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Data transmission

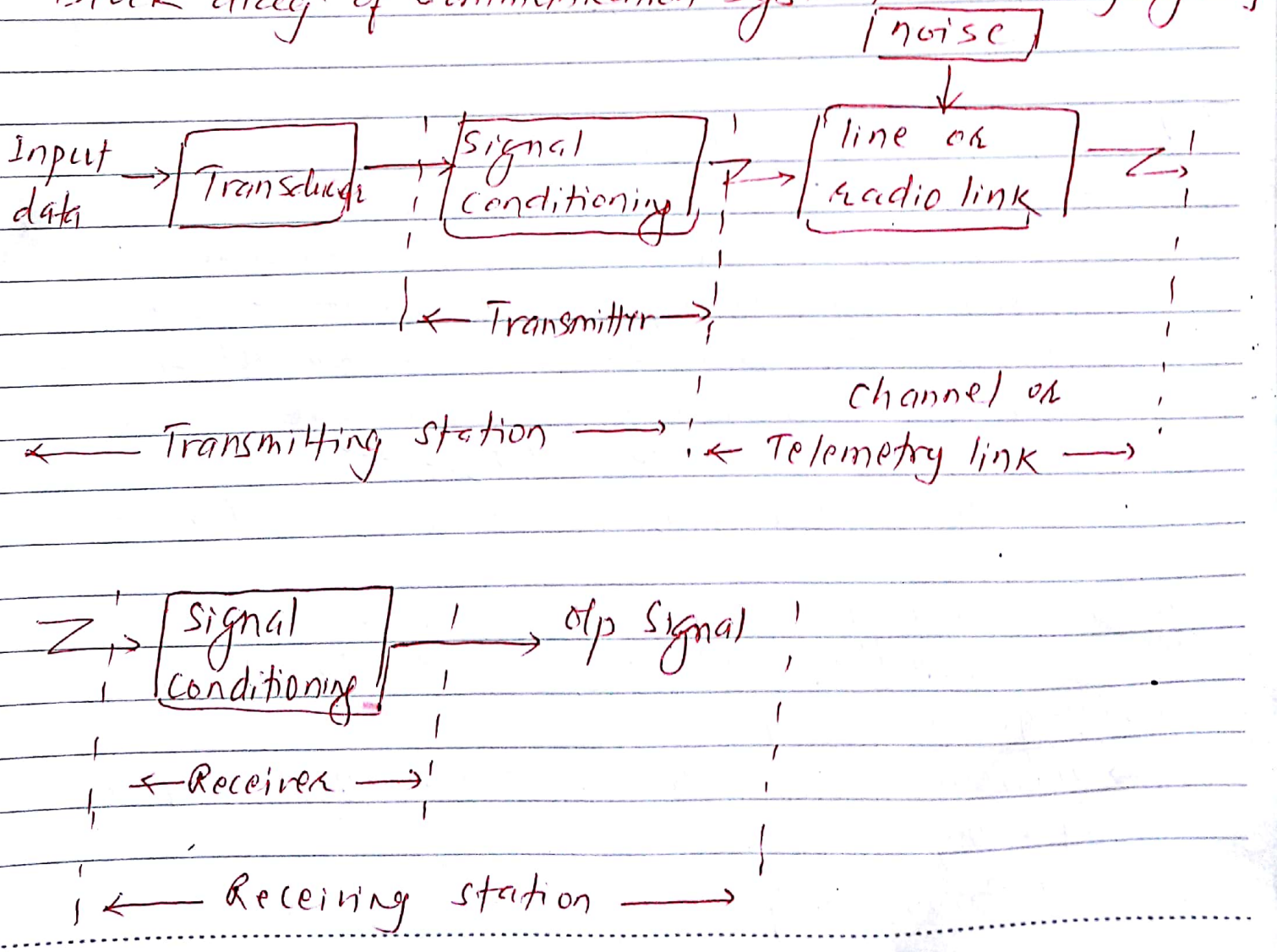
Introduction:

Data transmission or telemetry refers to a process by which information regarding the quantity being measured ~~may be used~~ is transferred to a remote location to be processed, recorded and displayed.

Telemetry involves three steps:

* Converting measured quantity to signal
* Transmission of that signal over proper channel
* Its reconversion to actual data for recording, displaying.

