Lect1: Architecture of a generic communication system

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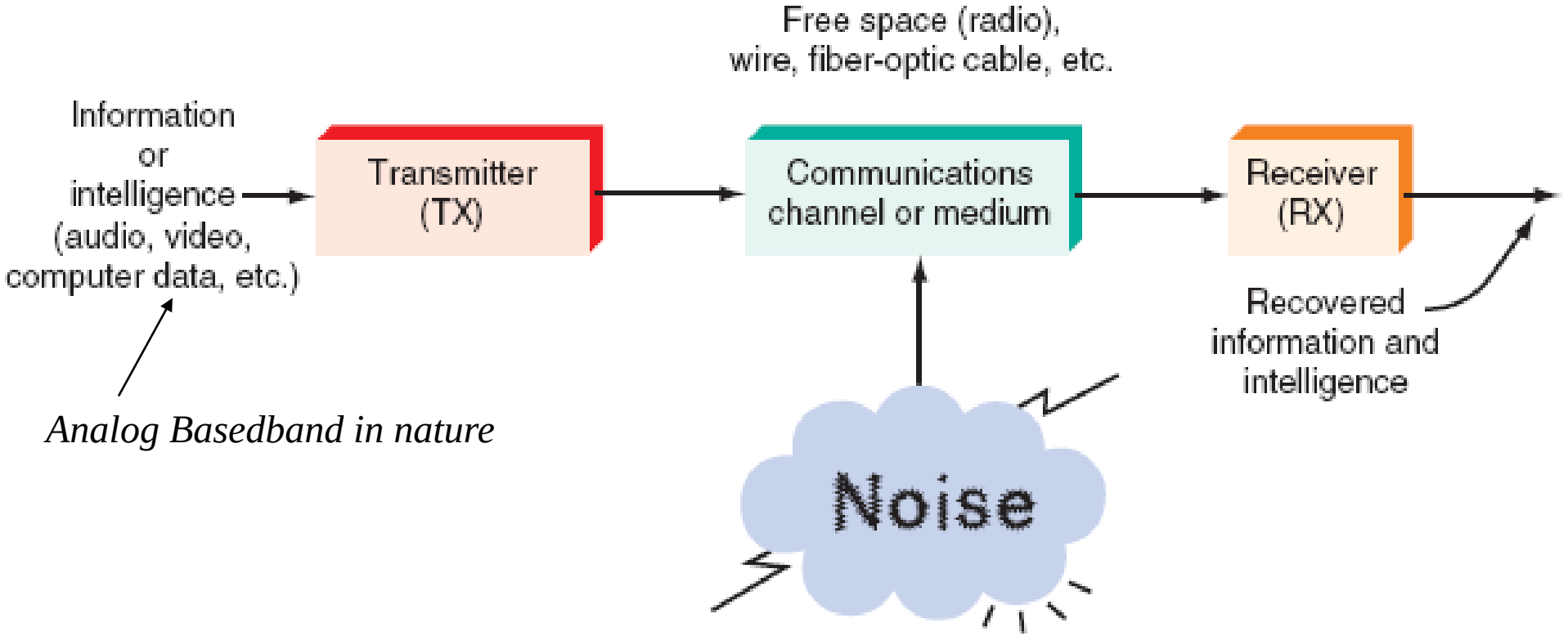
Architecture of a generic communication system

- Originally described by Claude Shannon of Bell Laboratories in his classic 1948 paper '*A Mathematical Theory of Communication' [Shannon, 48]*. [1]
- This representation applies to all types of communication systems (wireless or otherwise). [1]
- Noise: general term applied to any phenomenon that degrades or interferes with the txed information



Architecture of a generic communication system

❑The Transmitter:

- Converts the intelligence into electronic form suitable for transmission.
- 1st main stage is transducer: physical characteristics (sound, voice, temperature, pressure, light intensity) →→→ electrical signals.
- Transducers like: microphone, camera, computer keyboard.
- 2nd main stage modulator: transducer's electrical output usually modulates a higher-frequency carrier sine wave. Then amplified.

