



Introduction

Overview of the Advance of Wireless Technology

Example : Global cellular network

- Started as a replacement to the wired telephone
- Early generations offered voice and limited data
- Current third and fourth generation systems
 - Voice
 - Texting
 - Social networking
 - Mobile apps
 - Mobile Web
 - Mobile commerce
 - Video streaming
- Growth
 - 11 million users in 1990
 - Over 7 billion today
- Mobile devices
 - Convenient
 - Location aware
 - Only economical form of communications in some places

Example :

Satellite Communication Services

- Provide the backbone infrastructure for underlying communication services.
- In communication system, satellite is essentially a radio wave repeater, that is deployed in aerospace
- In navigation system, a set of satellite provides positioning service : GPS, GLONASS



Satellite
transceiver
station



Satellite telephone

Transceiver
station



Example :

Satellite Communication Services

- Fixed Satellite Service
 - Point to point communication between satellite terminal at specific fixed points around the globe
 - Make use of geostationary satellite
- Broadcast Satellite Service
 - Point to multipoint
 - Intended for direct reception by the general public
- Mobile Satellite Service
 - Provide wireless communication around the globe

Example :

Wireless Technology in Navigation

- In maritime transportation
 - Very High Frequency (VHF) radio with Digital Selective Channel
 - Global Maritime Distress Safety System
 - VHF Radio, Inmarsat, NAVTEX, INMARSAT
 - Automatic Identification System (AIS)
- In aviation
 - HF and VHF radio
 - VHF Omni Directional Radio Range (VOR) with DME (Distance Measuring Equipment) and Instrument Landing System
- In navigation :
 - GPS, weather radar

Wireless Technology in Communication : Future Trend

- Machine-to-machine communications
 - 100-fold increase in the number of devices
 - Type of communication would involve many short messages
 - Control applications will have real-time delay requirements
 - Much more stringent than for human interaction
 - Much more stringent than for human interaction
- Future networks
 - 1000-fold increase in data traffic by 2020
 - 5G – Not defined but envisioned by 2020

Wireless Technology in Communication : Future Trend

- LTE-Advanced and gigabit Wi-Fi now being deployed
- Machine-to-machine communications
 - The “Internet of Things”, Devices interact with each other
 - Healthcare, disaster recovery, energy savings, security and surveillance, environmental awareness, education, manufacturing, and many others
 - Information dissemination
- Data mining and decision support
 - Automated adaptation and control
- Home sensors collaborate with home appliances, HVAC systems, lighting systems, electric vehicle charging stations, and utility companies.
 - Eventually could interact in their own forms of social networking



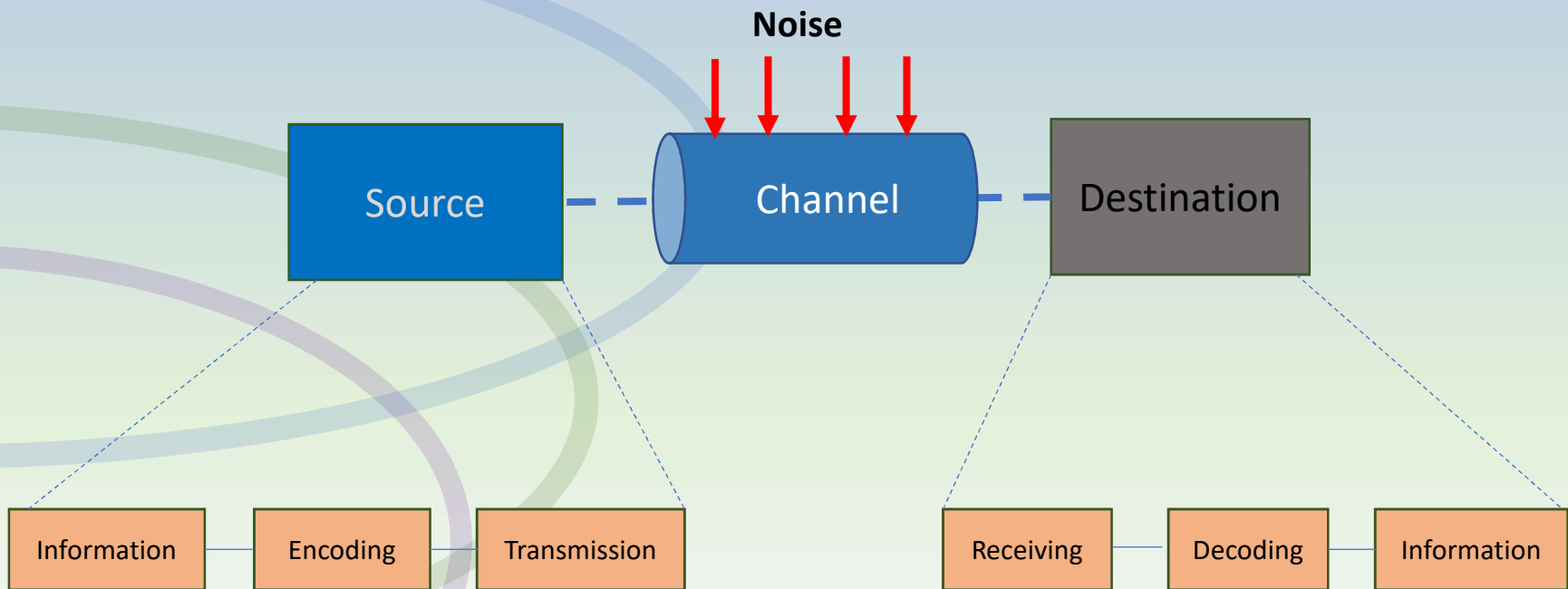
FUNDAMENTAL :
Essential Concepts in
Communication and Network