Block diag. of Communication System [Telemetry system]



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Types of telemetry system: (or schemes)

① Landline Telemetry system
- → Uses wires or cables to transmit the signals which establishes the physical connection b/n the transmitter & receiver
- → Channels used: Power lines, telephone lines & electrical wires
  (ie. guided medium: twisted pair of cable
  Co-axial cable
  optical fiber, wave guide
- → Distance ranges from 50m to 1km. eg: labs, industries
- → Types: voltage, current, & position

② Radio frequency System:
- → uses radio waves (no physical connection) with appropriate modulation, demodulation & multiplexing technique to transmit signal.
- → Radio links from 1km to 50km at 4MHz
- → for distance > 50km microwave links are used at 890MHz to 30GHz. Repeaters are installed after every 30 to 60 km for long distance transmission.

eg: in spacecraft, rockets & missiles.

Landline telemetry system [Analog]

(i) Voltage telemetry system:
- → measured variable is transmitted in form of voltage
- → At transmitting end, slide wire is connected in series with the battery.

If signal is low level (i.e. < 100mv) it can be directly sent thru connecting leads up to 1 to 2 m but for distance > 5m for low level signal, Analog voltage & current transmission is employed.

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→ Slide wire is further connected to Bourdon tube for pressure measurement.
→ When pressure changes, slider actuates the slider of potentiometer. Thus, ~~voltage~~ change in voltage is transmitted to receiver

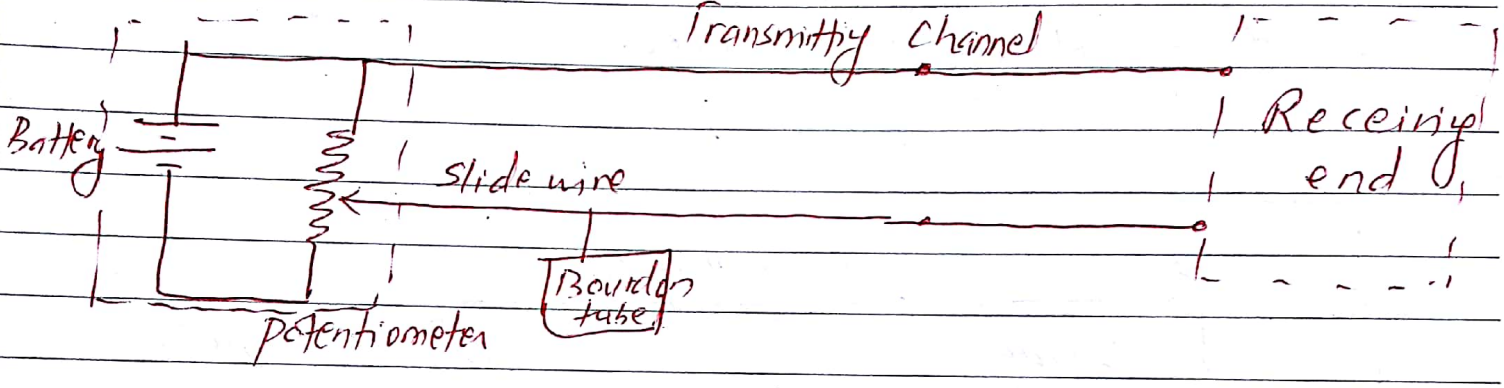

Fig: Circuit of voltage Telemetry system

→ it is applicable if the distance is less than about 30m.
→ For distance larger than 30m the effectiveness of the circuit is reduced due to cable resistance, grounding problem, etc.

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(ii) Current telemetry System

→ working is almost same as of voltage telemetry system.
→ when pressure changes, Bourden tube moves sliding contact thereby value of current changes
→ This current passes thru a pair of wires & measured by multimeter.

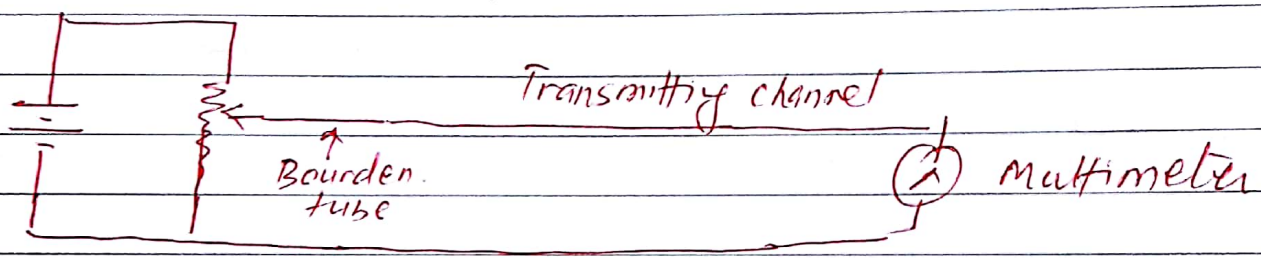

fig: ckt of Current telemetry system

→ limited to the distance of 300m.
→ The current signal can be converted back to the more usual voltage signal that can be measured by voltmeter, oscilloscope by the use of dropping resistor.
→ If desired to convert the signal to digital form, voltage observed across dropping resistor is in suitable form to be fed to an ADC.

