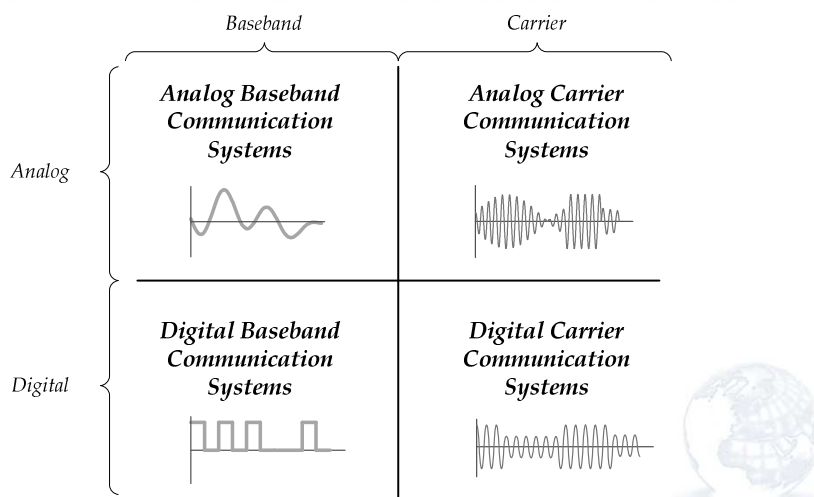


# Lecture 2: Classification of Communication Systems

Dr. Mohammed Hawa  
 Electrical Engineering Department  
 The University of Jordan

EE421: Communications I

Comm Systems are classified based on the type of signal sent on the Channel



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## Each system has its advantages!

### Analog Baseband

- **Simplest** system to build
- **Inexpensive**

### Analog Carrier

- Allows use of **Antennas**
- Allows **Multiplexing (FDM)**
- Allows **exchanging SNR for Bandwidth**

### Digital Baseband

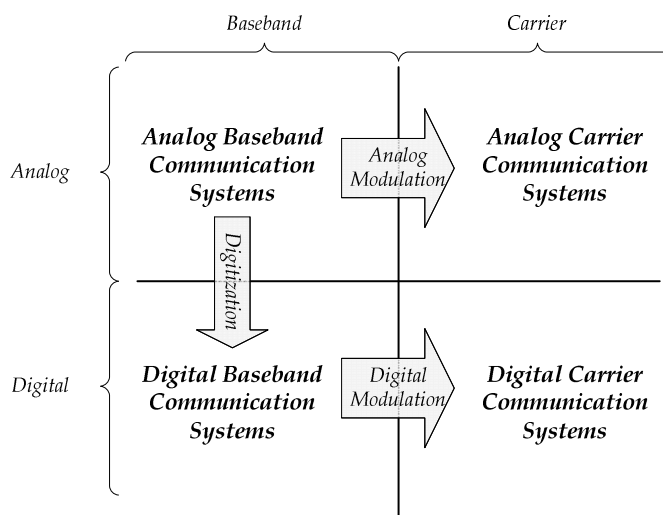
- **Immunity to Noise**
- Allows **Multiplexing at baseband level (TDM)**
- **More bandwidth efficient**
- Allows **exchanging SNR for Bandwidth**
- **For more, see Handout**

### Digital Carrier

- Allows use of **Antennas**
- Allows **Multiplexing (FDM)**
- Allows **exchanging SNR for Bandwidth**
- **Also the advantages of digital baseband**

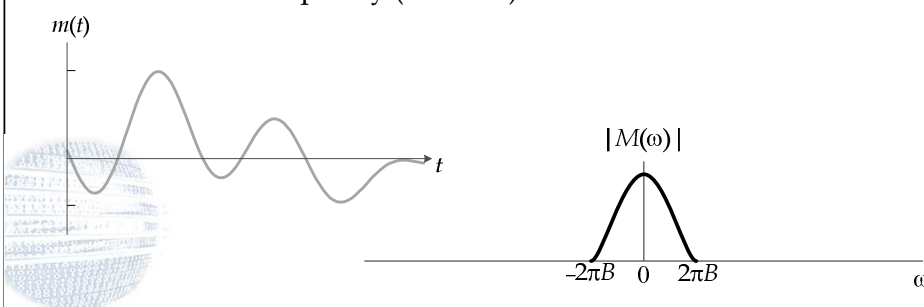


## Modulation and Digitization



## Analog Baseband Systems

- **Analog:**  $m(t)$  can assume **any** value in a continuous range of values at **any** point in time  $t$ .
- **Digital:**  $m(t)$  can assume only finite voltages or shapes and uses threshold detection.
- **Baseband:**  $m(t)$  has a frequency-domain spectrum clustered around zero frequency (the base).