Communication and Networking

- Data Communication : transmission of information in a reliable and efficient manner from origin endpoint to destination endpoint.
- Networking : Interconnecting communicating devices.
- To the context of the class, interconnection between communicating devices takes place wirelessly using radio-wave

Block Diagram of Communication Process

- Tasks during communication process

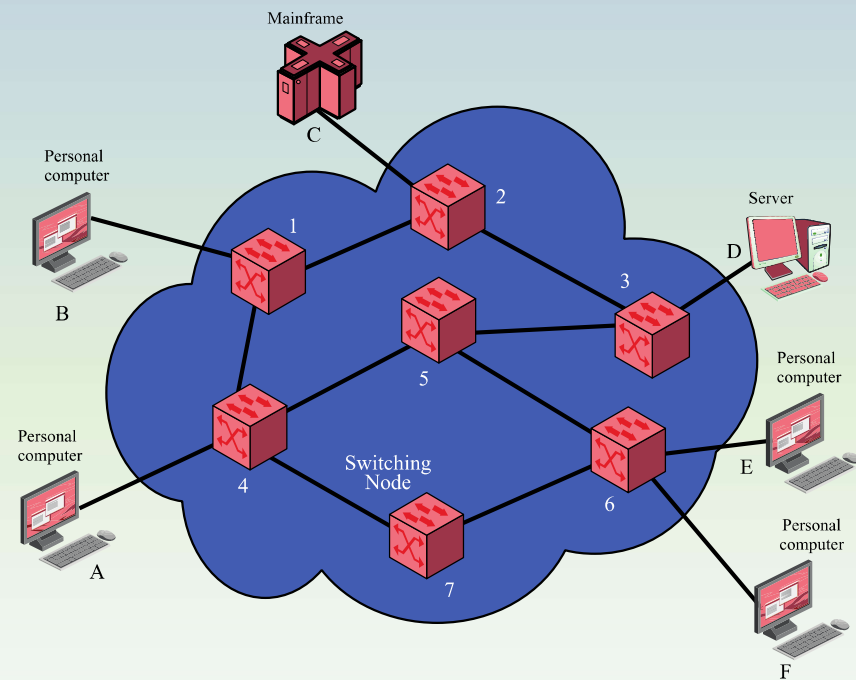


Communication Task

- Information : Meaningful stream of data
- Encoding : Transform the information into another format that would be needed :
 - To comply with subsequent process of information
 - To enhance the feature of the information
 - Error checking and correction
 - To reduce the size of the information
 - To security purpose
- Decoding : Reverse process of encoding
- Transmission : Putting the information into channel
- Receiving : Capturing the information from the channel

