Regulation and Policy in the Telecommunications Industry TM 612-WS

By Dr. Raziq Yaqub
dr.raziq@gmail.com

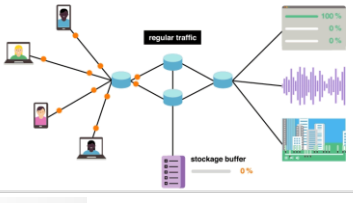
Lecture—02
Fundamentals of Telecommunications

Contents

What is Telecommunications?

Telecommunication

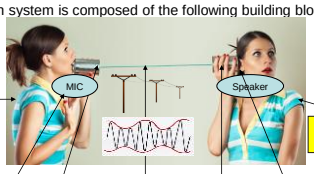
- **Telecommunication**
  - Transmission of information over a distance
  - Transmission my be Wireline or Wireless
- **Telecommunication Network**
  - Combination of Routers, Servers, and other network equipment

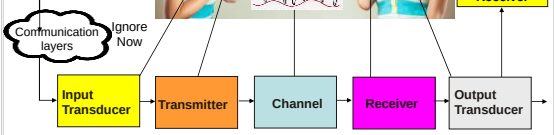


Building Blocks of Telecommunication System

Building Blocks of Telecommunication Systems

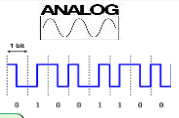
- **What are the components/blocks of a communication system?**
  - Communication system is composed of the following building blocks:

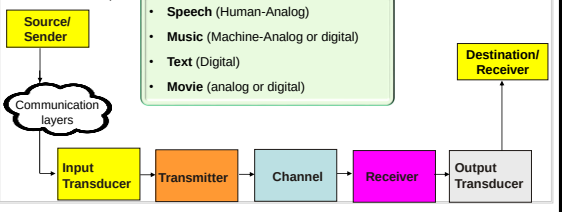




Source

- **Source may be**
  - Human, Machine, Computers
  - Source may produce Analog or Digital signals
    - Examples:
      - **Speech** (Human-Analog)
      - **Music** (Machine-Analog or digital)
      - **Text** (Digital)
      - **Movie** (analog or digital)

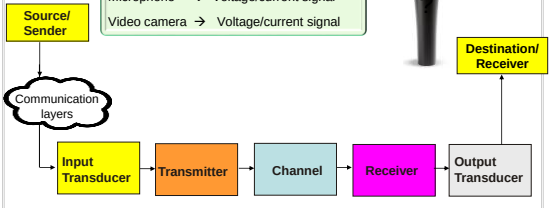




Input Transducer

- **Input Transducer:**
  - **Converts physical quantity** *(e.g. pressure, sound wave, temperature or brightness)*, **to electrical signal, voltage or current**

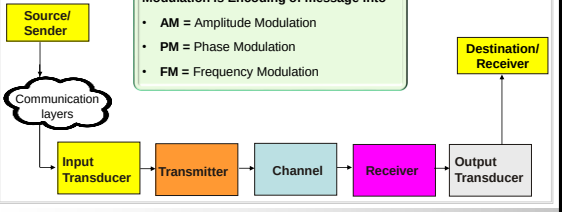
Example:
Microphone → Voltage/current signal
Video camera → Voltage/current signal



Transmitter

- **Transmitter Couples the message to the channel**
- **Performs 2 Functions:**
  - 1. Modulation
  - 2. A/D and D/A Conversion

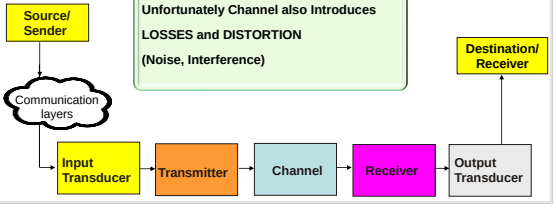
Modulation is Encoding of message into
- **AM =** Amplitude Modulation
- **PM =** Phase Modulation
- **FM =** Frequency Modulation



Channel

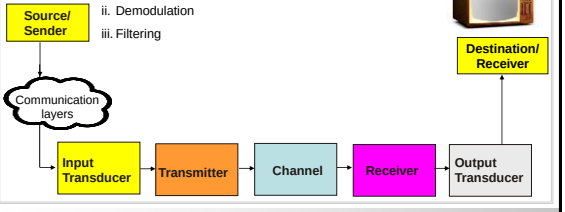
- **Physical medium that carries the signals**
  - Examples:
    - Wireless (i.e. Radio Wave, Laser Beam)
    - Wire-Line (i.e. Cupper, Coaxial Cable, Fiber Optic Cable)