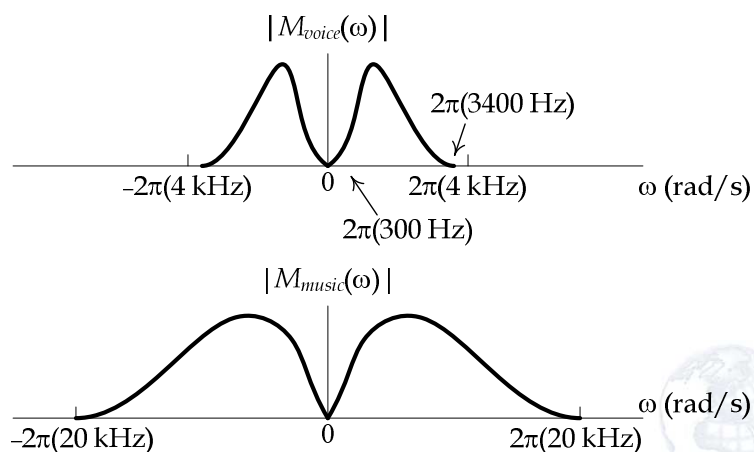


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## Examples: Audio

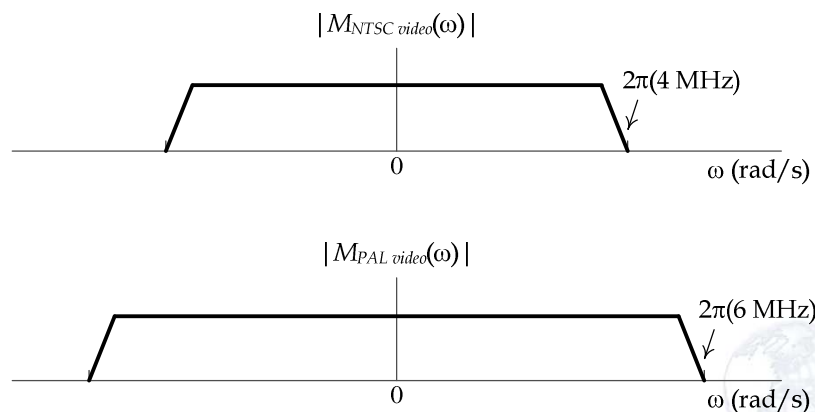


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## Examples: Video



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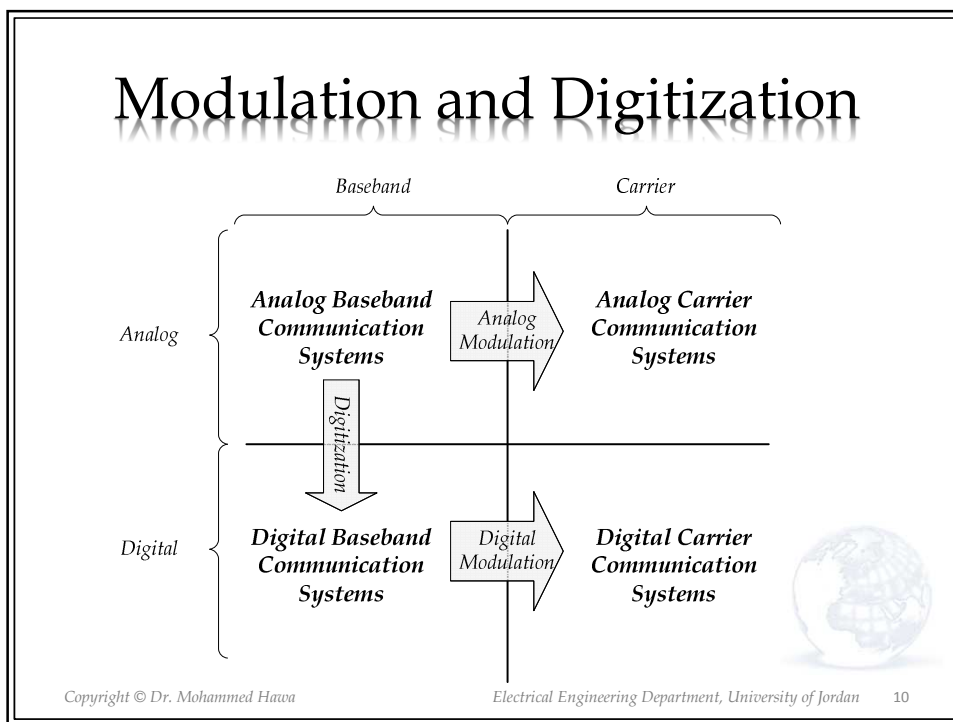