Communication Network

- Based on its geographic extent and scope, communication network can be seen as, local, metropolitan, and wide area network (abbreviated as LAN, MAN, and WAN respectively)
- When a transmission of data is needed beyond the scope of local area, data would traverse through a network of intermediate switching devices
 - Switching devices are not concerned with the content of the data
 - These devices in communication are also referred to as nodes
 - Collection of nodes forms a network



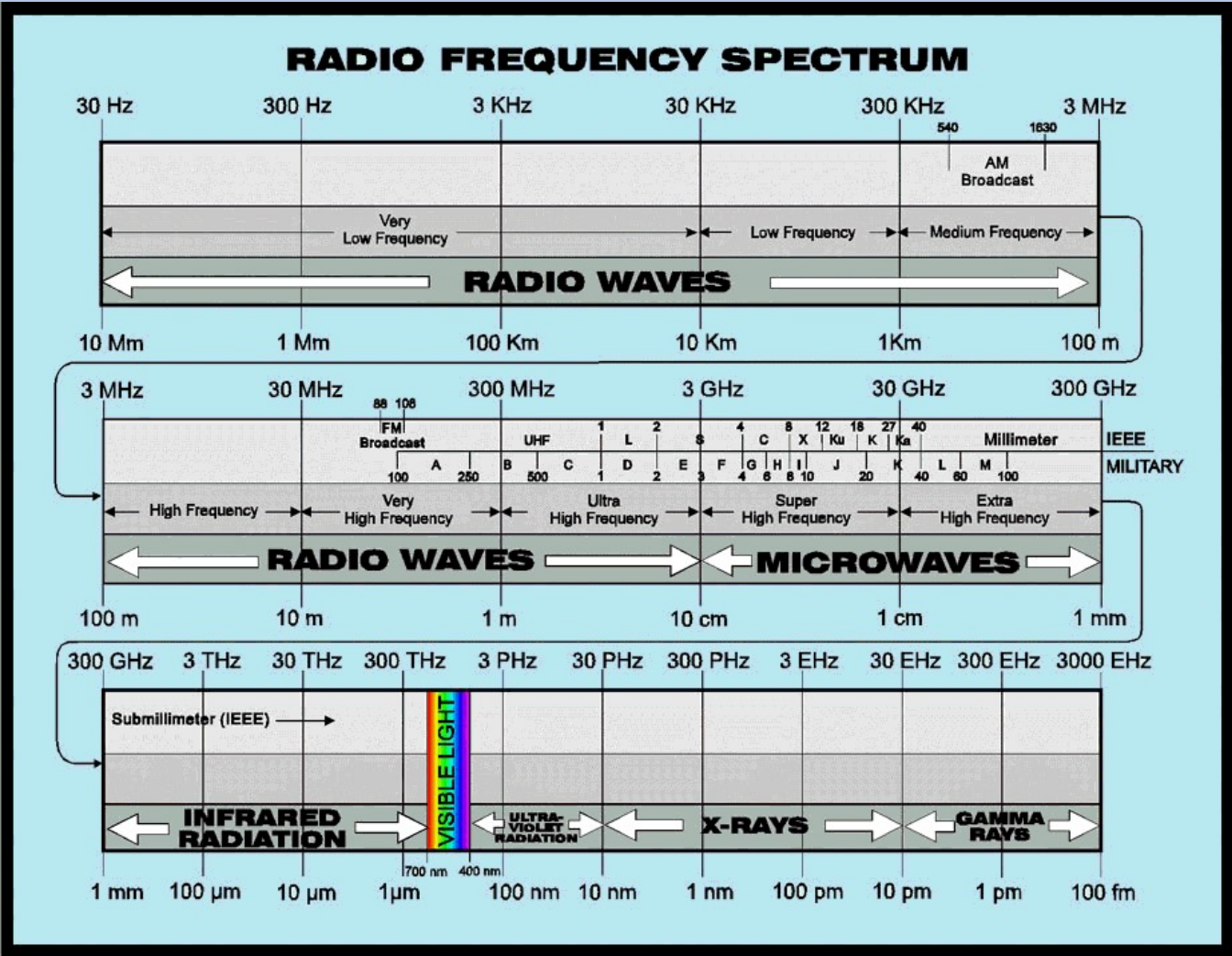


FUNDAMENTAL :
Wireless Channel at Glance

Wireless Media : Electromagnetic Wave

- The most viable, widely use media for wireless transmission in this world. Also commonly being called as radio wave
- Electric field+ Magnetic Field = Electromagnetic wave
 - Not an invention or investigation by a single person/scientist
 - Some of them are : Michael Faraday, H.C Oersted, Joseph Henry, Ampere
 - Magnetic field and electric field have strong correlation in nature.
- However, J.C Maxwell is the profound scientist who built theoretical basis for electromagnetic wave on 1873
 - Known as Maxwell equations