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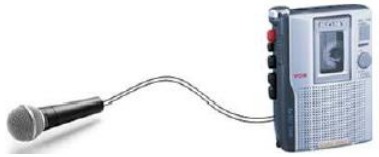
❑The Communication Channel

- The medium by which the electronic signal is sent from one place to another.
- Media or channels include:

❖Electric (wire) conductors



Pair of wires

Twisted-pair

Coaxial-cable

❖fiber-optic cable (light wave)

Pair of wires

❖free space (called wireless or radio communication) (Intelligence signals ---> EM signal).

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❑Other type of channels:

- Water in Sonar (Sound Navigation and Ranging): a technique that uses sound propagation (usually underwater, as in submarine navigation) to navigate, communicate with or detect objects on or under the surface of the water.

- The earth itself can be used as a communication medium, because it conducts electricity and can also carry low-frequency sound waves.

- Alternating-current (ac) power lines, the electrical conductors that carry the power to operate virtually all our electrical and electronic devices, can also be used as communication channels.

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❑The Receiver

- It accepts the transmitted message from the channel and converts it back to a form understandable by humans.
- Core stage is the demodulator (detector).

- **Transceivers:** have both a transmitter and a receiver (e.g., cell phone, modems, telephones).

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❑Attenuation & Distortion (by channels)

- Attenuation proportional to the square of the distance between the transmitter and receiver (inevitable no mater the channel type).
- channels are frequency-selective (as filters and distort out-of-band signal components).
- Amplification needed.

❑Noise (internal, external, multiplicative, interference) (its measure in SNR):

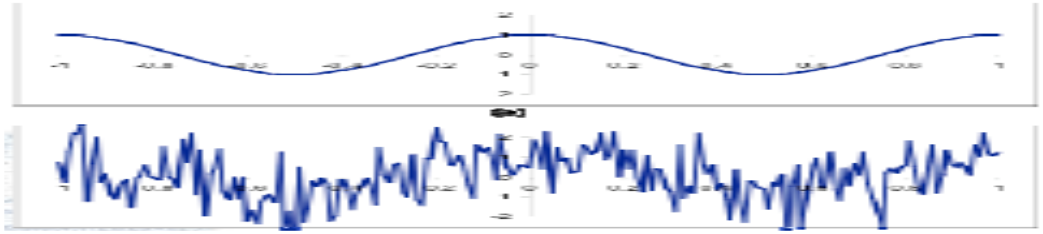

Fig Ref: http://www.hawa.work/421/index.html

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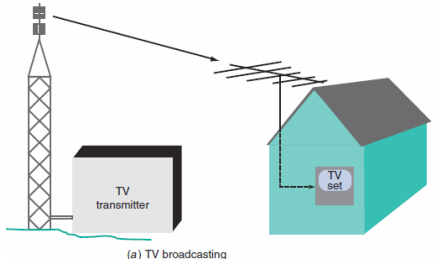
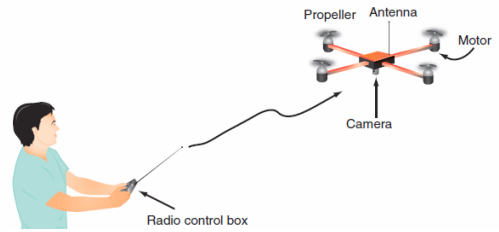
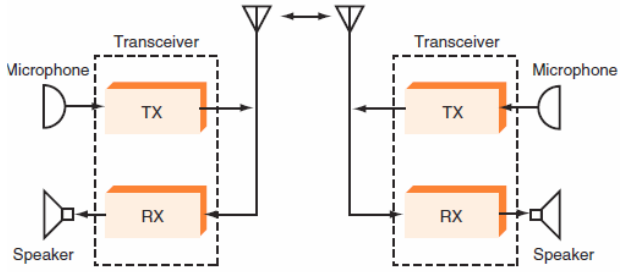
❑Types of Communication Systems:

- Simplex (one way): TV broadcasting.