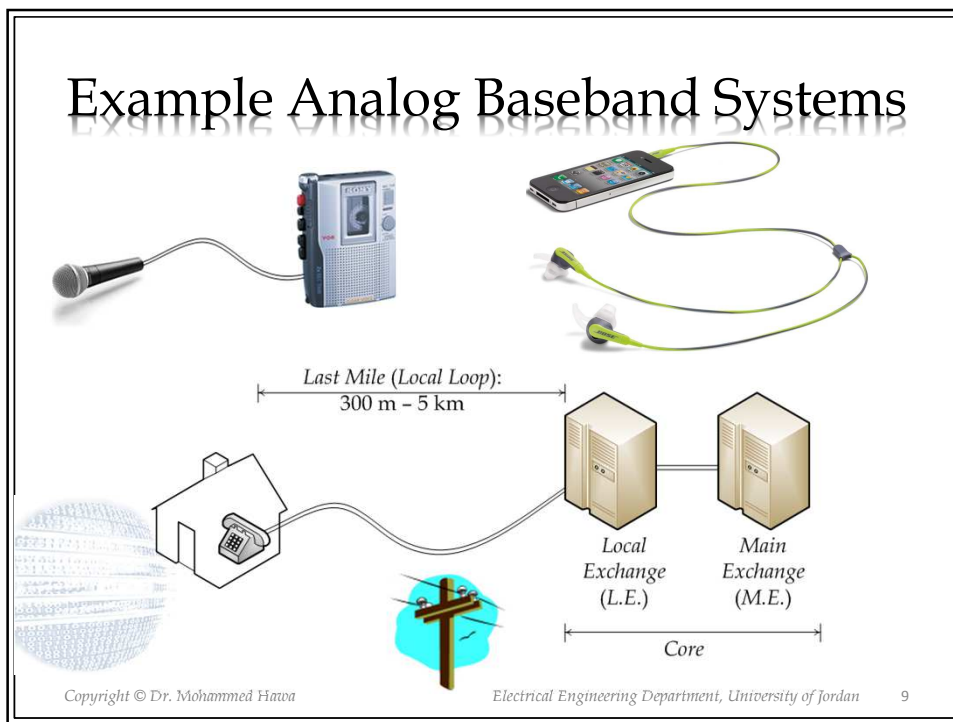
## Analog Baseband Systems

- An analog baseband system sends the analog baseband signal  $m(t)$  as is (without any modifications).
- Advantages:
  - Simplest possible system.
  - Inexpensive to build.
- Usually used for short-distance communications.
- Examples of such systems in the next slide.