Radio Frequency Spectrum



Radio Frequency Spectrum

- For the purpose of this class, electromagnetic wave can be illustrated as an oscillating magnitude of electric and magnetic field radiated from the source
- Oscillating → Cycles per unit time, or Hz
- General Range Classification :
 - Microwave frequency range
 - 1 GHz to 40 GHz
 - Directional beams possible
 - Suitable for point-to-point transmission
 - Used for satellite communications
 - Radio frequency range
 - 30 MHz to 1 GHz
 - Suitable for omnidirectional applications
 - Infrared frequency range
 - Roughly, 3×10^{11} to 2×10^{14} Hz
 - Useful in local point-to-point multipoint applications within confined areas

Challenges in Wireless Communication

- Wireless is convenient and less expensive, but not perfect
- Limitations and political and technical difficulties inhibit wireless technologies
- Wireless channel
 - Line-of-sight is best but not required
 - Signals can still be received
- Transmission through objects
- Reflections off of objects
- Scattering of signals
- Diffraction around edges of objects

Challenges in Wireless Communication

- Wireless channel Impairment
 - Reflections can cause multiple copies of the signal to arrive
 - At different times and attenuations
 - Creates the problem of multipath fading
 - Signals add together to degrade the final signal
 - Noise
 - Signals and noise also add together to degrade the final signal
 - Doppler spread caused by movement
 - Movement can cause frequency shift at receiver
 - Now, as wireless network become highly dense, frequency spectrum allocation turns out to be an issue

FUNDAMENTAL :

Communication Transmission

Learning Objectives :

- Distinguish between digital and analog information source
- Discuss the characteristics of analog and digital waveforms
- Roles of frequency and frequency component in a signal
- Identify the factors that affect channel capacity

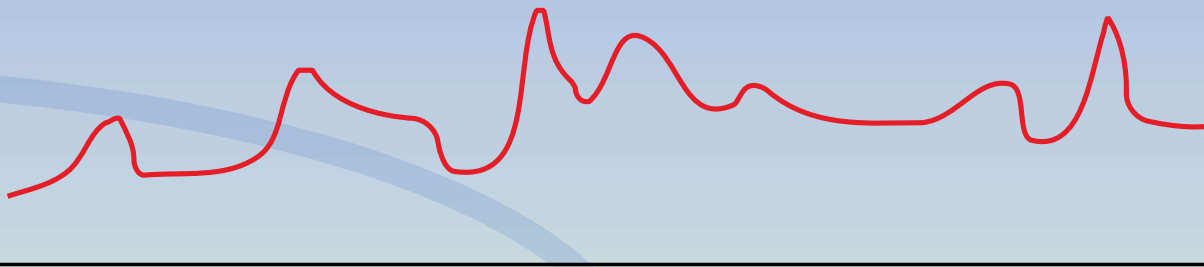
Signal

- Signal : Physical properties of transmission media as representation of data.
 - Data – a value that convey meaning, or information
- Analog signal - signal intensity varies in a smooth fashion over time and may be propagated over a variety of media,
 - No breaks or discontinuities in the signal
 - Examples of media:
 - Electric current through copper wire media (twisted pair and coaxial cable)
 - Light over fiber optic cable
 - Radio wave in atmosphere or space
 - In nature, electromagnetic wave is an analog signal
- Digital signal - signal intensity maintains a constant level for some period of time and then changes to another constant level
- Transmission - communication of data by the propagation and processing of signals

Signal

- Digital signal - signal intensity maintains a constant level for some period of time and then changes to another constant level
 - Less susceptible to noise interference
 - Suffer more from attenuation
- Transmission - communication of data by the propagation and processing of signals

Amplitude
(volts)



Time

(a) Analog

Amplitude
(volts)



