Module I

Lecture 1

Basics of Communication Systems and its Classification

What is Electronic Communication ?

Refers to conveying information from one location to another using electronic circuits

OR

Transmission, reception and processing of information between two or more locations using electronic circuits

What is Electronic Communication ?

- Text
- Video
- Image
- Speech
- Music
- Data

Refers to conveying **information** from one to another using electronic circuits

Electrical signal

OR

How??

Using a Transducer

Transmission, reception and processing between two or more locations using electronic circuits

Example

Speech: 0 Hz - 4 kHz

Music : 0 Hz - 15 kHz

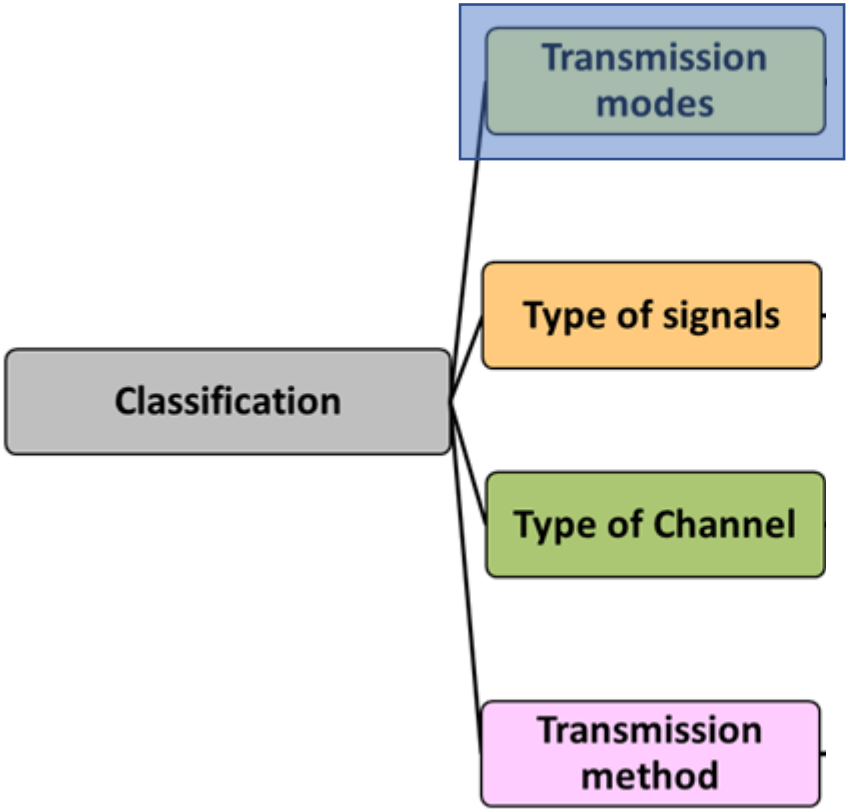
Video : 0 Hz - 5 MHz

- **History**
  - Telegraphy
  - Telephony
  - Radio broadcasting
  - TV broadcasting
  - Satellite communication
  - Cellular communication etc.

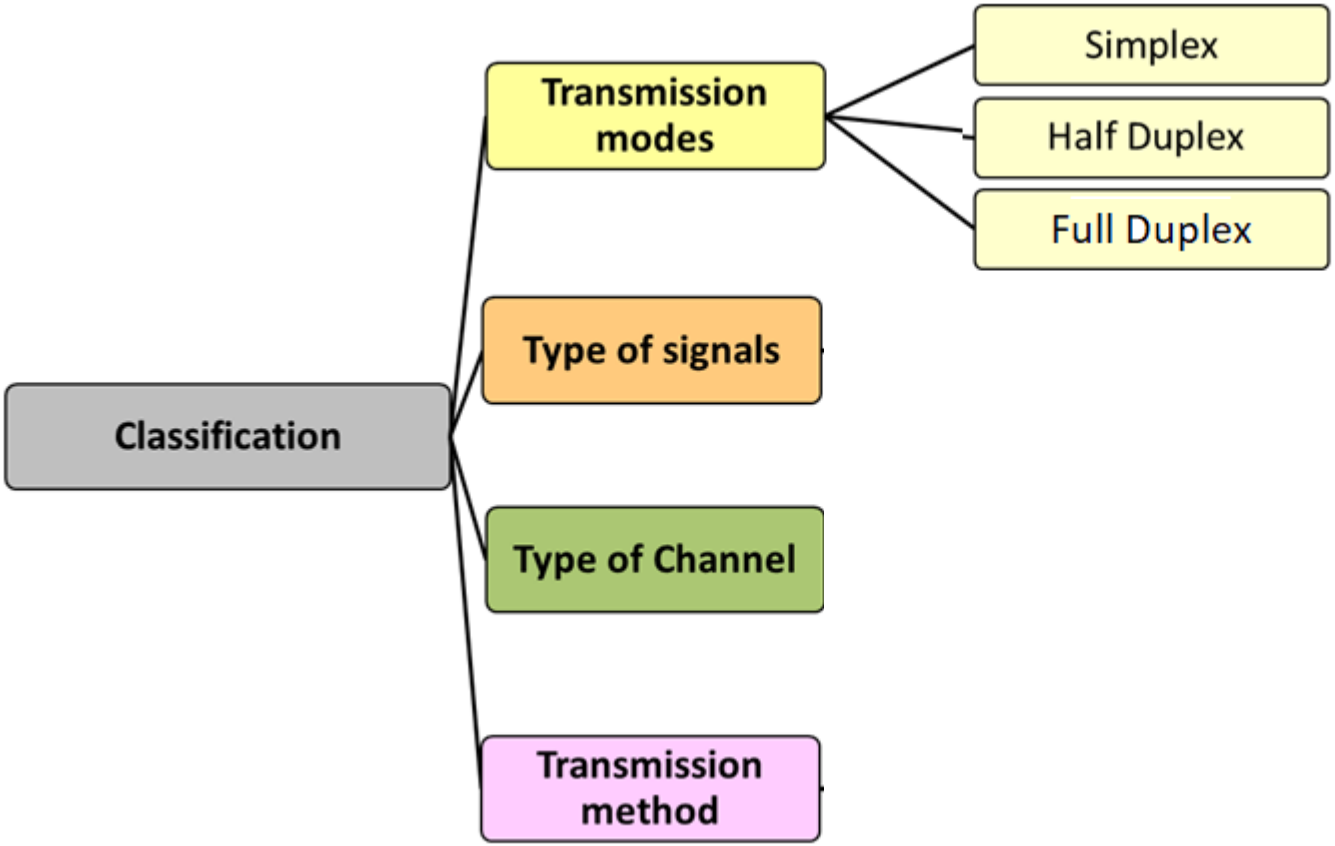
Fundamental concepts and principles of electronic communication is essentially same since inception…

The technology to implement has considerably changed…

Classification of Electronic Communication System

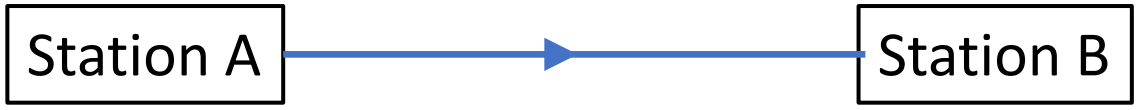


Classification of Electronic Communication System



Transmission Modes

Simplex Mode

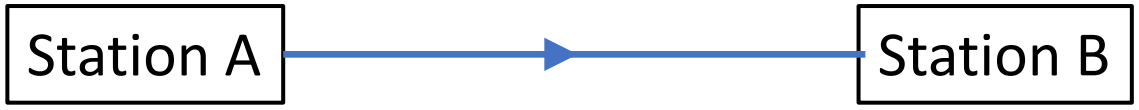


Transmission in one direction only

Example
- Radio Broadcasting
- TV Broadcasting

Transmission Modes

Simplex Mode



Transmission in one direction only

Example
- Radio Broadcasting
- TV Broadcasting

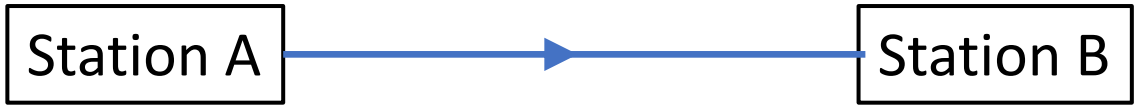
Half Duplex Mode

Example
- Walkie-Talkie

Transmission in either direction but not simultaneously

Transmission Modes

Simplex Mode



Transmission in one direction only

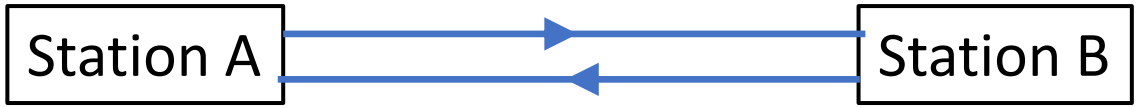
Example
- Radio Broadcasting
- TV Broadcasting