Unfortunately Channel also Introduces LOSSES and DISTORTION (Noise, Interference)



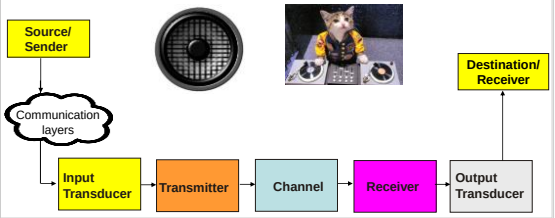
Receiver

- **Functions**
  - Receives signal from the channel
  - Extracts message from the received signal
  - Reconstructs the weakened/distorted signal, through:
    - i. Amplification
    - ii. Demodulation
    - iii. Filtering



Output Transducer

- **Converts electrical signal into the form desired by the system**
- **Examples:**
  - Loudspeakers
  - PC



Types of Electronic Communication

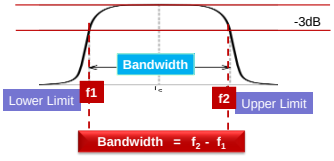
- **Simplex**
  - One way communication
    - E.g. Radio, TV Broadcast

- **Full Duplex**
  - Two way communication
    - E.g. Phone

- **Half Duplex**
  - Two way communication
  - One party transmits at a time
    - e.g. Walkie Talkie

Channel Bandwidth (B)

- **Channel Bandwidth (B)**
  - Is the RANGE of frequencies required to transmit the desired information
  - OR: Is the difference between the upper and the lower frequency limits



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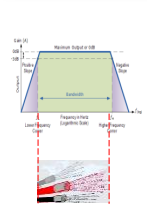
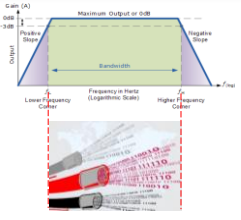
Channel Bandwidth

- **According to Shannon**

Maximum data rate for a communication channel is specified by:
(a) The Bandwidth, and (b) The presence of Noise



Less bandwidth less data can be transmitted



More bandwidth more data can be transmitted

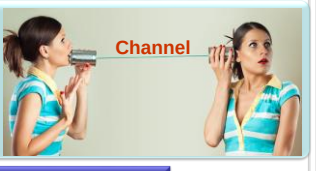
Interference and Channel Losses/Noise

Dr. Raziq Yaqub

Channel Loss

- **Is the loss of signal while it propagates from Source to Destination**
  - Channel losses are due to:

1. Attenuation
2. Nonlinearity
3. Sharing of medium
4. Interference (Noise)



Let's see these losses one by one

1. Attenuation

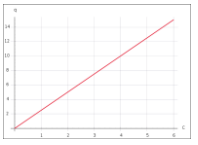
- **Signal degradation due to:**
  - Distance (attenuation proportional to square of distance between Tx & Rx)
  - Multiple transmission paths (Multipath)
  - Frequency Selective Fading (Media acts as a low pass filter and distorts signal)

1. Distance | 2. Multipath | 3. Frequency Selective Fading

2. Losses due to Nonlinearity

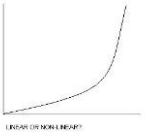
- **Electronic components (e.g. amplifier, diodes) are not perfect**
  - There behavior may be nonlinear
  - Nonlinearity introduces losses

Linear



Any Example?

Non Linear



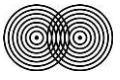
Any Example?

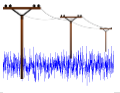
3. Losses due to sharing of medium

Data speed reduces if more users share the Wi-Fi

4. Losses due to Interference

- **What is Interference?**
  - Signals not related to the Information
- **Interference May**
  - Prevent reception altogether
  - Cause only a temporary loss of a signal
  - Affect the quality of the sound or picture produced by the equipment
  - Occur in copper as a result of electromagnetic interference (Cross talk)
  - Occur in optical fiber as a result of distortions of the light
  - Occurs in wireless due to several reasons (other frequencies, multipath, etc.)

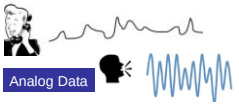




Analog Vs. Digital Communication

Digital Transmission of Data

- **Data (or Information) may be Analog, Or Digital**



Analog Data

Digital Data

DATA IS ANALOG if generated by

Human (voice)

Analog Devices (e.g. Video Cassette Recorder-VCR) etc.