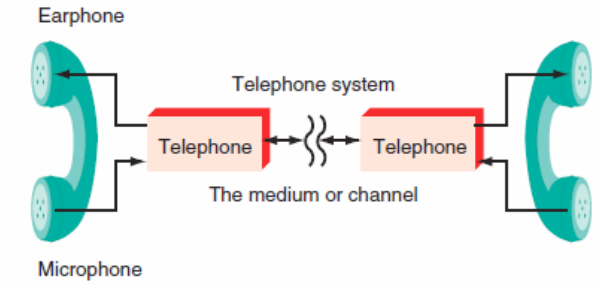




- Half duplex (one way at a time): Radio transmission in military, fire, police, aircraft, marine.



- Full duplex (simultaneous, two-way): Telephone system.



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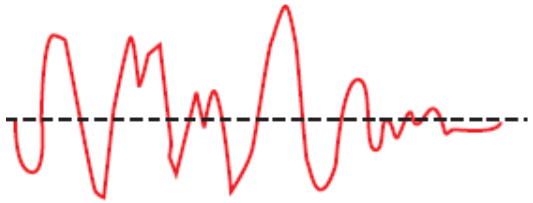
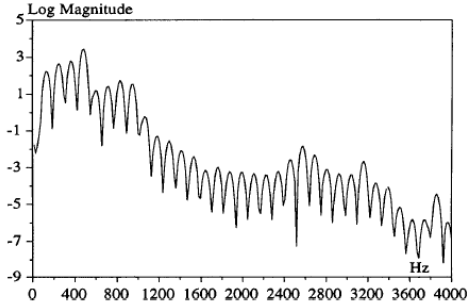
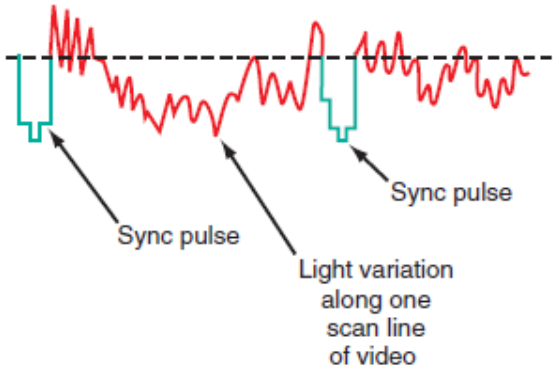
❑The Analog Signal

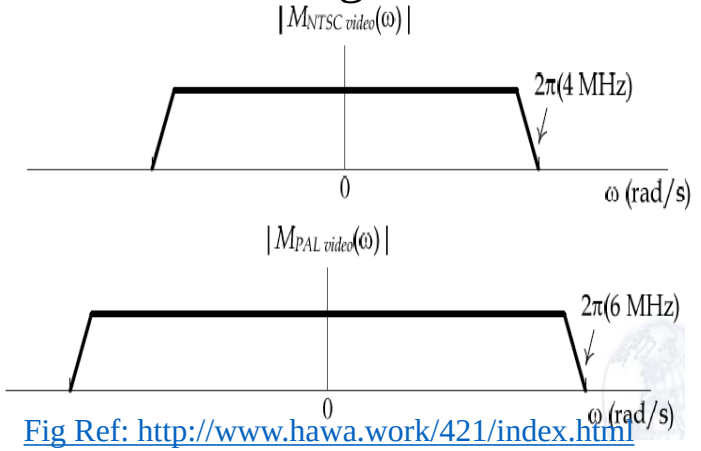
- Is a smoothly and continuously varying voltage or current; examples:
- Voice voltage: analog baseband signal that vary in accordance with the sound.





- Video voltages: analog baseband signal that vary in accordance with the light variations.





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- AM & FM signals: are analog bandpass (carrier) signals.