Half Duplex Mode

Example
- Walkie-Talkie

Transmission in either direction but not simultaneously

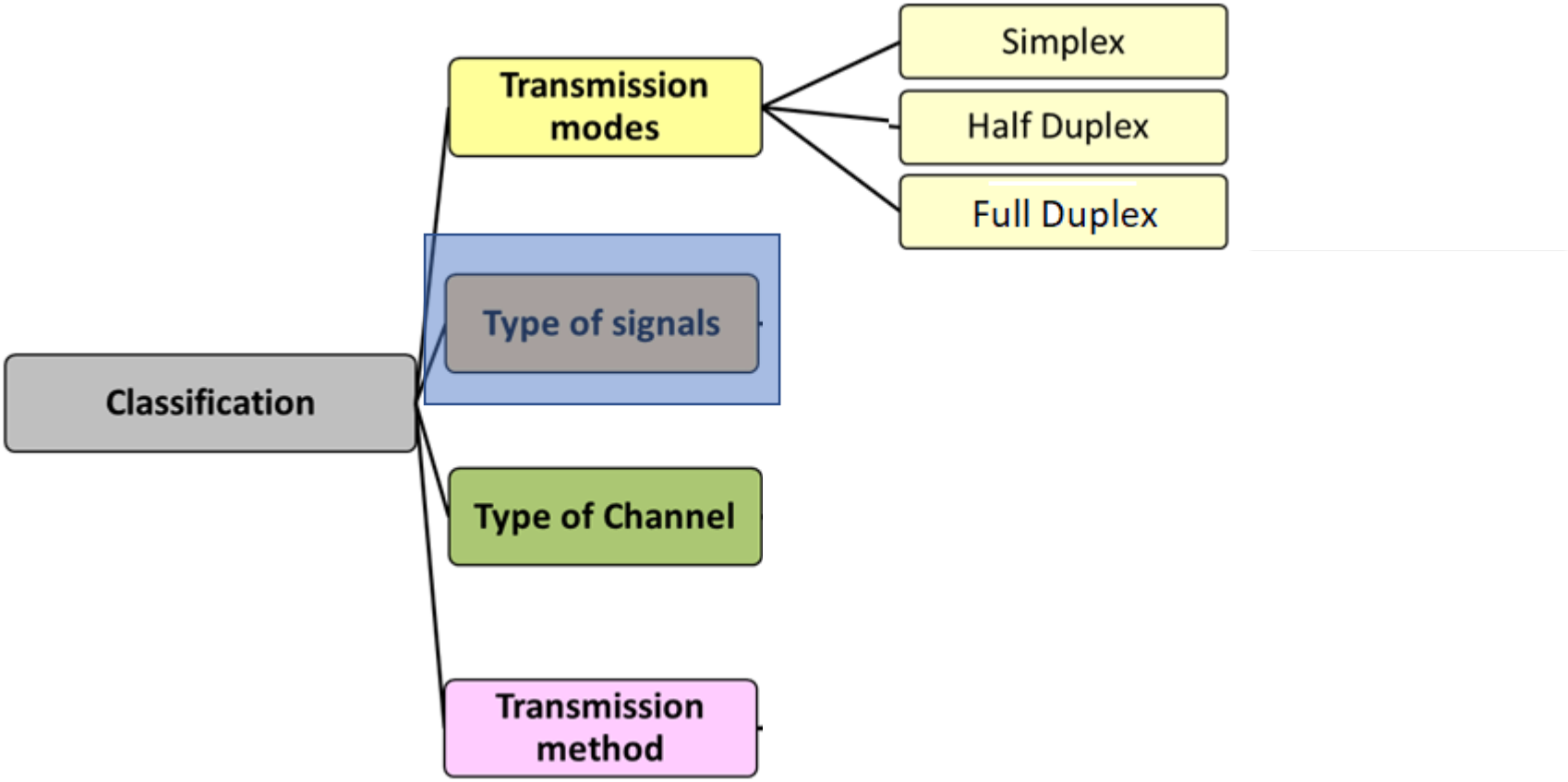
Full Duplex Mode



Example
- Telephony

Transmission in both directions simultaneously

Classification of Electronic Communication System



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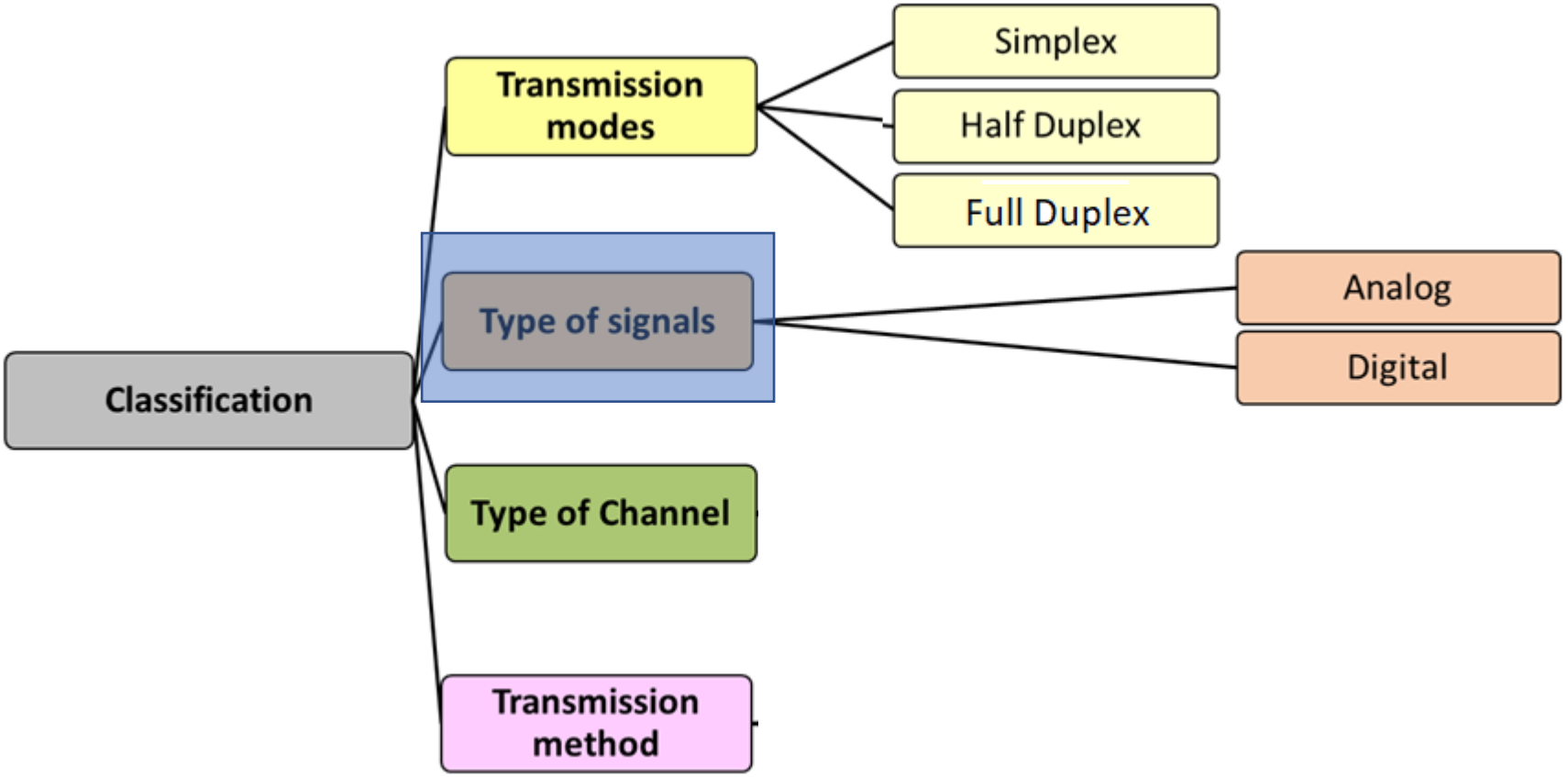

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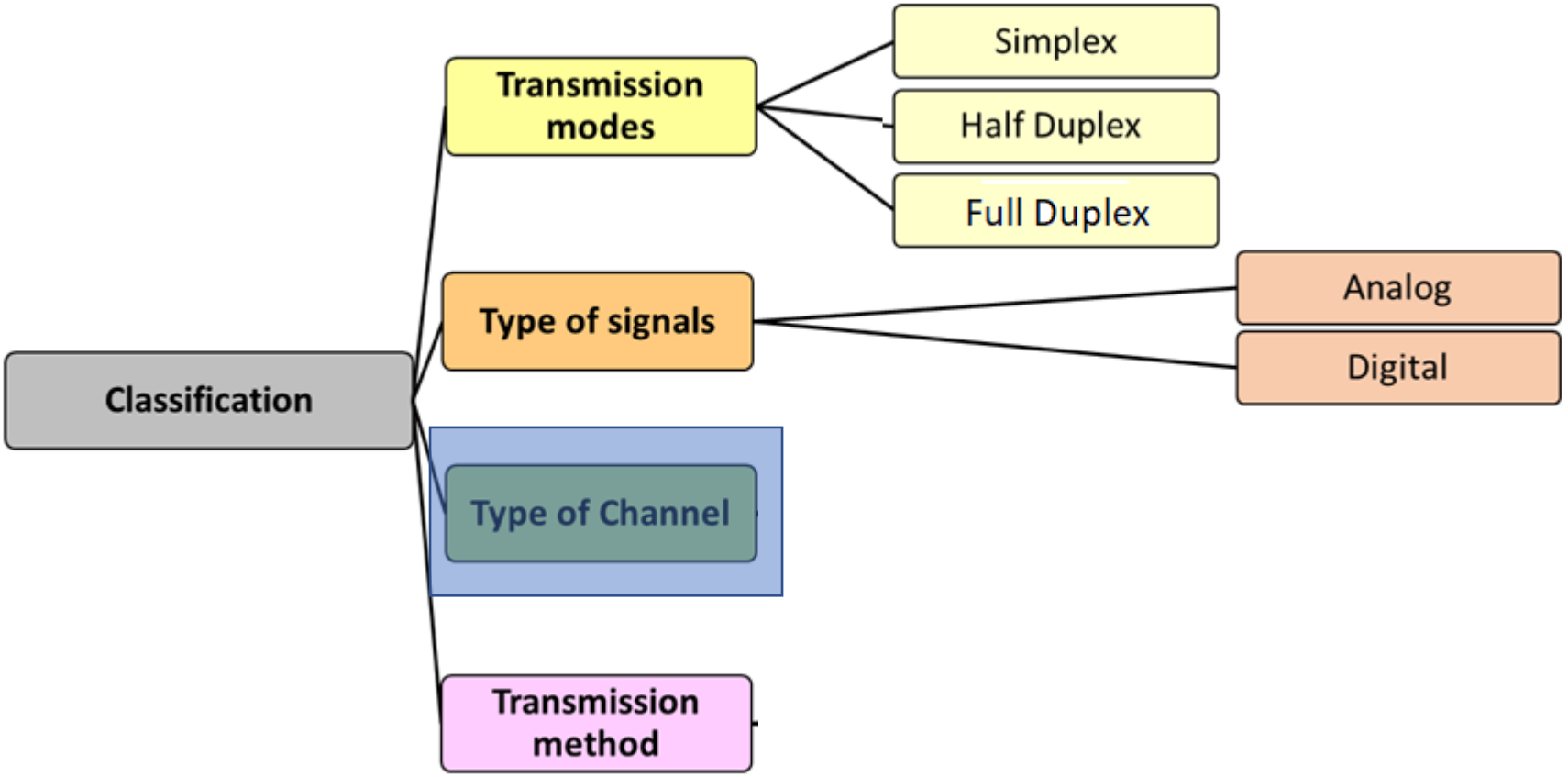

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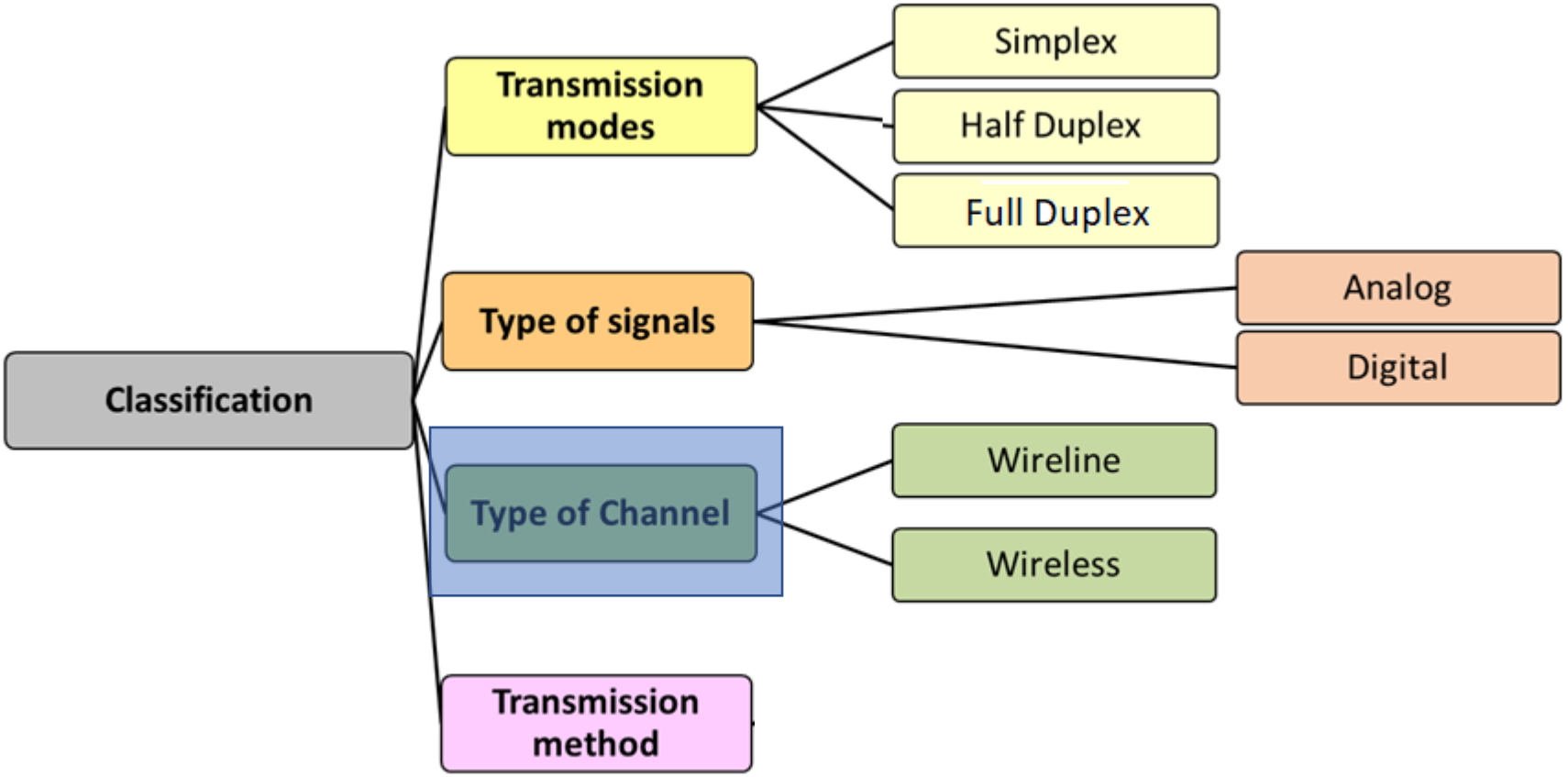
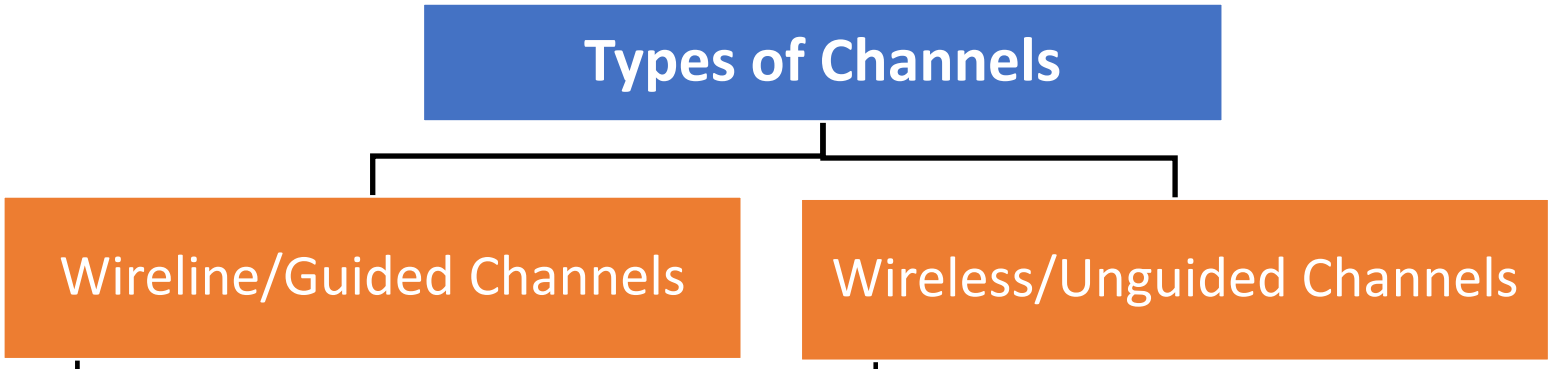
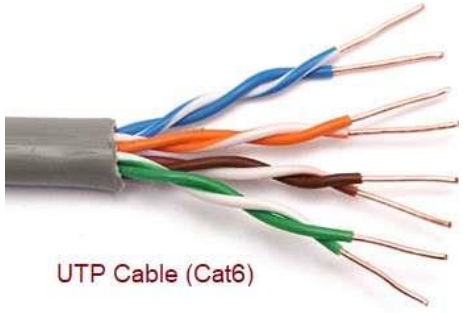




Types of Channels

- Wireline/Guided Channels
  - Twisted Pair
  - Coaxial Cable
  - Fibre Optic Cable
- Wireless/Unguided Channels

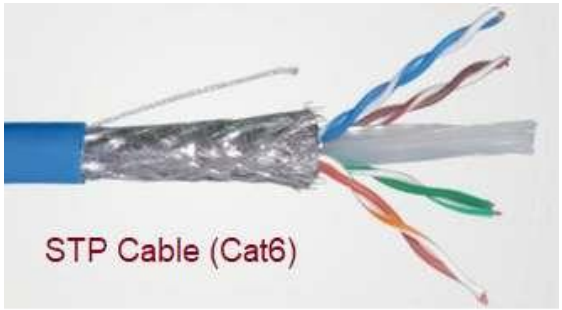


UTP - Consists of two insulated Cu wires twisted to reduce interference

Uses – Home telephones, Intercoms

STP - Consists of two insulated Cu wires twisted and enclosed in a shield for better interference reduction

Uses – LAN setups



https://www.rfwireless-world.com/

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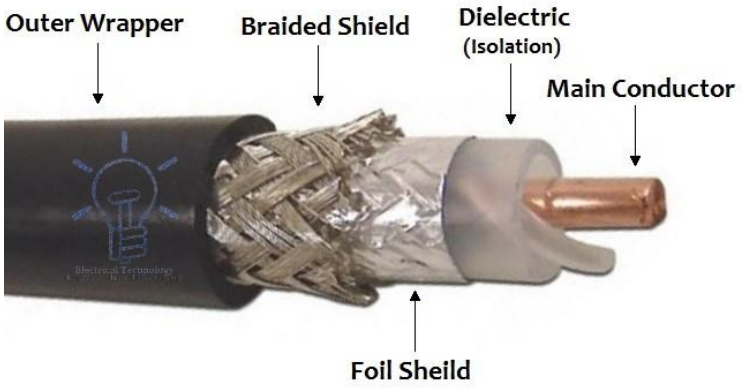