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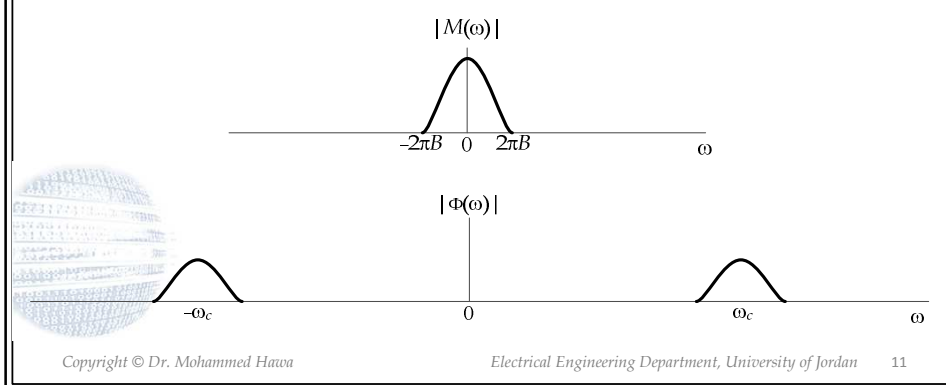
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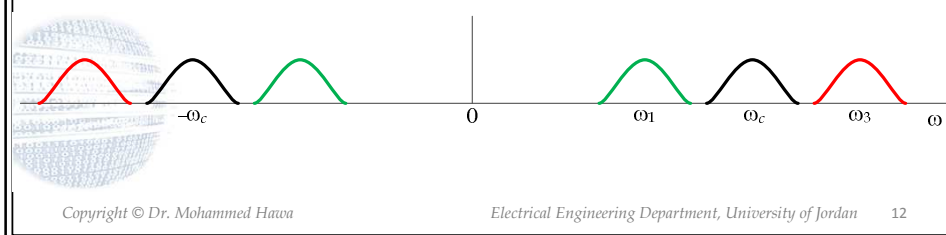
## Modulation

- In modulation, the signal  $m(t)$  is combined with a high-frequency signal called the carrier.
- Hence, frequencies are shifted.



## Analog and Digital Carrier Systems

- Modulation (i.e., analog and digital carrier systems) advantages:
  - Allows the use of reasonable antenna lengths.
  - Allows Multiplexing (FDM). As well as CDMA and OFDMA in digital systems.
  - Allows exchanging SNR for Bandwidth.

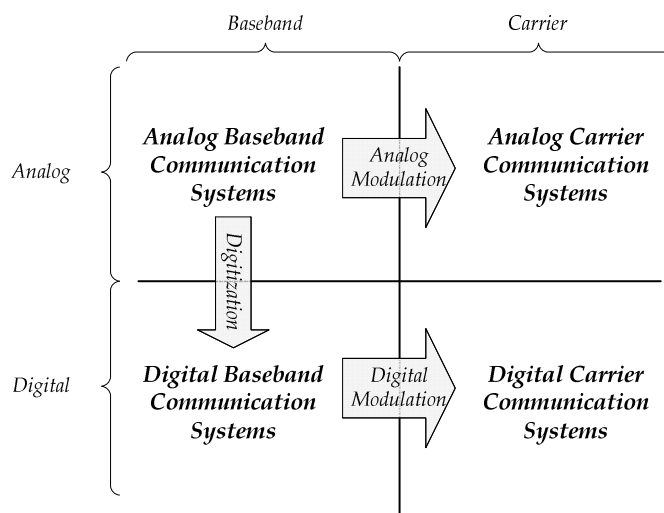


## Example Carrier Systems

- Examples of **analog carrier** systems:
  - AM and FM radio broadcasting.
  - Analog TV broadcasting (NTSC and PAL).
- Examples of **digital carrier** systems:
  - Digital radio broadcasting (DAB).
  - Digital TV broadcasting (DVB-S, DVB-T, ATSC)
  - WiMAX metropolitan area network.
  - Wi-Fi wireless local area network.
  - Cellular Telephony (2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> generations).
  - Bluetooth, Zigbee and NFC
  - Old dial-up modems.
  - ADSL modems.



## Modulation and Digitization



## Digitization

- To convert the analog baseband signal into a digital baseband signal :
  - Sampling.
  - Quantization.
  - Mapping.
  - Encoding (coding).
  - Pulse Shaping.
- Digital baseband Advantages:
  - Immunity to Noise.
  - Allows Multiplexing at baseband level (TDM).



## Example Digital Baseband Systems

- Digital baseband Advantages (*Continue*):
  - More bandwidth efficient (compression and line coding).
  - Allows exchanging SNR for Bandwidth at the baseband level.
  - For more, see Handout.
- Examples of digital baseband systems:
  - Serial (RS-232) and USB port connections.
  - Ethernet (a popular local area network).
  - Telephony (between local exchanges), such as the T-1, T-2, ..., E1, E2, ... etc PDH carriers.





# Block Diagram of a Communication System



*Impairments:  
Attenuation, Distortion,  
Noise, etc*



# Source and Destination