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Merits of land line telemetry

→ Effective for short distance measurement
→ V & I can be easily transmitted
→ Circuit is simple
→ wide variety of primary sensing elements are available to measure required variable.

Demerits:

→ Demands high S/N ratio that is difficult to calibrate
→ Need to be protected from EMI, Noise & distortion in the channel.
→ Multiplexing is difficult.
→ Limited frequency response.

Comparision among Channels

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NO. Attributes	Twisted pair	Co-axial	optical fiber	Microwave	Satelite
1. Bandwidth	0-100 MHz	0-600 MHz	0-1 GHz	1-40 GHz	1GHz - 13.5GHz
2. Data rate	10 - 100 Mbps	upto 100 Mbps	extremely high upto several Gbps	high freq. gives higher data rate.	
3. Repeaterless distance	Digital: 2-3 km Analog: 5-6 km	2-3 km 5-6 km	100 km	needs repeaters for long haul comm^n only.	Satelite transponder act like active repeater.
4. Impedance	100, 110, 120, 150, 300, 600 Ω	50 & 75 Ω	-	-	-
5. Cost/km	Least	Medium	Expensive (than electrical)	high	very high
6. Life Span	Medium	Medium	Very high	-	-
7. Environmental Effect	Medium	Medium	very low	-	-
8. Signal Security	low	low	very high	-	-
9. Susceptibility to Interference, Noise, Crosstalk	High to interference & low capacitive coupling & cross talk.	Good noise immunity	very high noise immunity	highly prone to attenuation, free space loss, multipath refraction, thermal noise	Most dominant is thermal noise.
10. Propagation delay	570ns/100 m at 1MHz 45ns/100m at 100MHz	1.15ns/Ft	0.65ns/km	depends upon available reflector or obstruction in the dir^n of propagation	270ms
11. Application area	Telephone (house to local exchange) as ethernet cable in Computer N/w	LAN, Cable TV, long distance telephone connection	Telecommunication N/w, LAN, WAN	Telephone comm^n, RADAR, Space comm^n, heating	TV, long distance comm^n MSS - Mobile satellite service FSS (fixed), BSS (Brodcast)
12. Types:	Shielded (Cat 1 to Cat 6) & Unshielded	Hard line, leaky cable, Trixial, Twin axial, Biaxial, Semi rigid, RG-62.	Single & multimode step & graded indexed	Bands: L, S, C, X, KU, K, Ka, Q. short haul, long haul	sky wave propagation GEO, LEO, MEO, Molniya, orbit HAPS.
13. Advantage:	low resistance to electrical current	Transmits faster, not susceptible to interference	Immune to EMI, long dist. Rate-faster, Security↑	Carry large information, require smaller antenna, radio wave easily propagate, donot require Right-of-way	large coverage area satellite-satellite comm^n is very precise, higher b/w available
14. Disadvantage	Susceptible to EM wave, large copper loss	heavy & bulky, Repeaters needed. large Copper loss	Physical vibration, difficult to split, can't be bent too much	Attenuation by solid object, Reflected by flat surface.	Launching satellite into orbit is costly, larger propagation delay.

(2) Digital Signal transmission :-

Digital data transmission takes place through the digital signals which are the function of discrete values at discrete time. It is widely used in modern age. Basically, there are two types of digital data transmission.

(i) Parallel Data transmission
(ii) Serial Data transmission.