Consists of a single Cu conductor at its centre. Has layers of insulation to reduce interference

Uses – For long distance communication like cable TV, high speed LAN cabling, CCTV

https://www.electricaltechnology.org/

Types of Channels

- Wireline/Guided Channels
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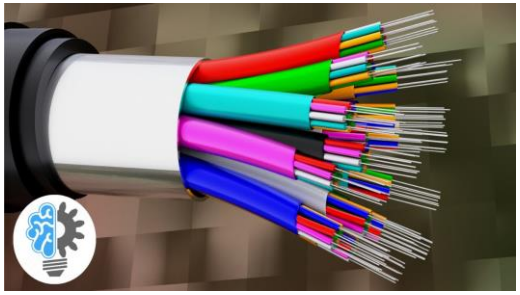
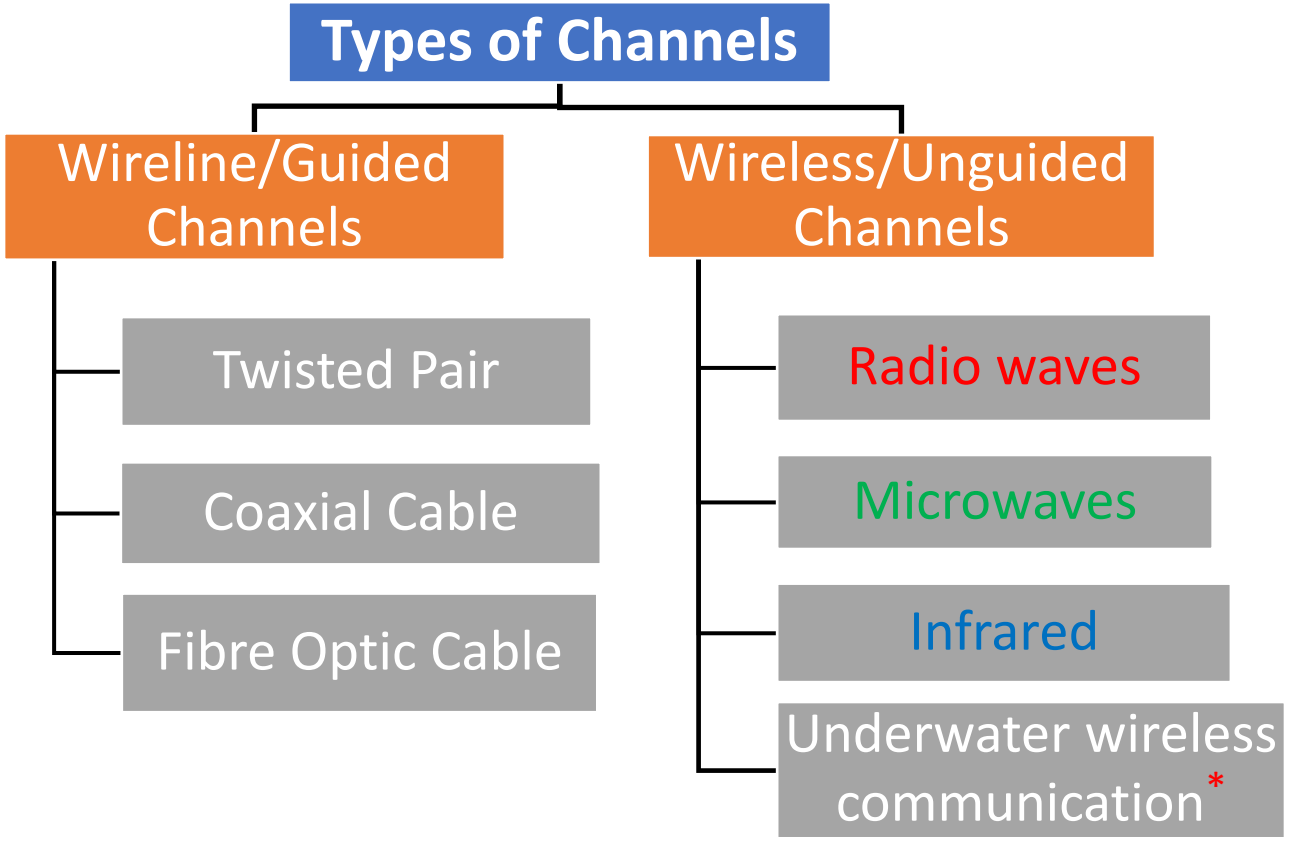


Consists of a glass core that carries light signal, works on principle of TIR, supports very high BW, attenuation very less, so used for very long distance communication

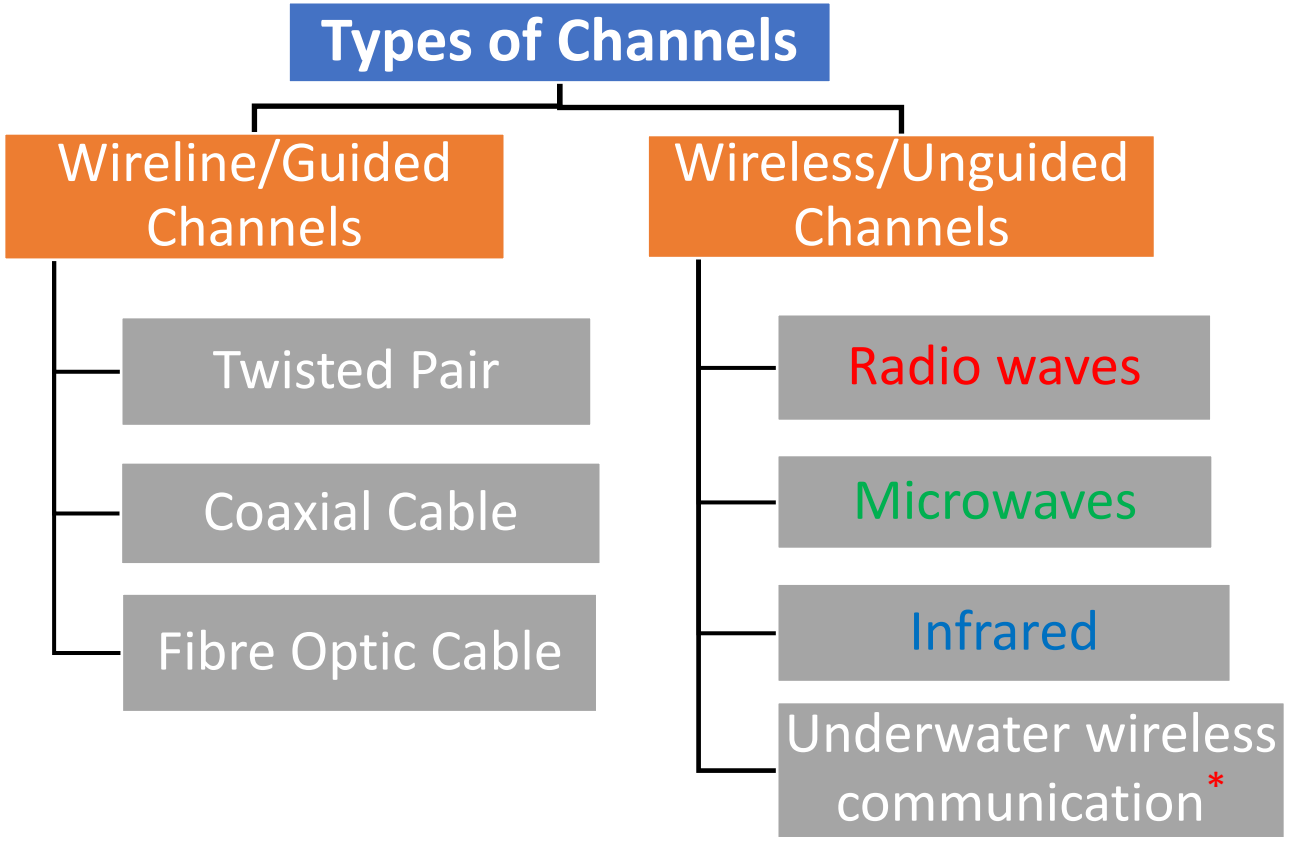
Uses –High speed internet connectivity for real time, interactive multimedia applications

https://www.rfwireless-world.com/



- **Radio Frequencies:** Upto 300 MHz (λ: upto 1m)
- **Microwave Frequencies:** 300 MHz - 300 GHz (λ: 1m - 1mm)
- **IR Frequencies:** 300 GHz - 430 THz (λ: 1mm - 700nm)

*Gussen C. Diniz, Diniz P., Campos M., Martins W., Costa F., Gois J., "A Survey of Underwater Wireless Communication Technologies", VOL. 31, NO. 1, 2016Journal of Communication and Information Systems, Vol. 31, No.1, Jan 2016, pp. 242-255.



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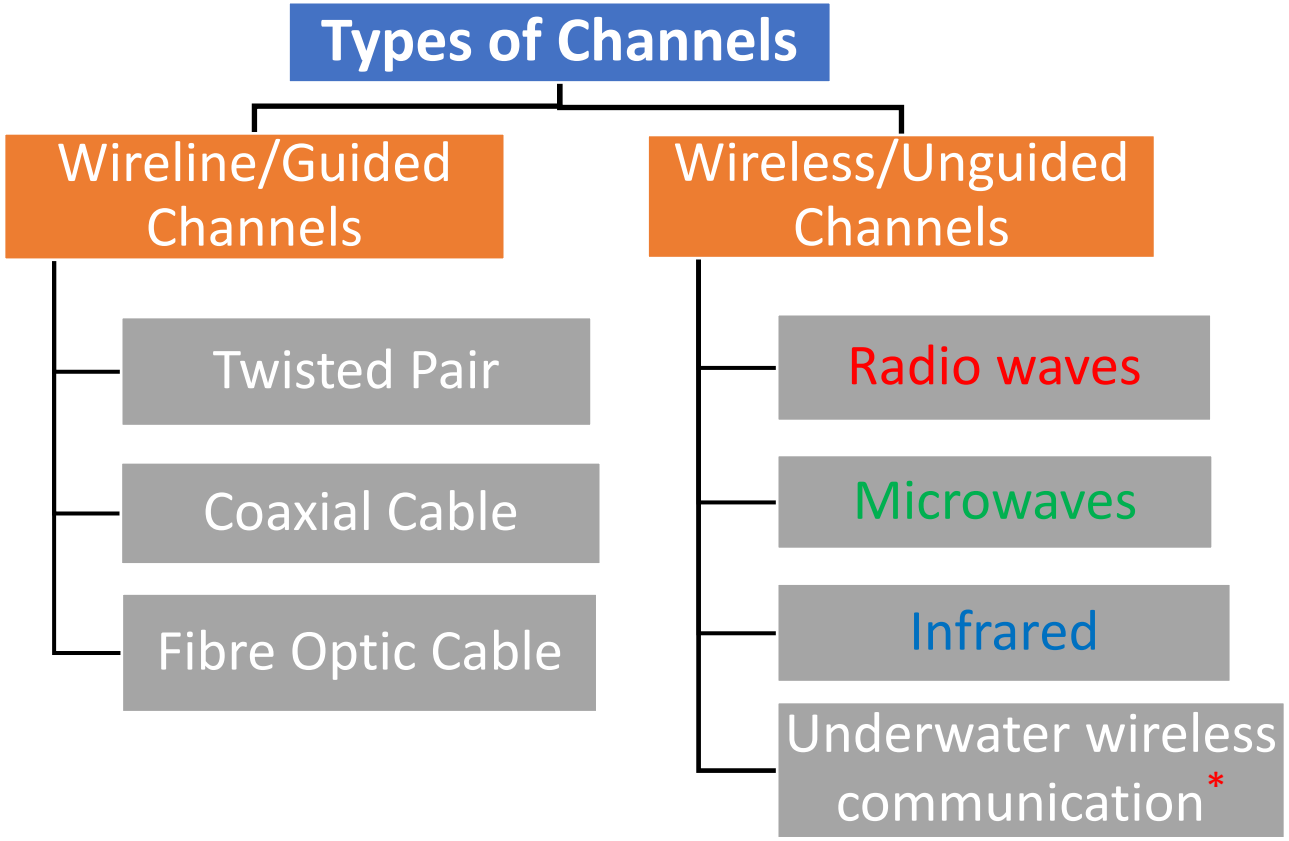

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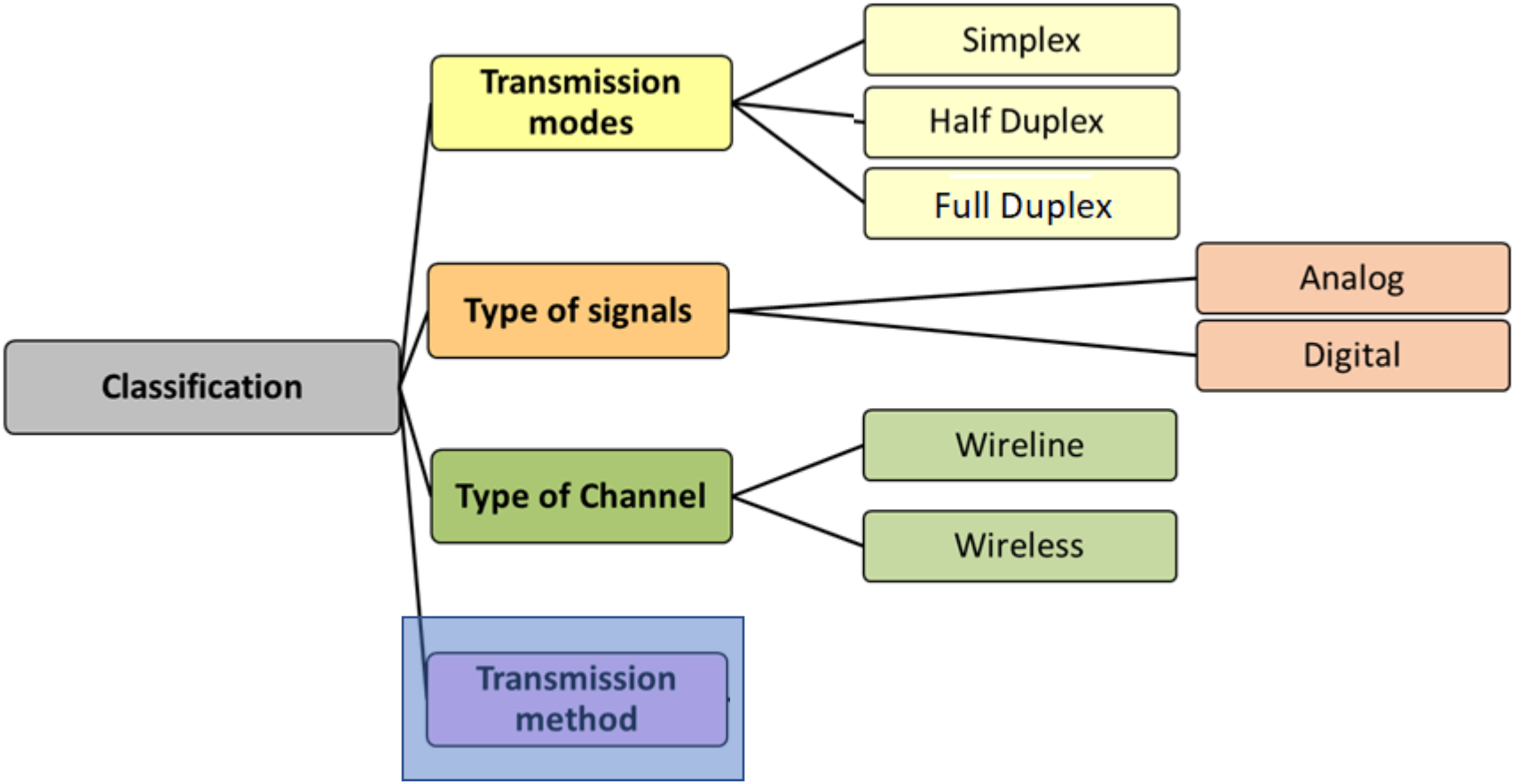
Classification of Electronic Communication System



