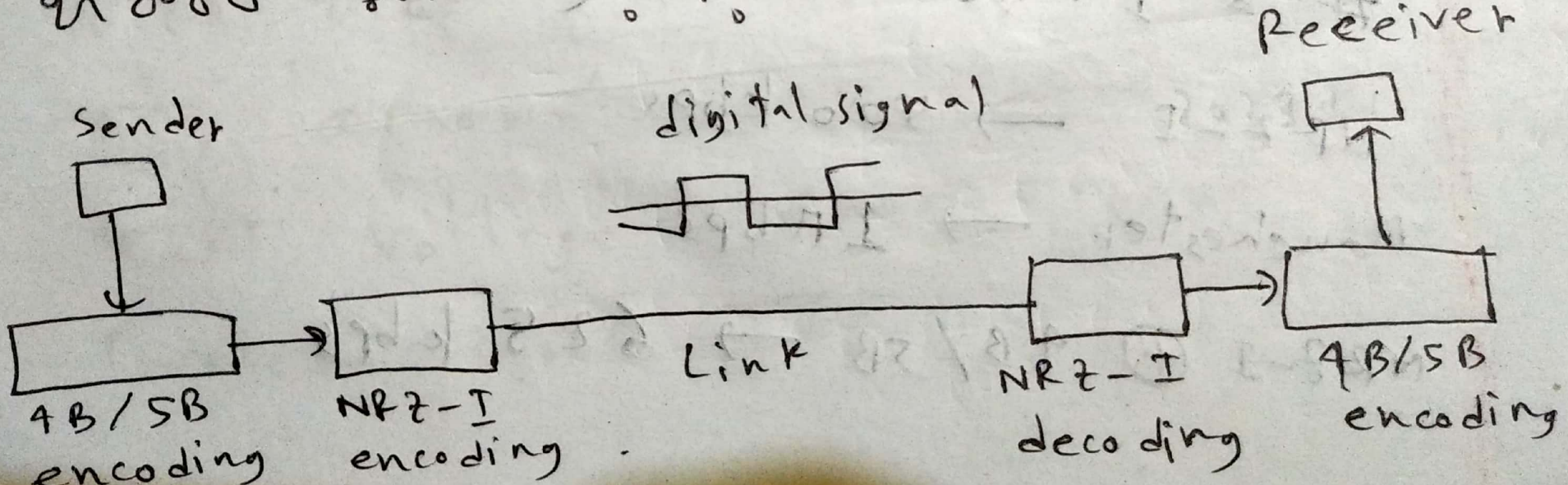
4B/5B coding:

NRZ-I -এ সবসময় 3 টি করে কমপক্ষে 0 থাকবে না তাহলে সমস্যা।



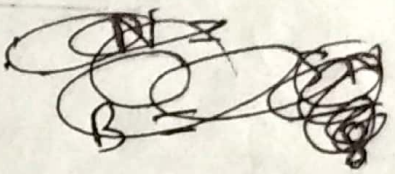
$\frac{5N}{4} = 2B \quad \therefore B = \frac{5N}{8}$

Bandwidth requirement $= \frac{N}{2r}$

For 4B/5B,

$r = \frac{4}{5}$

$B = \frac{5N}{8}$



[25% হারে bandwidth from $\frac{N}{2}$]

	Bandwidth Req.	
NRZ-I (+) 4B/5B	125% of NRZ-I	Solved
Manchester	200% of NRZ-I	Solved

1 MHz datarate (1 Mbps)

NRZ-I → 500 kbps

Manchester → 1 Mbps

NRZ-I ⊕ 4B/5B → 625 kbps

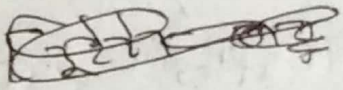
← Guided medium

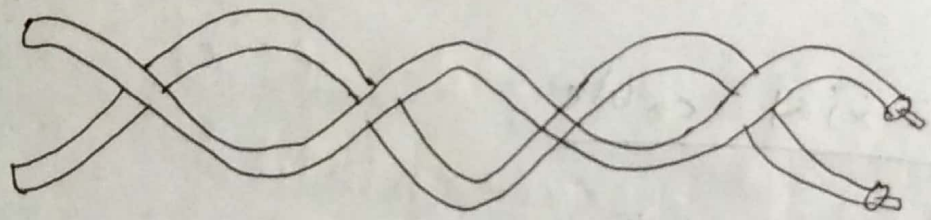
3 types of network wire:

1. Co-axial cable
2. Twisted pair
3. fibre-optics

- wireless media inherently insecured.
- wired more secured.