(i) Parallel Data transmission :-

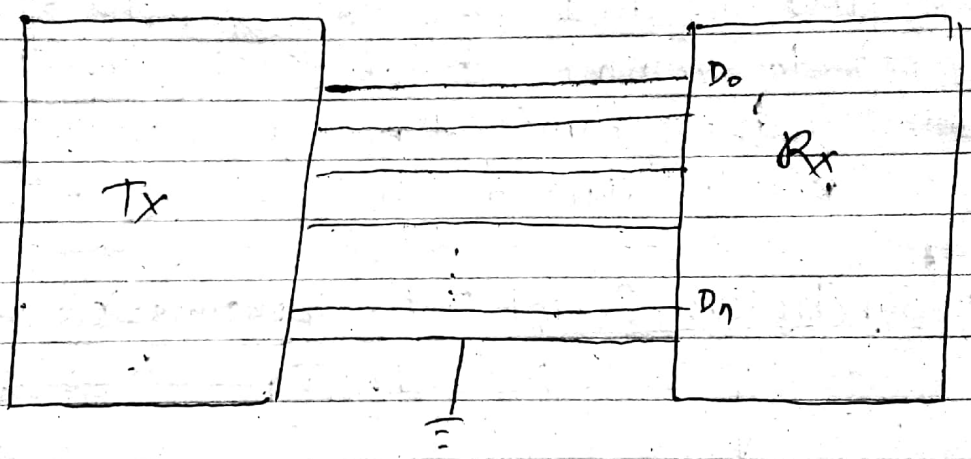


Fig: Parallel data transmission

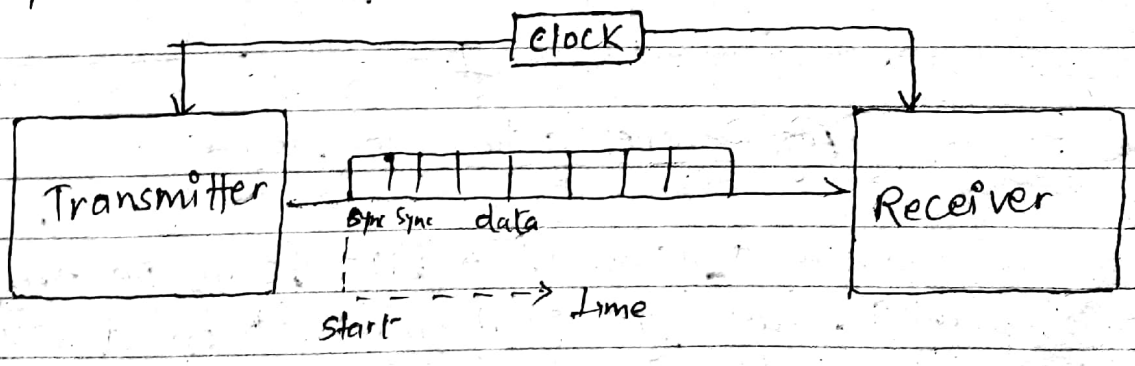
when a word of n bits is to be transferred in parallel, each bit is transmitted on a separate line along with a common ground line with respect to which the status of each line is measured. Thus a channel comprises of n+1 lines. Extending the example, if the time betn successive samples is 's' seconds, n = 8 bits, then the time taken to transmit the whole or complete word is 's' second. It can be seen that the time required to transmit one word is

equal to that of a single bit. Parallel data transmission is impractical over a long distance because of the cost of installing a large number of lines.

(ii) Serial Data transmission :-

In this, each bit of the word is sent in succession, one at a time over a single pair of wires. A parallel to serial converter is used to convert the incoming parallel data to a serial form and then the data is sent out with the least significant bit D_0 first and MSB (D_n) coming last of all. The time taken to transmit a word in serial data transmission is n times ~~the~~ more than the time taken in parallel data transmission.

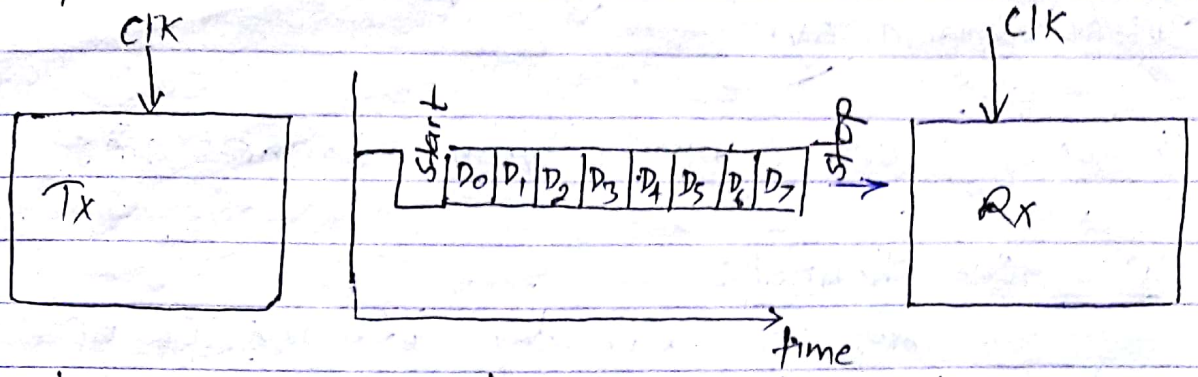
* Synchronous Serial Data transmission :



Synchronous communication is used for transferring large amounts of data without frequent start or stop. In synchronous systems, line is maintained at idle value when no data is being transmitted.