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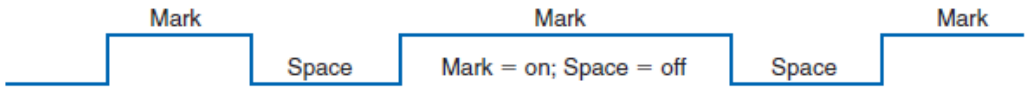
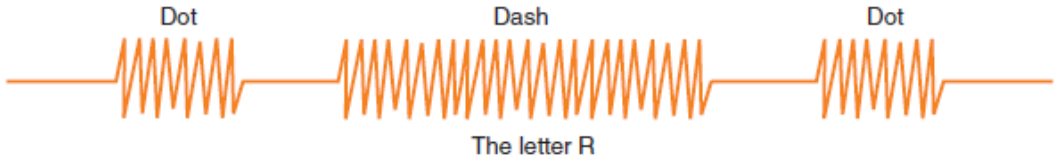
❑The digital signal

- Does not vary continuously. Most use binary or two-state codes, examples:
- Early wire and radio comm. systems used a type of on/off digital code
  - The telegraph used Morse code (system of short and long signals (dots and dashes) to designate letters and numbers):



  - In radio telegraphy (continuous-wave transmission), a sine wave signal is turned off and on for short or long durations to represent the dots and dashes (*Marconi*).



  - https://www.youtube.com/watch?v=bNoOYeS0gs0

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- **The digital signal**
  - Telegraph using Morse-code

Character	Morse Code	Character	Morse Code	Number	Morse Code
A	•–	N	–•	1	•–––––
B	–•••	O	–––	2	••–––
C	–•–•	P	•––•	3	•••––
D	–••	Q	––•–	4	••••–
E	•	R	•–•	5	•••••
F	••–•	S	•••	6	–••••
G	––•	T	–	7	––•••
H	••••	U	••–	8	–––••
I	••	V	•••–	9	––––•
J	•–––	W	•––	0	–––––
K	–•–	X	–••–		
L	•–••	Y	–•––		
M	––	Z	––••		

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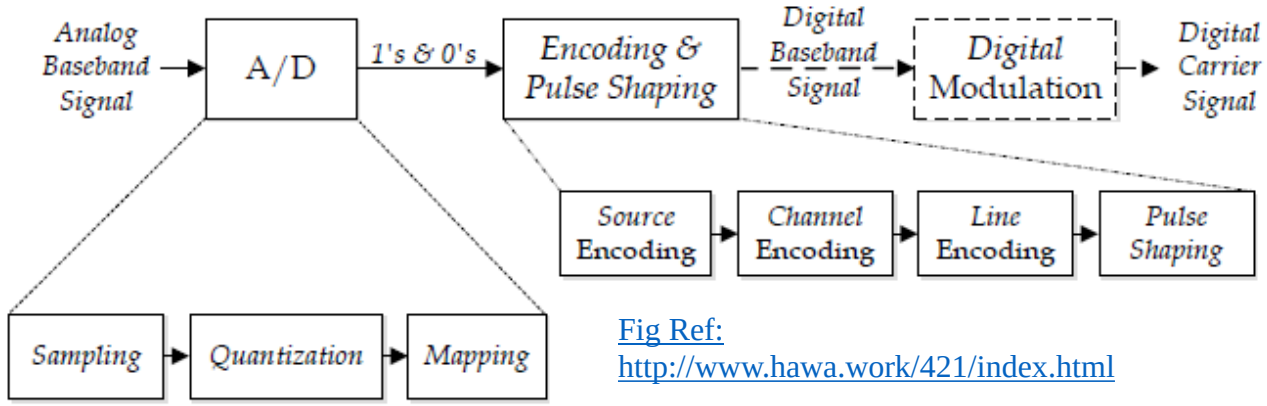
❑The digital signal

- Data in computers is binary digital (standard ASCII code converts letters, numbers ,.. to binary code)

- In digital comm. systems: analog intelligence is first converted into digital signal



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❑**Baseband Transmission**:

- Baseband information signals (like voice, video, or digital signals) are sent directly and unmodified over the medium.
- Ex1: in many telephone systems, the voice itself is placed on the wires and transmitted over some distance to the receiver.
- Ex2: In most computer networks, the digital signals are applied directly to coaxial or twisted-pair cables for transmission to another computer.