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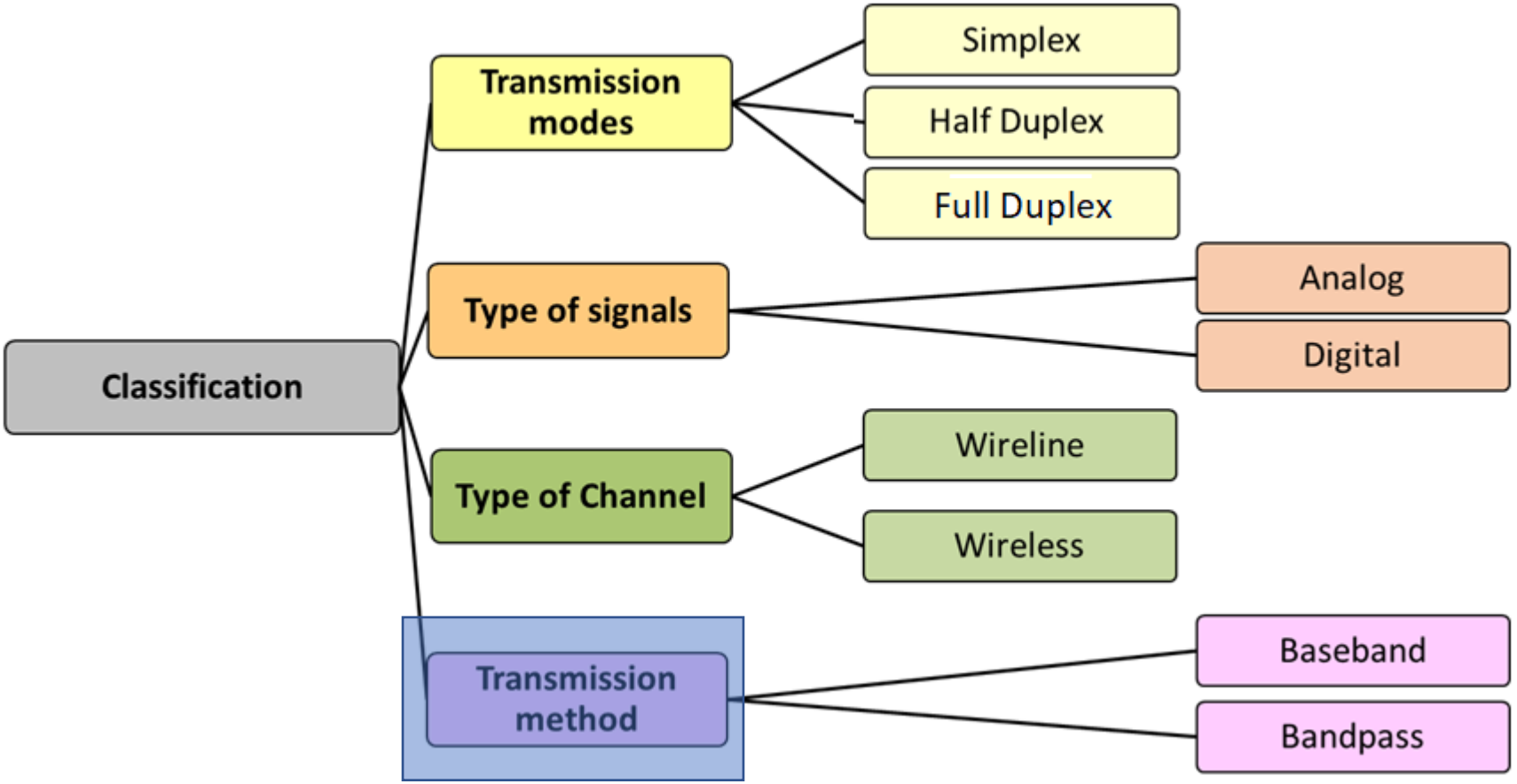
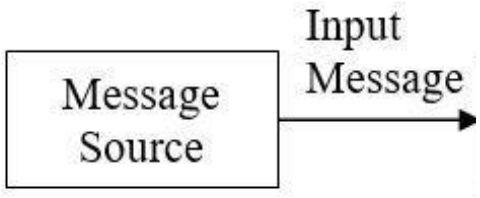


Module I

Lecture 2

- Block Diagram of Analog Communication Systems

BLOCK DIAGRAM OF ANALOG COMMUNICATION SYSTEM



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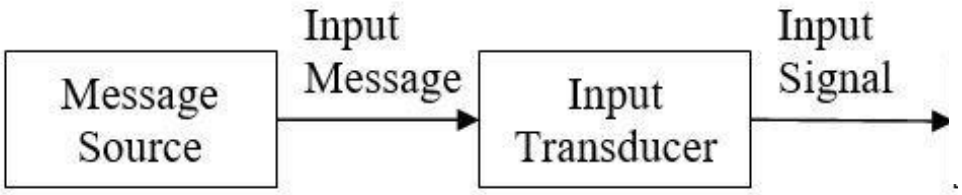

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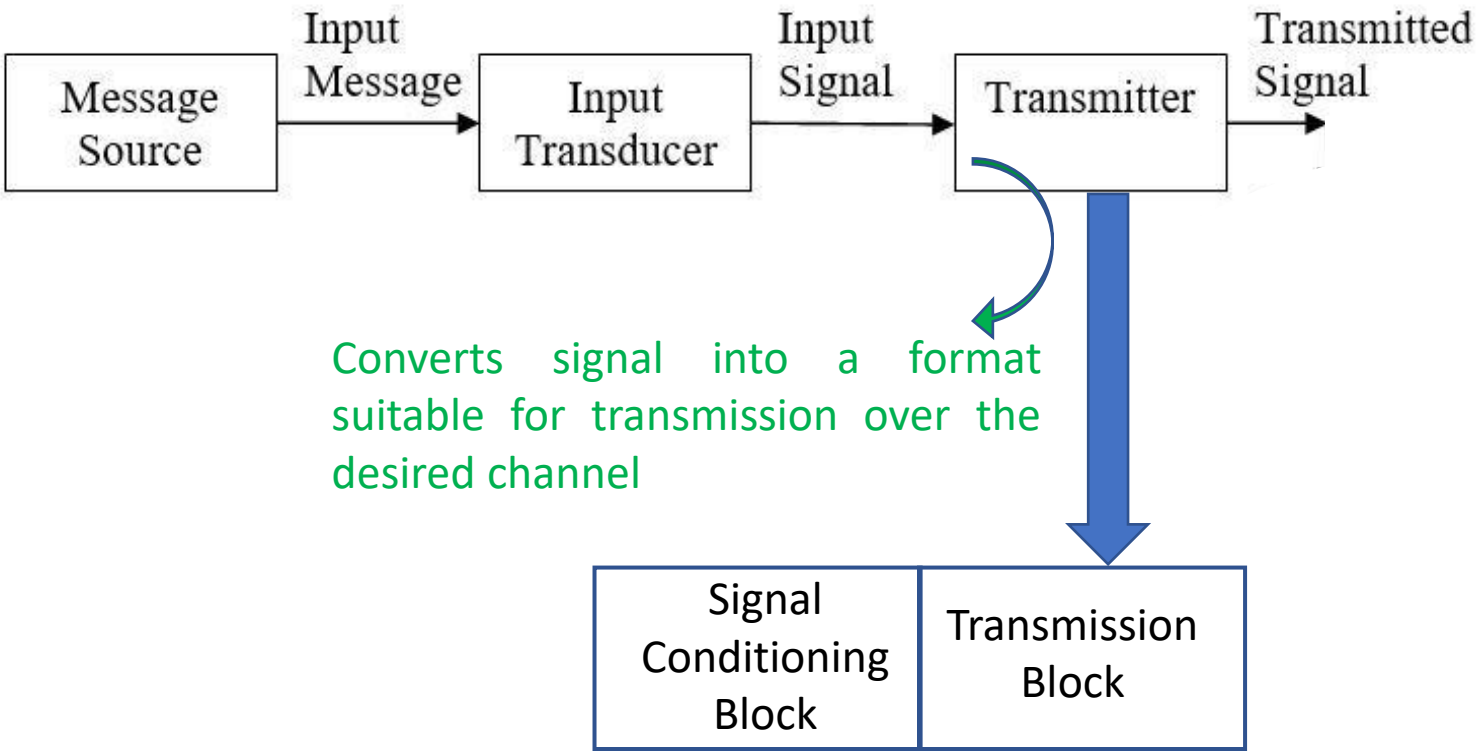

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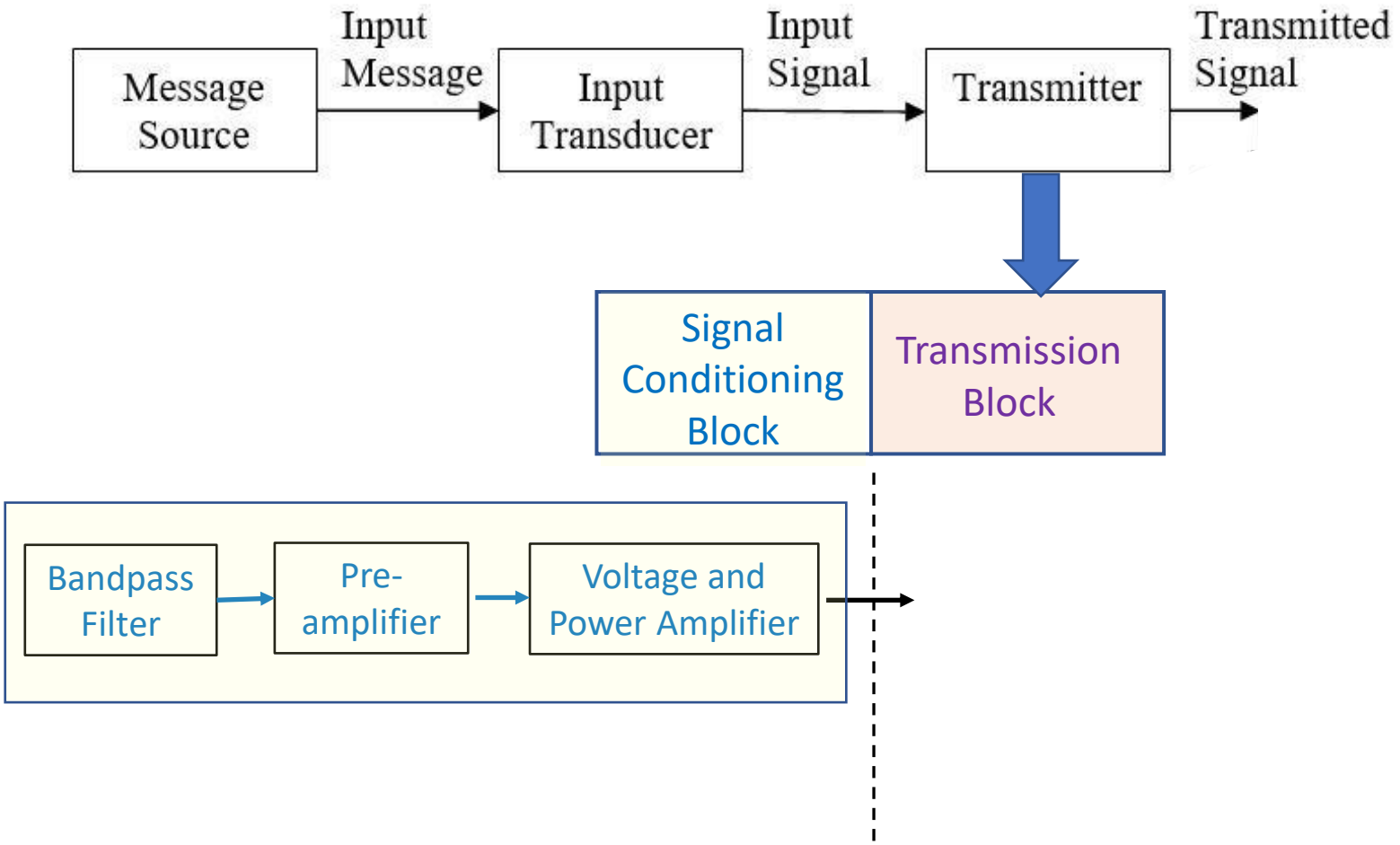