Time

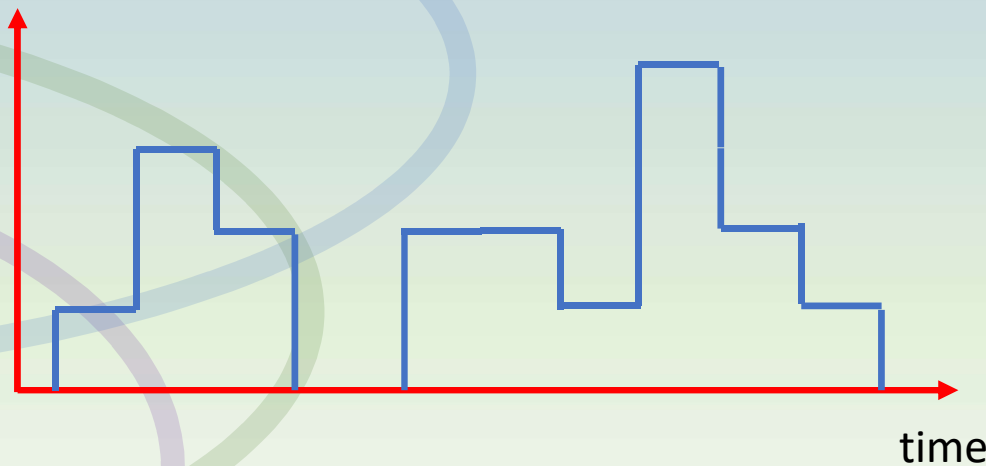
(b) Digital

Analog and Digital Waveforms of electric voltage

Signal

- Is it digital or analog signal?

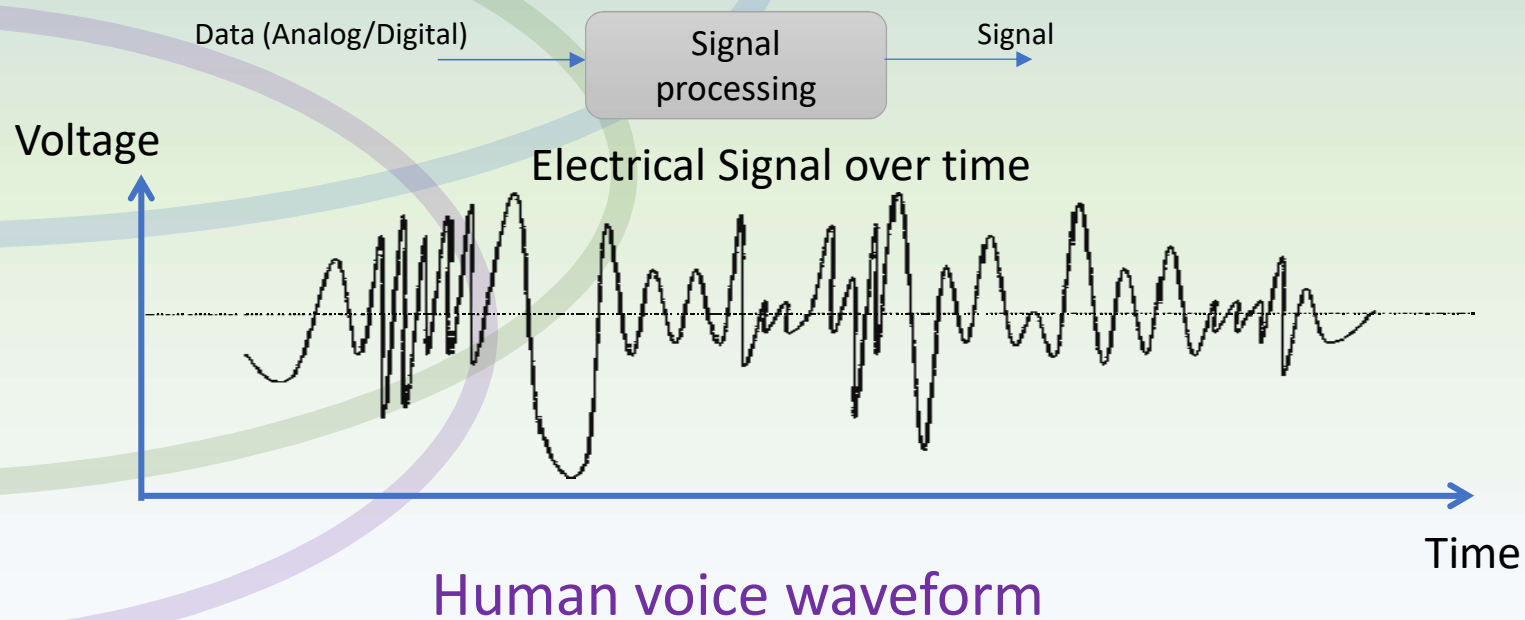
Magnitude



- This is a multilevel digital signal
- Unless otherwise mentioned, digital signal in this course refers to two level (binary) digital signal