❑**Broadband Transmission:**

- Baseband voice, video, or digital signal modify another, higher-frequency signal, the carrier. The information or intelligence to be sent is said to be impressed upon the carrier.
- Over free space (radio transmission)

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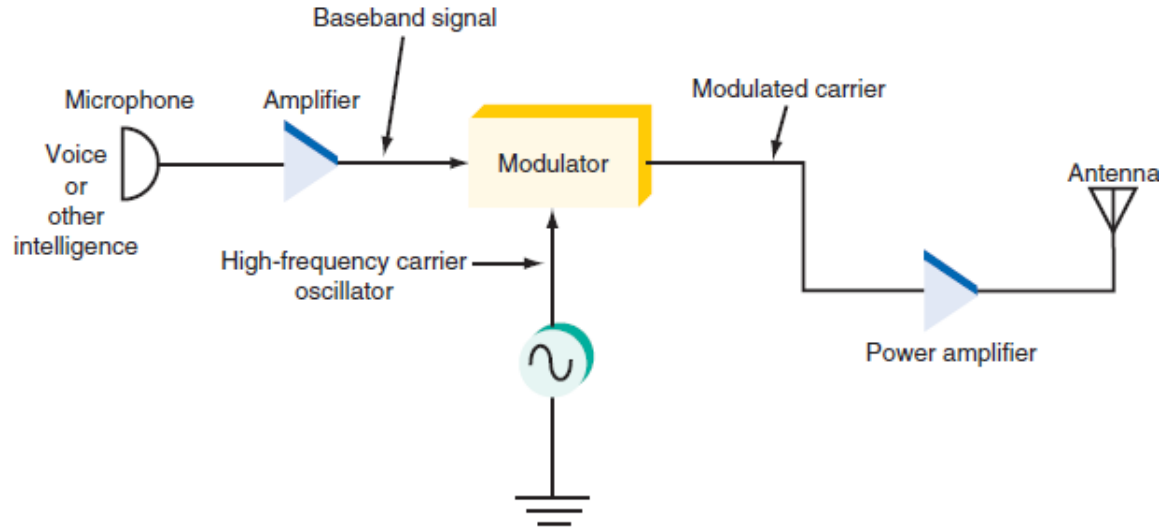
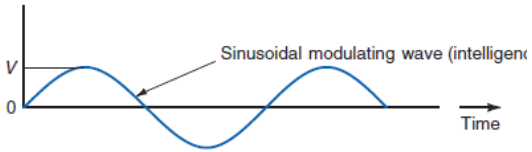
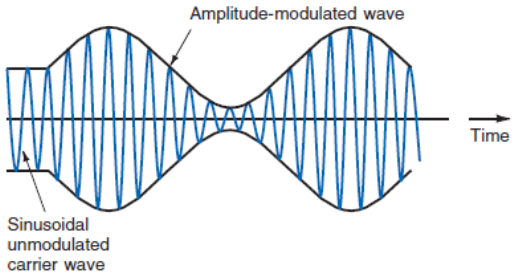
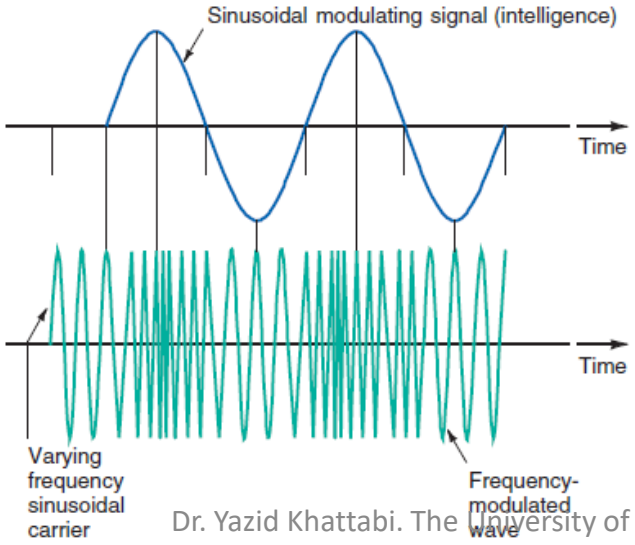
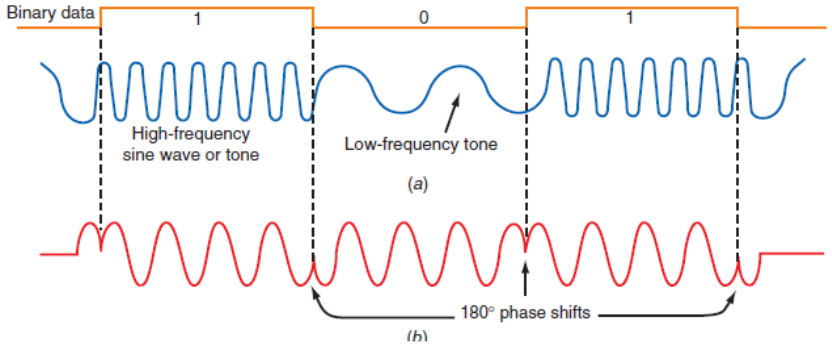
❑Broadband Transmission