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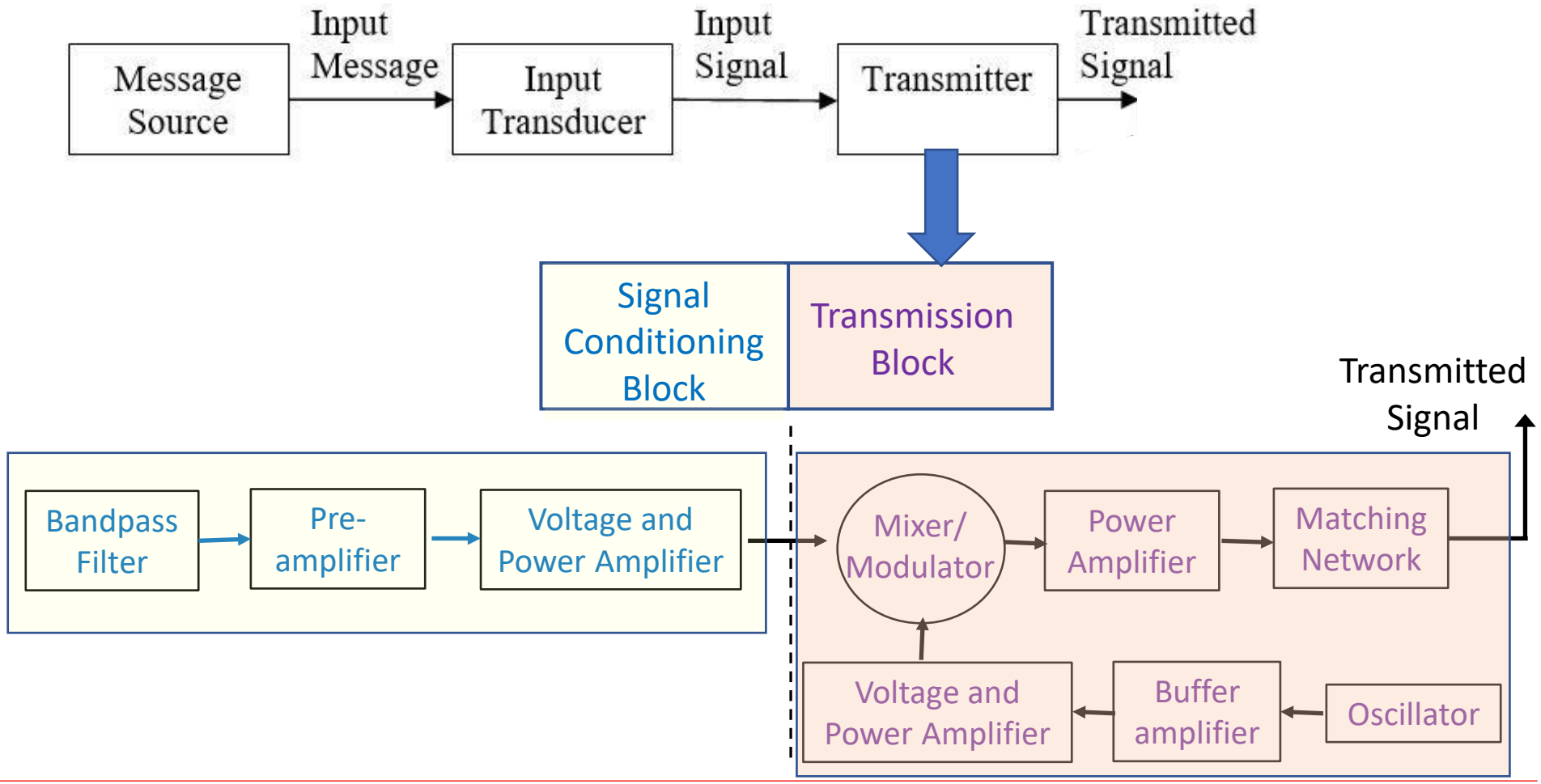

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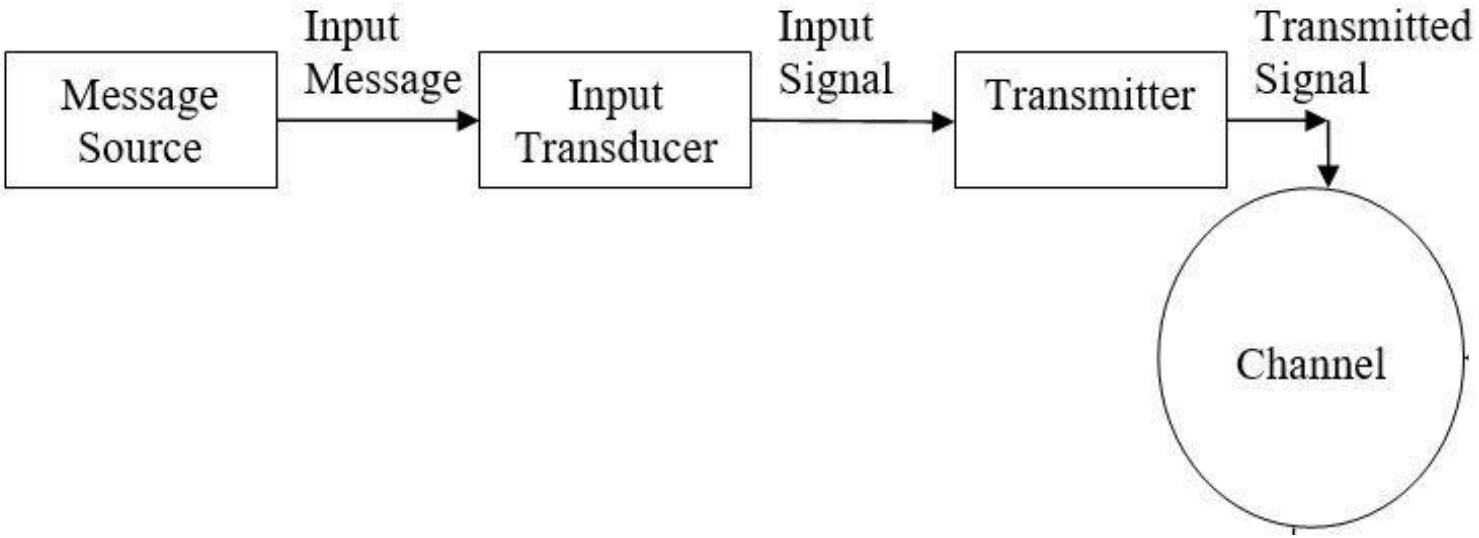

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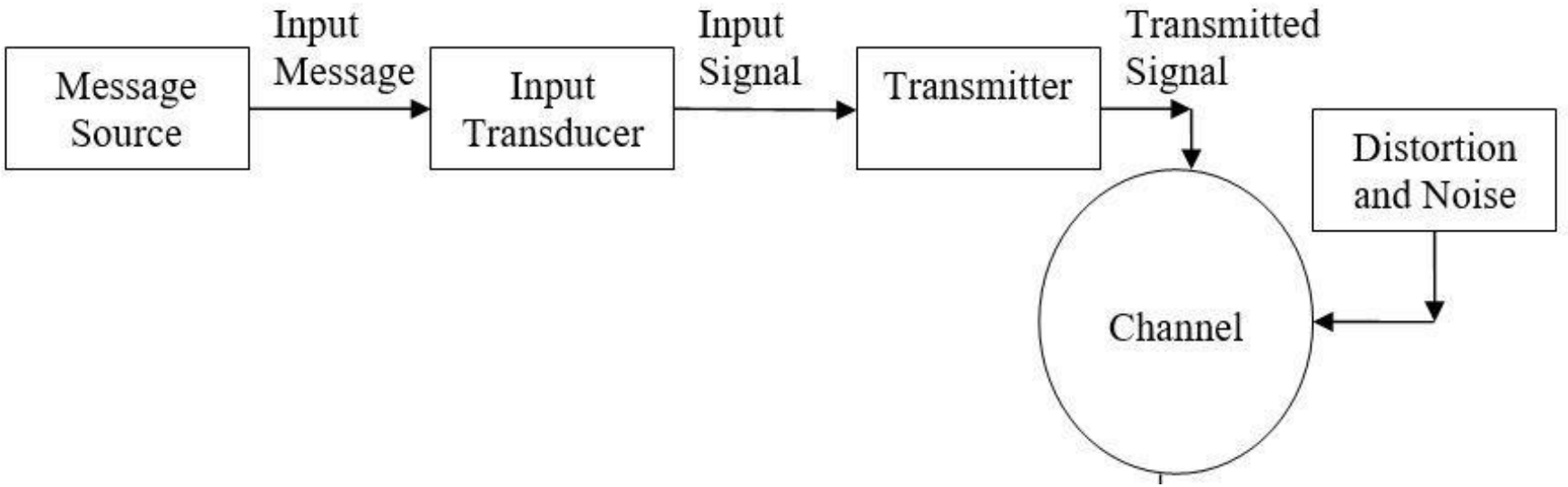

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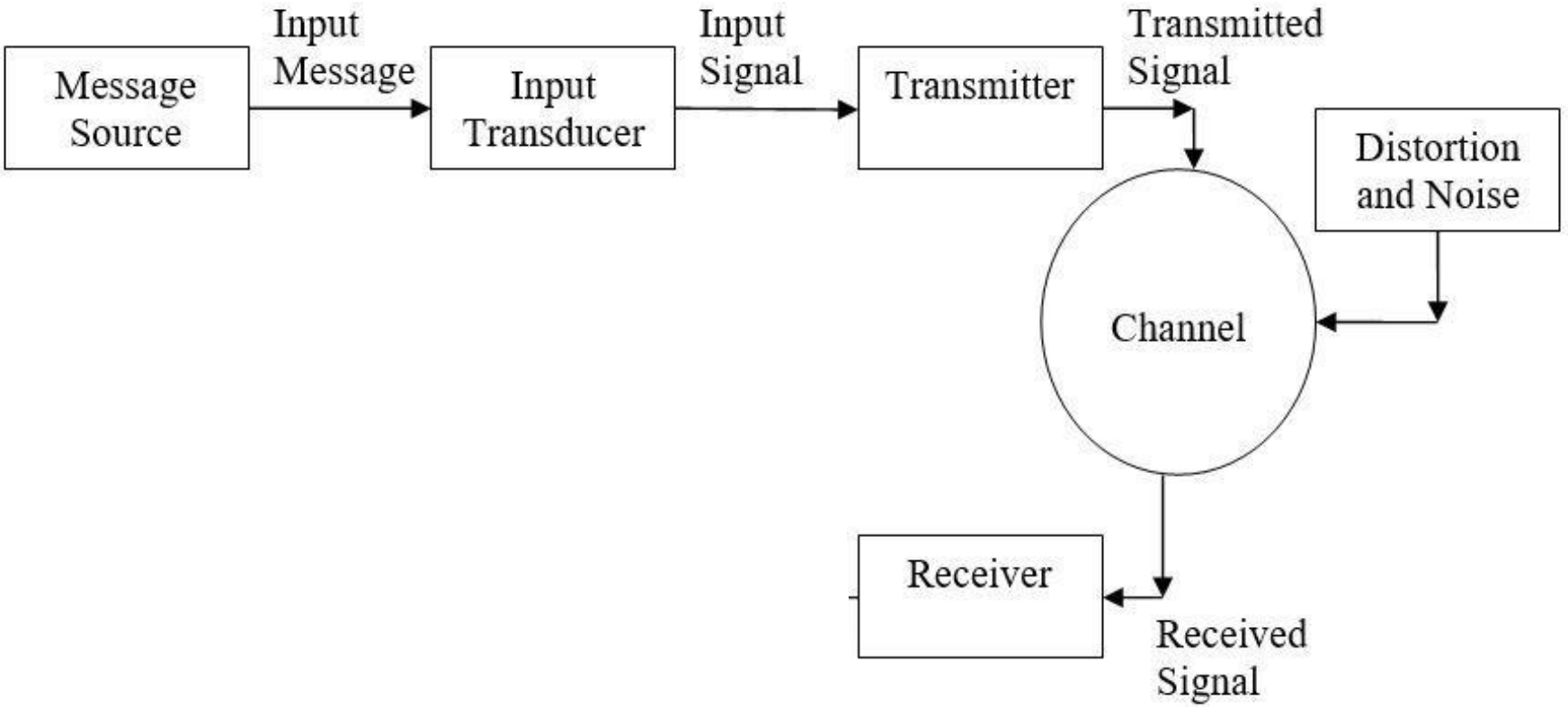

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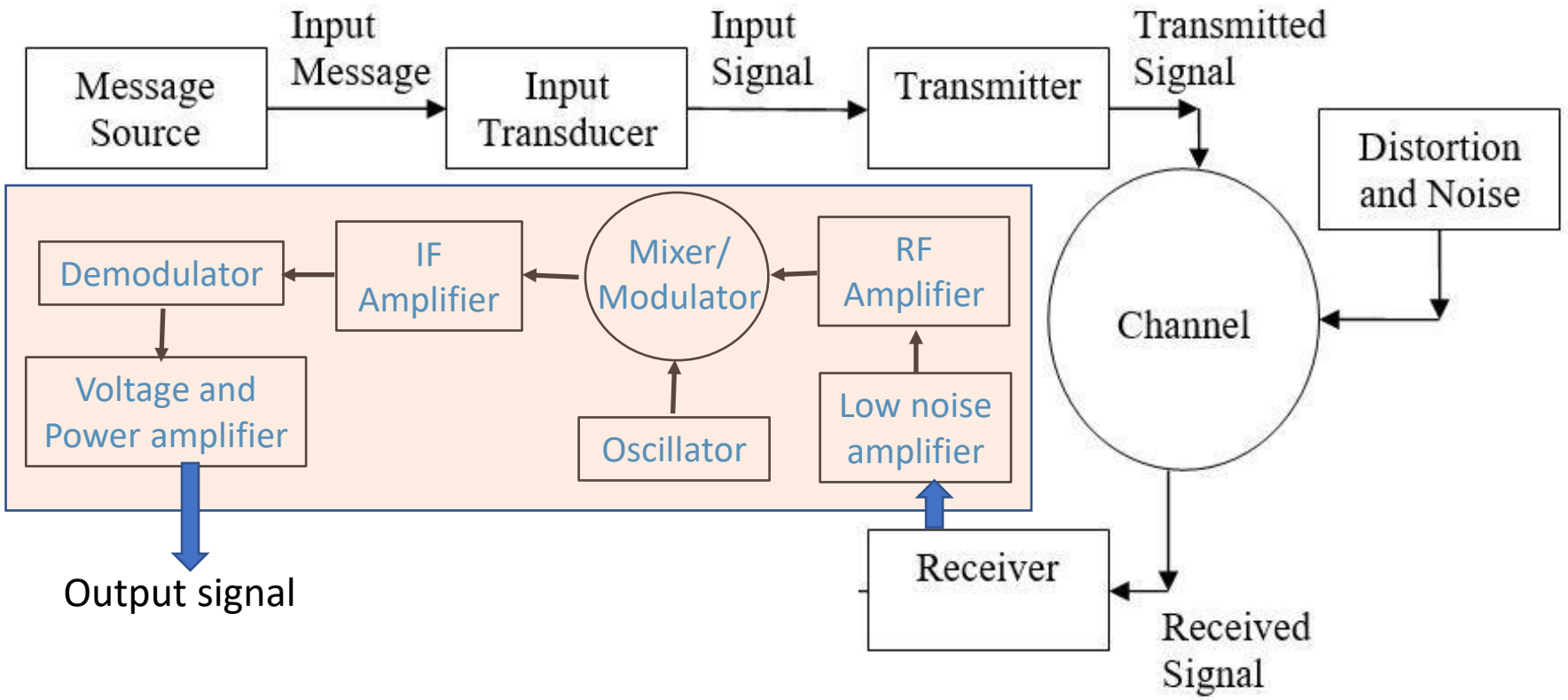