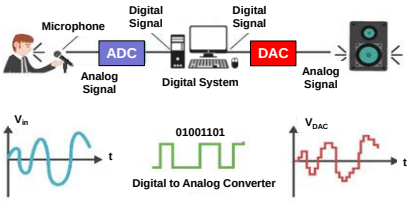
DATA IS DIGITAL if generated by:

Computer

Digital instruments

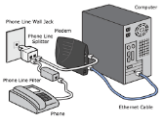
Analog to Digital Conversion

ANALOG DATA can be converted into DIGITAL DATA



Prevalent of Digital Transmission

- **Past of Data Communication**
  - Used for ***"Computer to Computer"*** communication
    - E.g. LANs, WLANS
  - Also, used for ***"Analog Telephone Lines"*** but by using MODEMS



- **Present of Data Communication**
  - Not limited to "Computer to Computer" communication anymore
  - Even analog data/signals use Digital Communication techniques
  - Because cheaper ways of A/D and D/A conversion availabl
  - Any Example?

Primary Reasons for Growth of Digital Communication

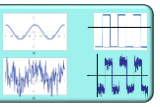
Primary Reasons

1. Proliferation of computers

Computers have made digital communication necessary (File transfer, e-mail, Internet access. LANs)

2. Noise Immunity

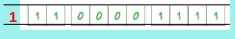
Noise can be easily treated in Digital (via signal regeneration) for digital signals, whereas it cannot be treated easily in analog (that require amplification)



Primary Reasons (Contd.)

3. Error Detection & Correction

Errors can be detected & corrected easily



e.g. for even no. of Ones, the last bit is 1

4. Digital ICs

Smaller and easier to make
Provide greater processing capability
Thus cheaper than Analog Communication

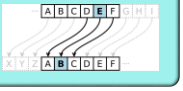
Primary Reasons (Contd.)

5. Easy to Save

Can be saved/retrieved easily compared to analog

6. Easy to Secure

Encryption/Decryption of Digital data is easier



Telecommunication Networks Convergence

Convergence

- **Also known as:**
  - Technological Convergence, Digital Convergence, Network Convergence

Integration or unification of diverse and unrelated technologies

e.g. GPS, Telephone, TV, Radio, Watch, Camera, Calculator, began as separate and unrelated technologies, but have converged into interrelated parts of a telecommunication sharing elements of digital electronics and software

Convergence

- **Digital Convergence**
  - Convergence of following four into one
    - Information Technologies (IT)
    - Telecommunication (Telephone)
    - Consumer Electronics (TV, Radio, Camera, etc.)
    - Entertainment (Video)
- **Network convergence (aka Telecommunications convergence)**
  - Radio broadcast service
  - TV broadcast service
  - Internet service
  - GPS/Satellite Communication
  - Telecommunication Networks

Chapter Review Questions (CRQ)

Chapter-02

CRQ 1

- **Input Transducer is a device that**

A. Converts variations in a physical quantity, such as pressure or brightness, into an electrical signal

B. Converts variations in a physical quantity, such as pressure or brightness, into Noise

C. Converts electrical signal into EMF (Electro-Motive Force)

D. None of above

CRQ #2

- **Pick the most accurate statement**
- **Any Telecommunication Network is composed of:**

A. At least 3 KEY blocks i.e., (Transmitter, Channel, and Receiver)

B. 3 fundamental components i.e., (Frequency, Attenuation, and Wavelength)

C. Simplex, Duplex, and Half Duplex

D. Both A and B

CRQ #3

- **Some of the Channel Losses are**
  - A. Application Layer Losses
  - B. Attenuation loss, logical loss, and multiplexing loss
  - C. Loss due to Propagation, Loss due to nonlinearity and Loss due to noise
  - D. Paging loss, time loss, Error Correction Loss

CRQ #4

- **Pick the correct statement**
  - A. Simplex is defined as simple way of communication as voice in GSM system
  - B. Full Duplex is defined as two way authentication (i.e. networks authenticates the user and user authenticates the network)
  - C. Half Duplex is defined as half way communication (e.g. from mobile to base station only)
  - D. None of above is correct

CRQ#5

- **Main functions of a receiver are**
  - A. Amplification, Demodulation, Filtering
  - B. Attenuation, Modulation, multiplexing
  - C. Handover, enhancing QoS, and enhancing security
  - D. None of above

Answers to CRQ

CRQ 1

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A: At least 3 KEY blocks (Transmitter, Channel, and Receiver)

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A: Amplification, Demodulation, Filtering

Home Assignment

Chapter-02

- **Q1.**
  - Define Simplex, Duplex and Half Duplex. Give at least one example to explain these terms.
- **Q2.**
  - What are the Building Blocks of a Telecommunication System? Provide one line explanation of each block.
- **Q3.**
  - What are the Primary Reasons for Growth of Digital Communication. Give at least 6 reasons.