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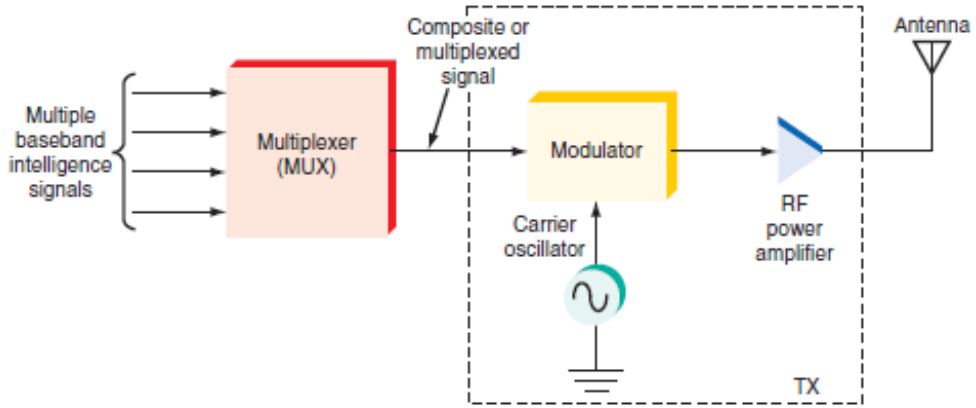
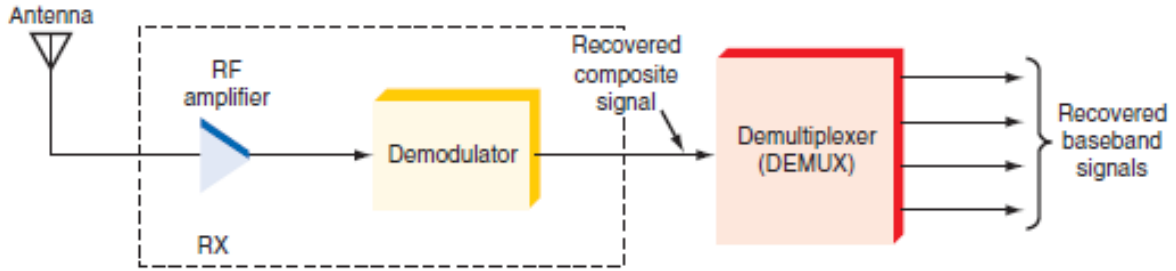
❑Multiplexing

- It is the process of allowing two or more signals to share the same medium or channel.
- It converts the individual baseband signals to a composite signal that modulates a carrier in the transmitter.
- The composite signal is recovered at the receiver by the demodulator, then to the demultiplexer where the individual baseband signals are regenerated.





Thank you