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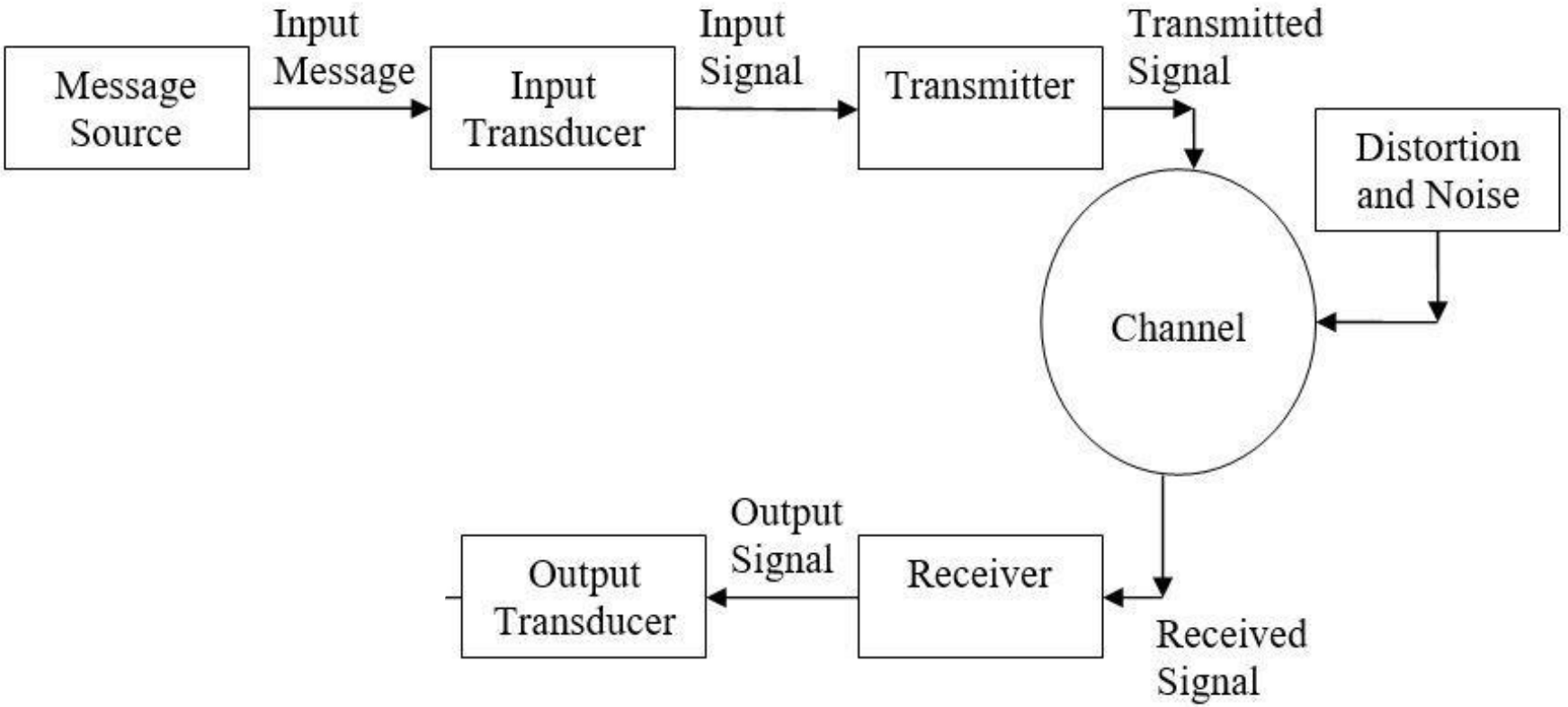

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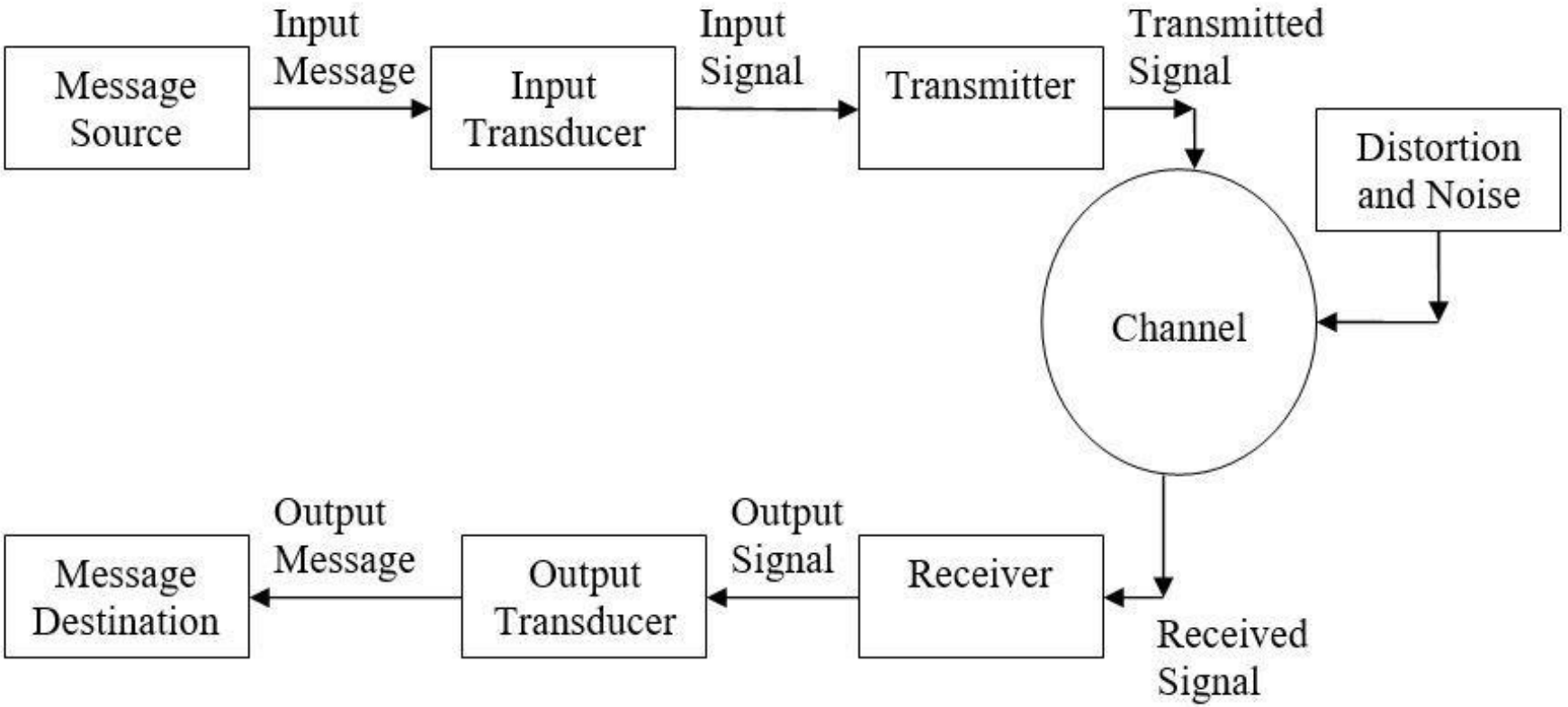
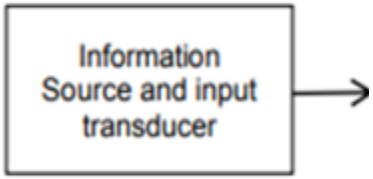


Module I

Lecture 3

- Block Diagram of Digital Communication Systems
- Advantages and Limitations of Digital Communication Systems
- Comparison of Analog and Digital Communication Systems

BLOCK DIAGRAM OF DIGITAL COMMUNICATION SYSTEM



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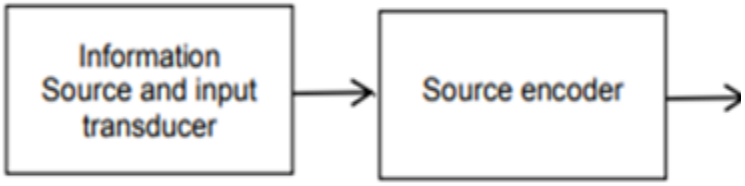

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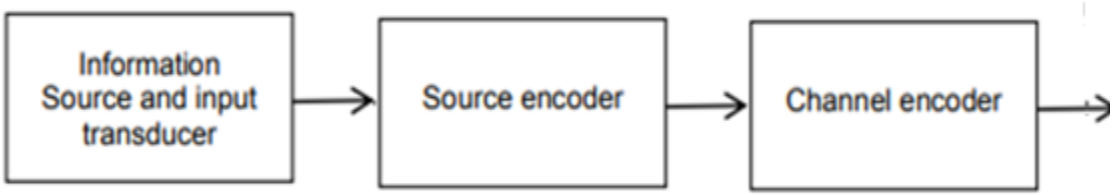

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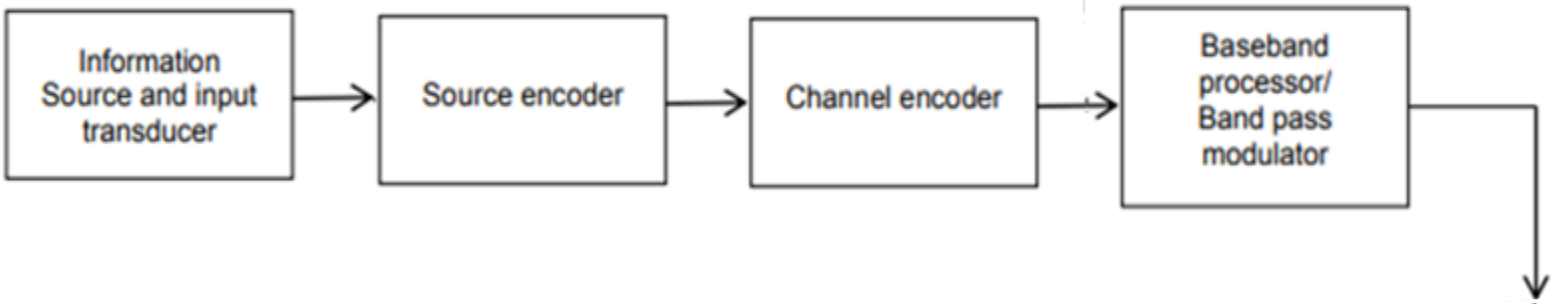

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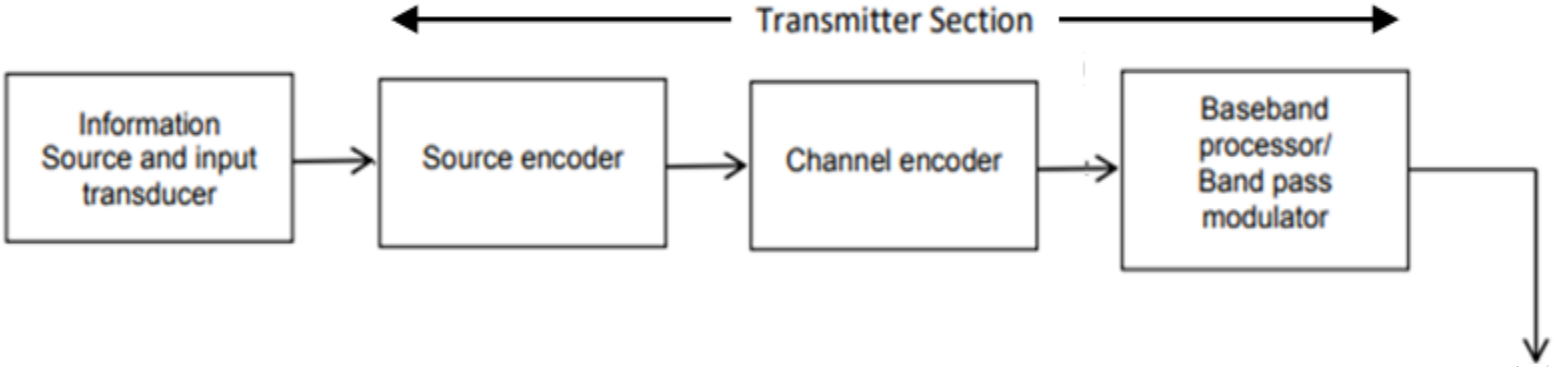