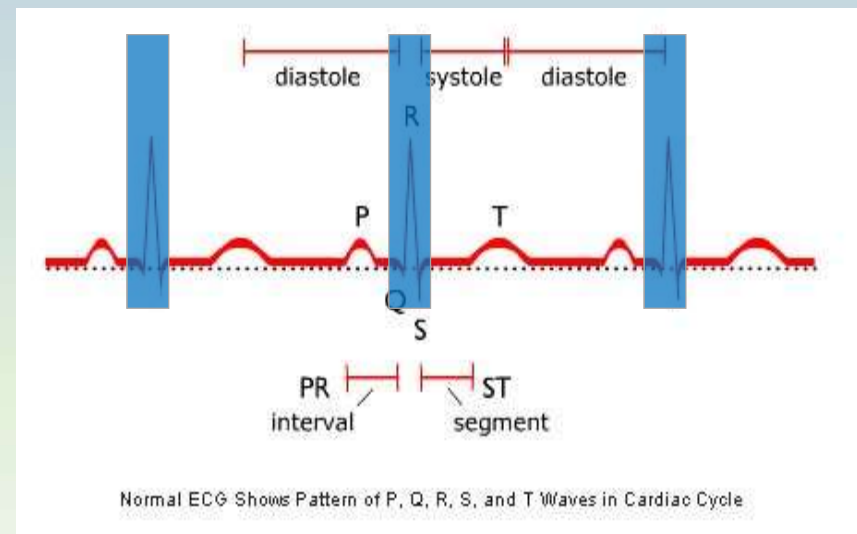
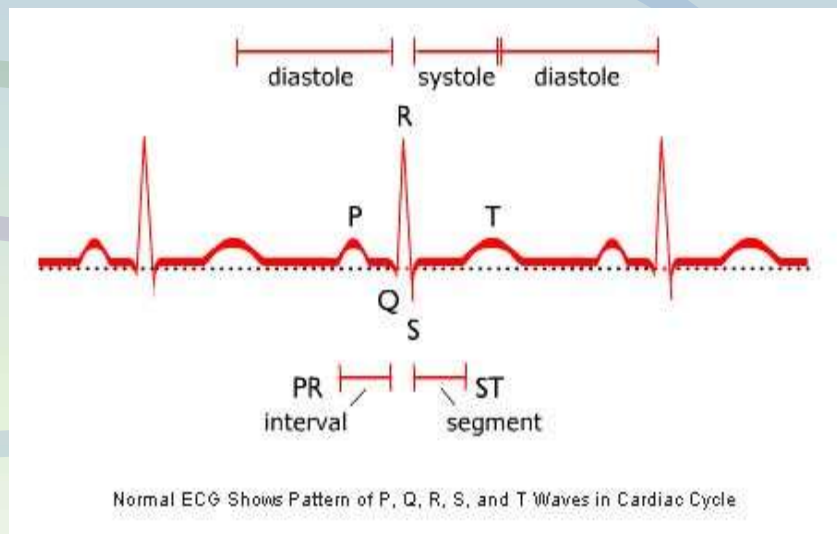
Data

- Analog data
 - Continuous values of a physical quantity in some interval of time : voice, video
- Digital data
 - Discrete values of a physical quantity over some interval of time



Data

- Human heart pulse wave form : Analog or digital data?



Signal and Data Combination

- Digital data, digital signal
 - Equipment for encoding is less expensive than digital-to-analog equipment
- Analog data, digital signal
 - Conversion permits use of modern digital transmission and switching equipment
- Digital data, analog signal
 - Some transmission media will only propagate analog signals
 - Examples include optical fiber and satellite
- Analog data, analog signal
 - Analog data easily converted to analog signal

Signal and Data Combination