→ for high speed transmission (more than 20kbps)

* Asynchronous Serial Data transmission :-



Asynchronous communication is a start-stop type of communication and is used where a source of data ~~is not~~ may not be providing a steady stream of new characters. The data comes to the receiver at unevenly spaced intervals without reference to a master clock, hence the name 'asynchronous'.

→ It is relatively slow because it ~~they~~ requires hand-shaking for each character by data transfer. In this system handshaking is performed by using start and stop bits at the beginning and end.

Modes of Transmission :-

(i) Simplex :- In Simplex mode, the communication is unidirectional, as on a one-way street. Only one of the two devices on a link can transmit, the other can only receive. The simplex mode can use the entire capacity of the channel to send data in one direction.
eg: keyboards and traditional monitors, Radios, etc.

(ii) Half-Duplex :- In this mode, each station can both transmit and receive, but not at the same time. When one device is sending, the other can only receive and vice-versa. The half-duplex mode is like a one-lane road with traffic allowed in both directions. In this mode, the entire capacity of a channel is taken over by whichever of the two devices is transmitting at a time. The half duplex mode is used in cases when there is no need for communication in both direction at the same time; the entire capacity of the channel can be utilized for each direction.
eg: walkie-talkie.

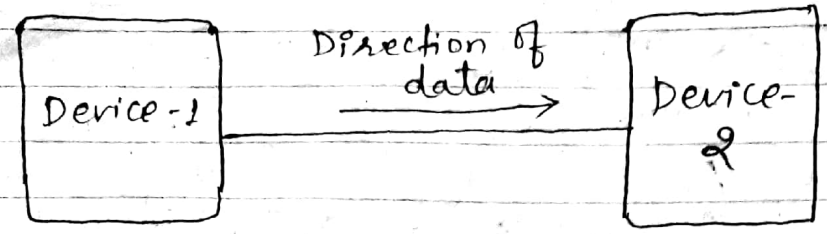


Fig: Simplex mode

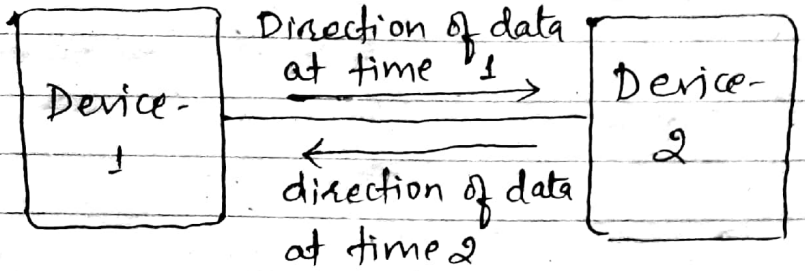


Fig: Half-duplex mode

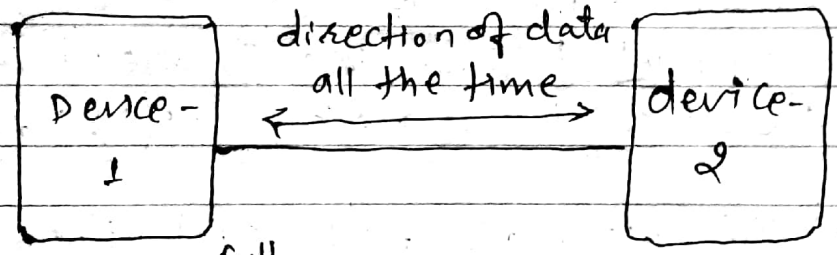


Fig: Full Duplex mode

(iii) Full-Duplex Mode :- In this mode, both stations can transmit and receive the data simultaneously. The Full-Duplex Mode is like two-way street with traffic flowing in both directions at the same time. In full-duplex, signals going in one direction share the capacity of the link with signals going in the other direction. This sharing can occur in two ways. Either the link must contain two physically separate transmission paths, one for sending and the other for receiving, or the capacity of the channel is divided

between signals travelling in both directions.

One common example of full-duplex communication is the telephone n/w. When two people are communicating by telephone line, both can talk and listen at the same time.

The full-Duplex mode is used when communication in both directions is required all the time. The capacity of the channel, however, must be divided betn the two directions.