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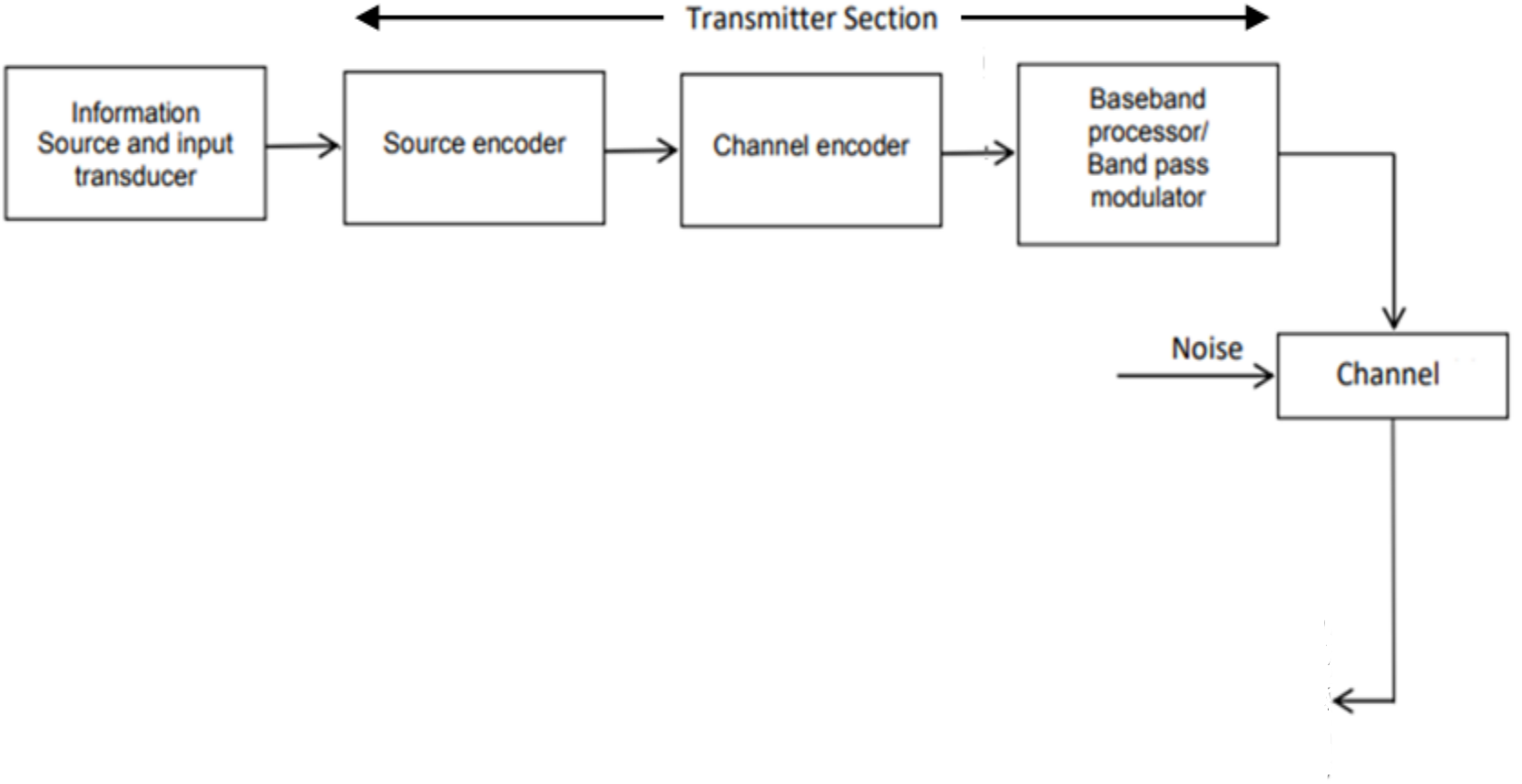

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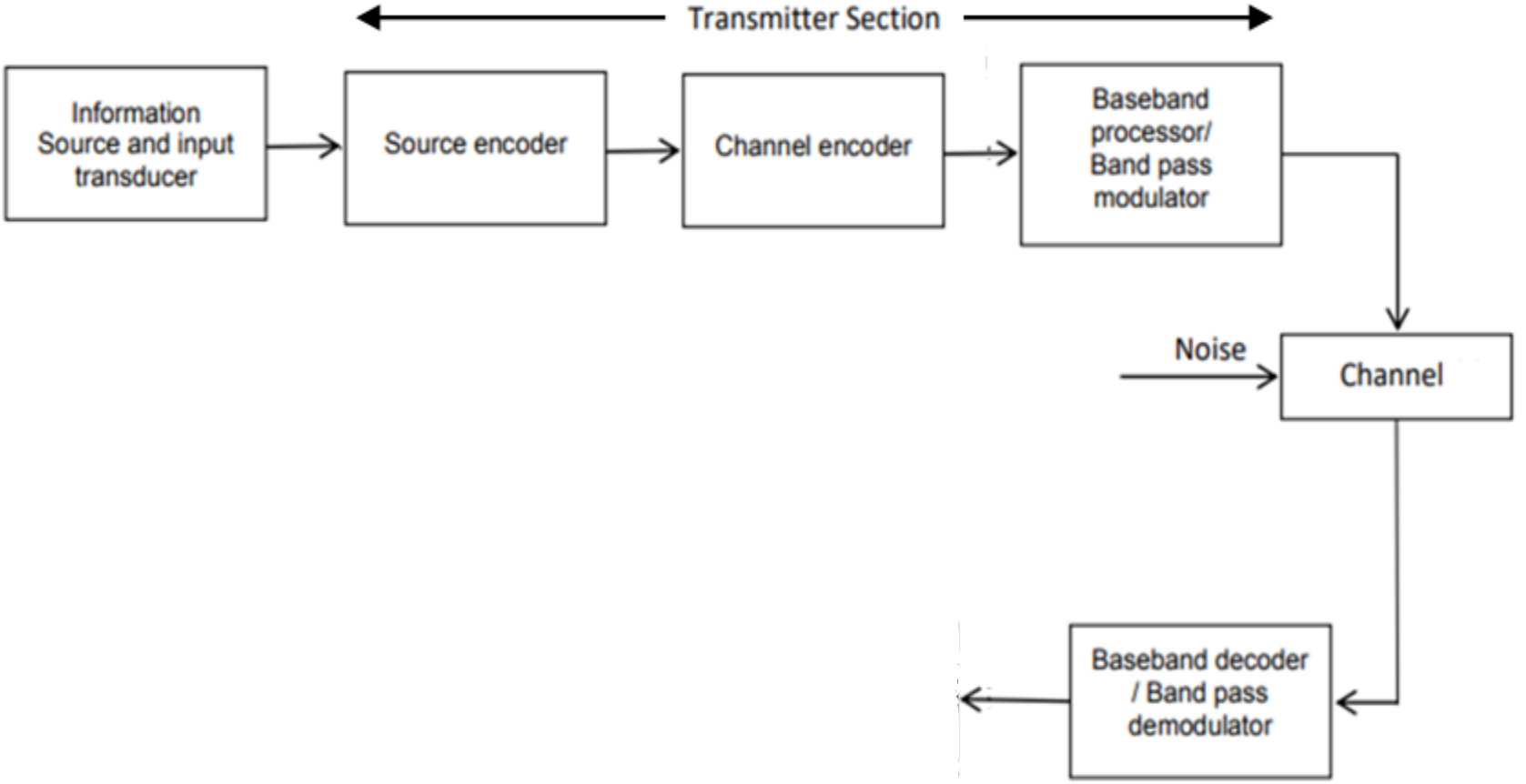

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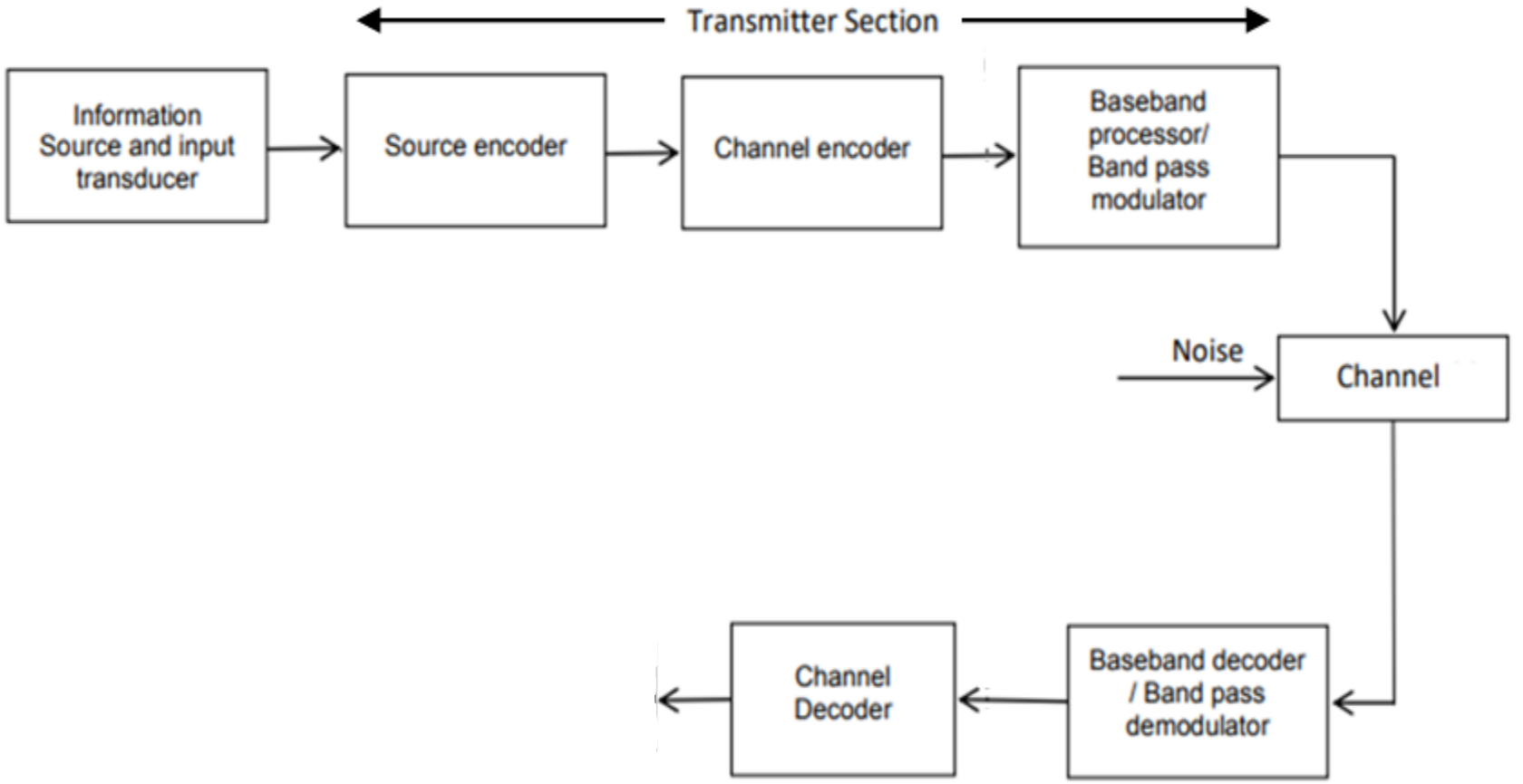

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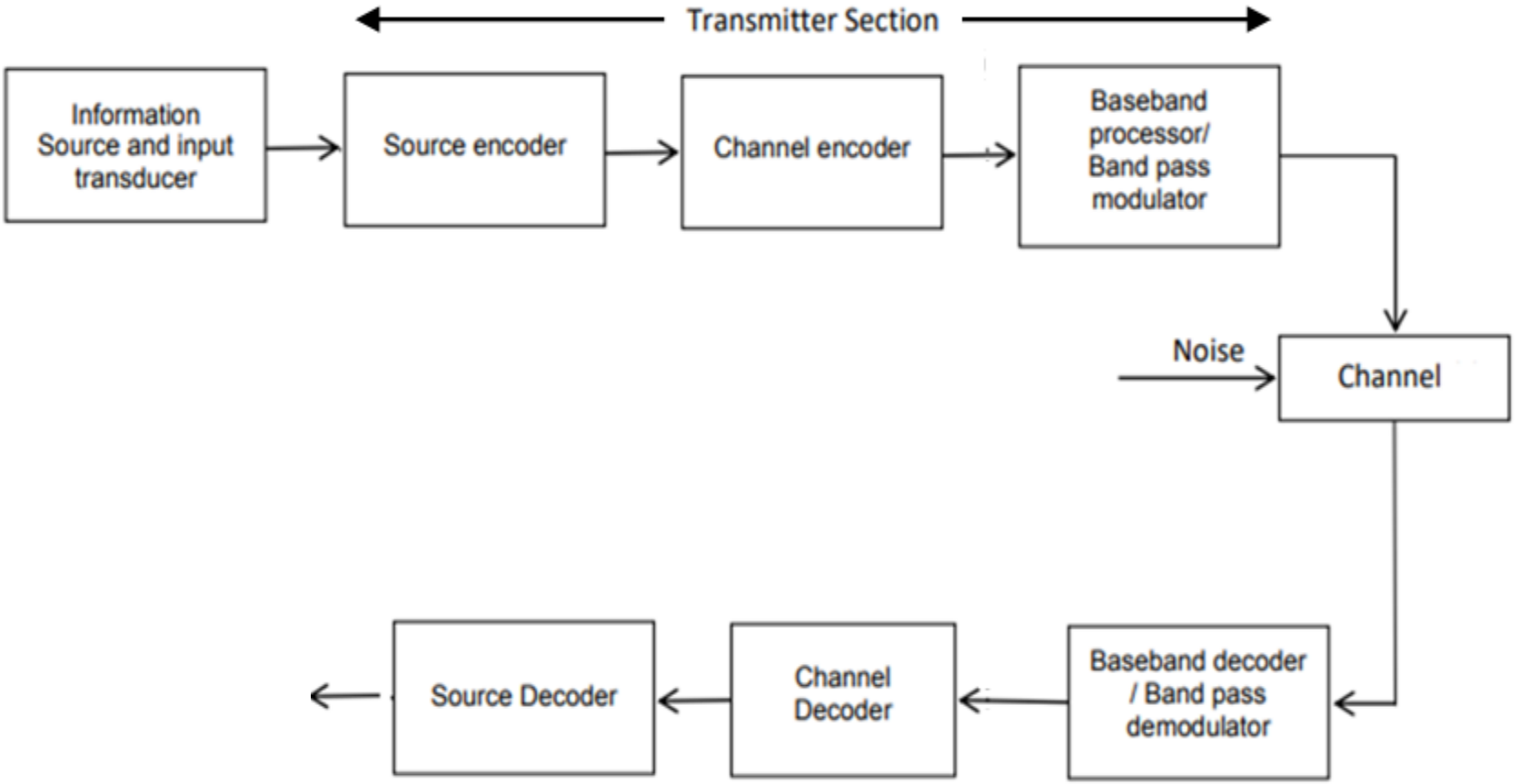