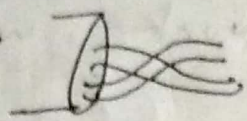
Twisted pair





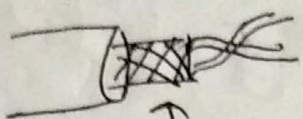
দুটি লাভ থাকায় ~~voltage~~ একটা reference, আবার voltage change হচ্ছে, Twisted হওয়ায় একই দুইটায় almost same amount noise থাকে থাকবে, তাতে দুইটায় দুই amount-এর noise হতে পারে, তবে voltage measurement-এ Problem হবে না।

UTP →



Plastic cover

STP →

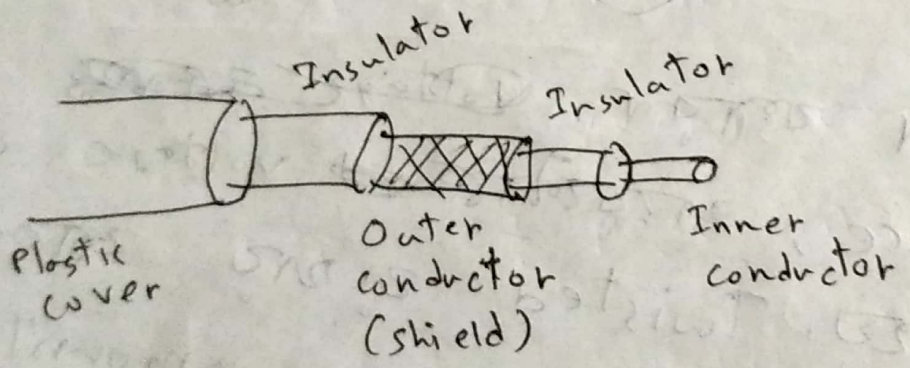


Plastic cover

Metal shield

[যখন noise এর possibility থাকলে use করা হয়]

Co-axial cable

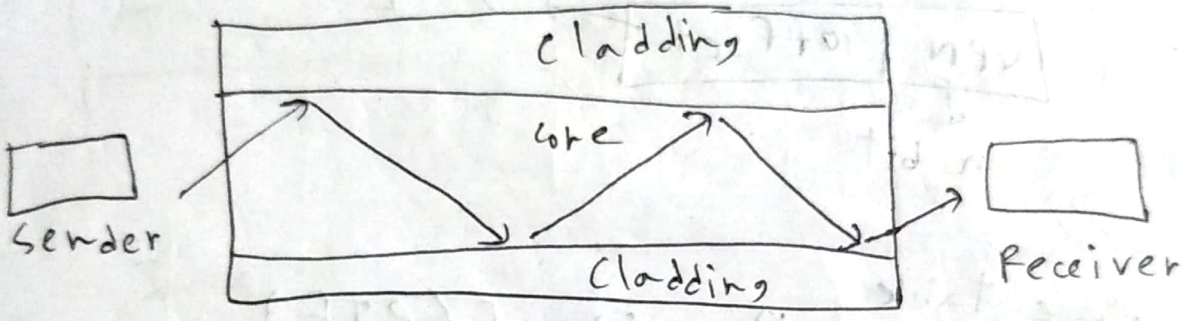


Noise এর effect কম,

Fiber Optics

প্রায় $2 \times 10^8 ms^{-1}$ range এ speed.

Application layer ka data unit message.



Data-link layer