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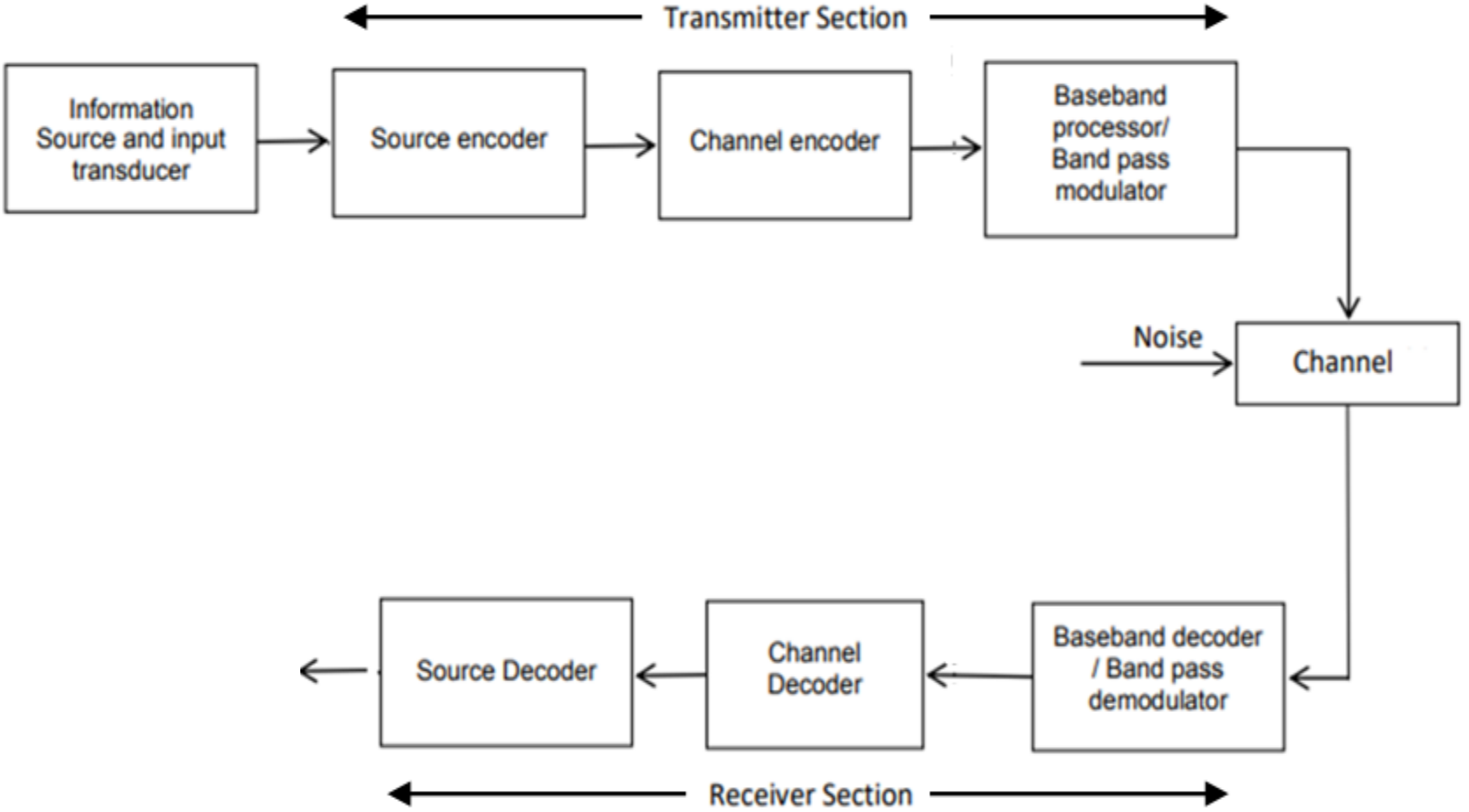

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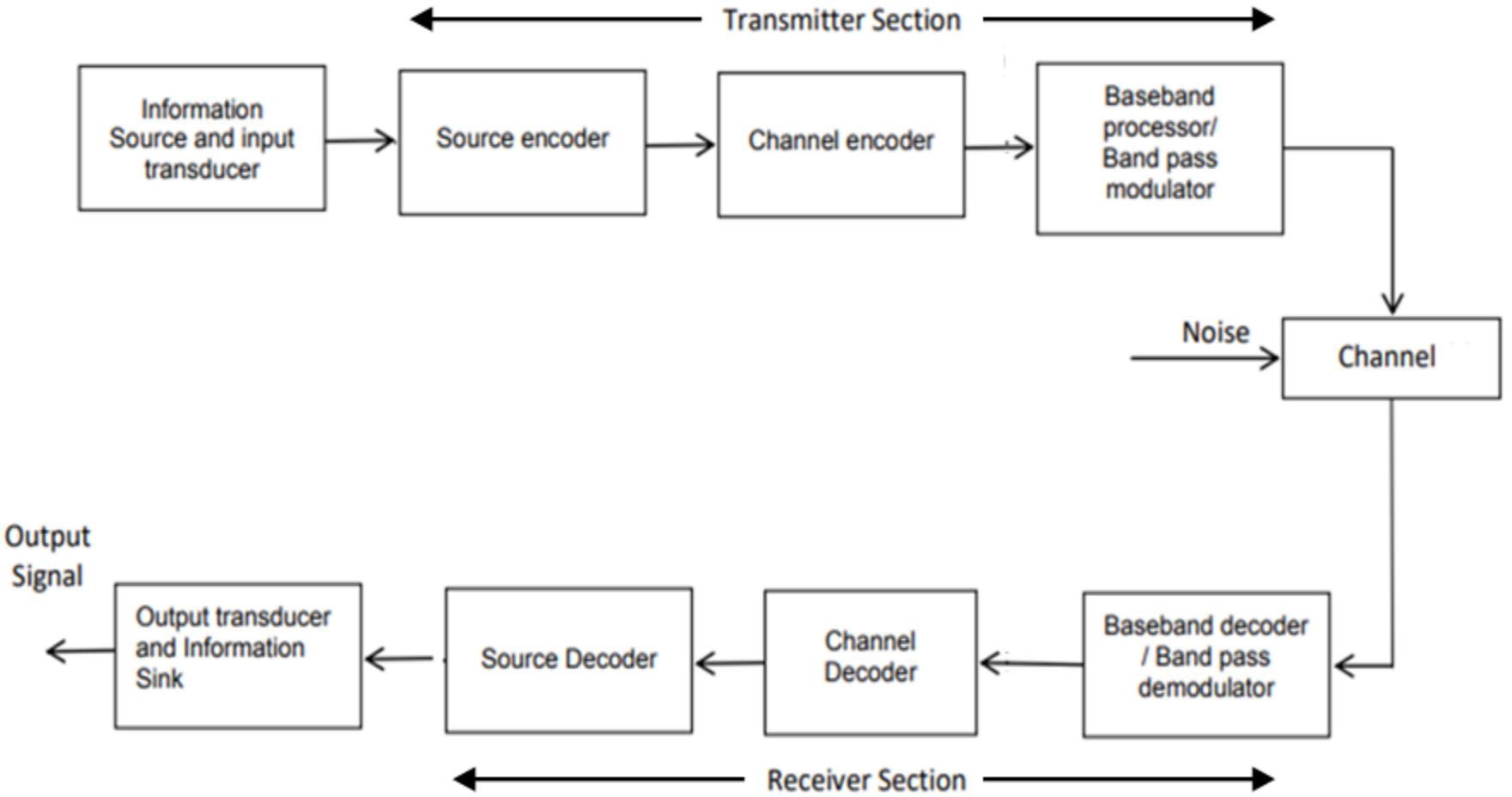


Advantages of Digital Communication Systems

- Hardware design and implementation of digital circuits more flexible, easy and cheaper than analog circuits
- Occurrence of cross-talk is very rare in digital communication
- Regenerative repeaters can be used at fixed distance along the link to identify and regenerate a pulse before it degrades to an ambiguous state
- Digital signals less affected by distortion, noise, and interference
- Signal processing functions such as encryption and compression employed to maintain the secrecy of the information and efficiency of the system
- *Probability of error* reduced by employing error detecting and error correcting codes. Hence, digital circuits are more reliable

Advantages of Digital Communication Systems

- Spread spectrum technique can be used to avoid signal jamming
- Combining digital signals using TDM is easier than combining analog signals using FDM
- Digital signals can be saved and retrieved more conveniently than analog signals
- Many of the digital circuits have almost common encoding techniques and hence similar devices can be used for a number of purposes

Limitations of Digital Communication Systems

- Quantization or sampling error occurs while conversion of signal from analog to discrete
- Needs synchronization
- Requires more bandwidth as compared to analog systems

Comparison of Analog and Digital Communication Systems

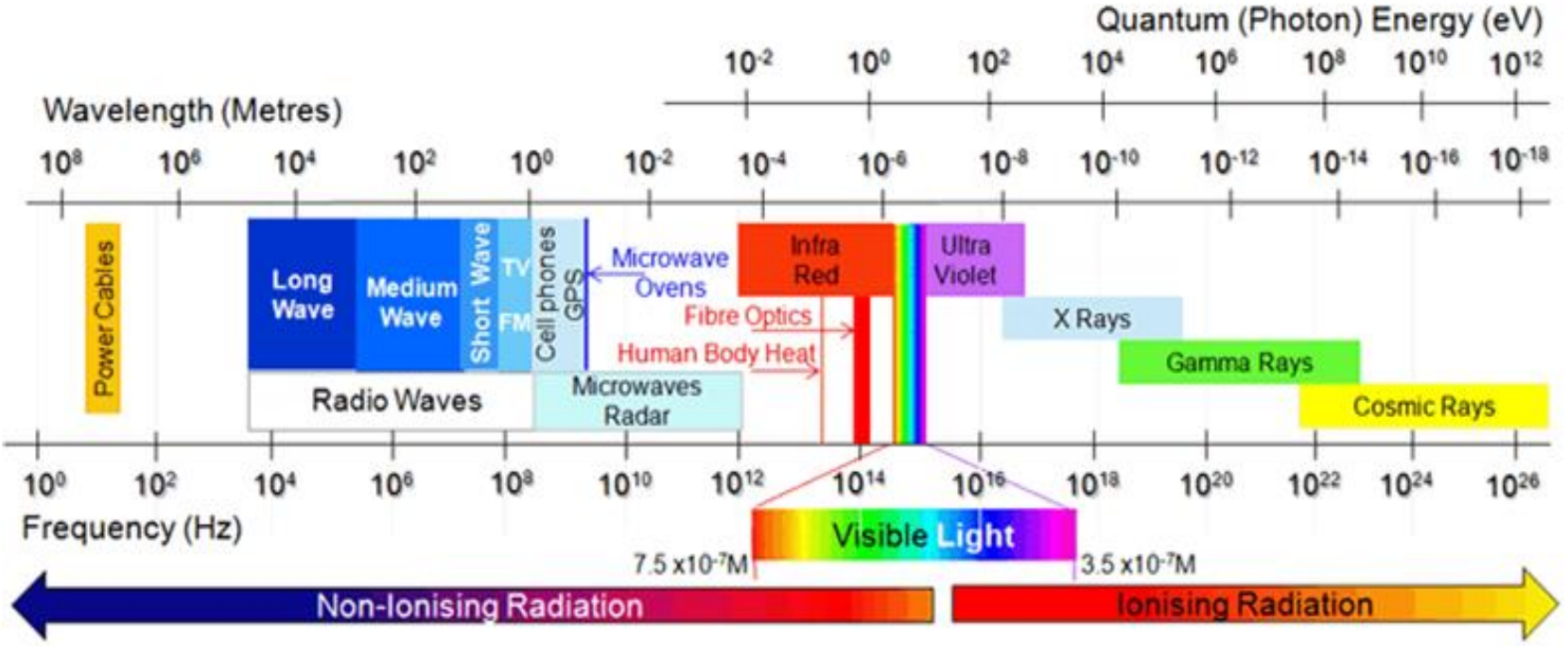
PARAMETERS	ANALOG COMMUNICATION	DIGITAL COMMUNICATION
Definition	Uses analog signal for transmission of information	Uses digital signal for transmission of information
Signal Values	Consists of continuous signals with varying magnitude	Consists of discrete signals as on/off representing binary format
Noise and Distortion	Get affected by Noise	Immune from Noise and Distortion
Error Probability	Error Probability is high	Error Probability is low
Hardware	Complex and not flexible	Less complicated and very flexible
Cost	Low Cost	High Cost
Bandwidth Requirement	Low bandwidth requirement	High bandwidth requirement for the same information
Power Requirement	High power requirement	Low Power Requirement
Portability	Less portable as the components are heavy	More portable due to compact equipment
Modulation Used	Amplitude and Angle Modulation	PCM, DPCM, ASK, FSK, BPSK etc.

Module I

Lecture 4

- Electromagnetic Spectrum

Electromagnetic Spectrum



- **Radio Frequencies:** Upto 300 MHz (λ: upto 1m)
- **Microwave Frequencies:** 300 MHz - 300 GHz (λ: 1m - 1mm)
- **IR Frequencies:** 300 GHz - 430 THz (λ: 1mm - 700nm)

*https://www.mpoweruk.com/radio.htm

- **Licensed and Unlicensed bands**

- **Unlicensed Band: ISM Band** (Industrial, Scientific and Medical) - **2.4 GHz and 5.8 GHz**
  - Originally reserved for industrial, scientific and medical applications
  - However.. Now used more for short-range, low power wireless communications systems like cordless phones, WiFi, Bluetooth, NFC etc.

ITU-R Nomenclature

Frequency	Frequency Band	Application
30 Hz - 300 Hz	Extremely low frequency (ELF)	Power Transmission
300 Hz – 3 KHz	Voice frequency (LF)	Audio Applications
3 KHz - 30 KHz	Very Low Frequency (VLF)	Telegraphy, human range frequency, naval and military communication
30 KHz - 300 KHz	Low Frequency (LF)	Point to point, navigation, aeronautical applications
300 KHz - 3 MHz	Medium Frequency (MF)	AM radio broadcast, maritime/aeronautical mobile
3 MHz - 30 MHz	High Frequency (HF)	Shortwave Radio, Amateur and CB communication
30 MHz - 300 MHz	Very High Frequency (VHF)	TV broadcasting, FM radio
300 MHz - 3 GHz	Ultra High Frequency (UHF)	TV broadcasting, cellular phones
3 GHz - 30 GHz	Super High Frequency (SHF)	Satellite communication, Radar
30 GHz - 300 GHz	Extremely High Frequency (EHF)	Satellite, radar system, IR, UV, X-rays, Gamma Rays.

Older Nomenclature

Frequency band	Frequency range (GHz)
L band	1–2
S band	2–4
C band	4–8
X band	8–12
Ku band	12–18
K band	18–27
Ka band	27–40
V band	40–75
W band	75–110