
Instructor:
• Mohammed Taha O. El Astal
Wired and Wireless Comm.
# Wired and Wireless Comm.

<table>
<thead>
<tr>
<th>Medium</th>
<th>Wired Communications</th>
<th>Wireless Communications</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>• Well defined.</td>
<td>• Varies strongly with time</td>
</tr>
<tr>
<td></td>
<td>• Time –invariant</td>
<td>• Multipath propagation</td>
</tr>
<tr>
<td>Capacity</td>
<td>Can be increased by simply:</td>
<td>Can be increased by:</td>
</tr>
<tr>
<td></td>
<td>• Using another frequency without cost</td>
<td>• Using another frequency</td>
</tr>
<tr>
<td></td>
<td>• Using another cable.</td>
<td>• with additional cost</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Using more sophisticated</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• transceiver.</td>
</tr>
<tr>
<td>Range</td>
<td>Is limited by:</td>
<td>Is limited by:</td>
</tr>
<tr>
<td></td>
<td>• Attenuation of the medium</td>
<td>• Attenuation +fading + noise</td>
</tr>
<tr>
<td></td>
<td>• noise</td>
<td>• Requirement of spectral</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• efficiency (cell size)</td>
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</tbody>
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### Wired Communications vs. Wireless Communications

<table>
<thead>
<tr>
<th></th>
<th>Wired Communications</th>
<th>Wireless Communications</th>
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</thead>
<tbody>
<tr>
<td><strong>delay</strong></td>
<td>• Constant and depend on wire length</td>
<td>• Varying and partly depend on path length</td>
</tr>
</tbody>
</table>
| **Relation between SNR and BER** | • Log  
• Since there is just noise.                                                   | • Linear  
• Due to fading.                                             |
| **Energy Consumption** | • Is not one of major concern                                                        | • Is one of most important design factors                    |
2.1 Multipath Propagation

- Each path has a distinct amplitude, delay, direction of departure from TX. and direction of arrival, phase shift with respect to each other.
Line of Sight (LOS) is a term used to describe radio transmission across a path that is completely not obstructed.
2.1.1 Fading

- The receiver cannot distinguish between MPC, it simply adds them up.
- Low Signal Amplitude (power) → Low Transmission Quality → Low QOS.
- High Signal Amplitude (power) → High Transmission Quality → High QOS.
The phases of MOC depend on:

- run length of the path.
- position of MS.
- position of IOs.

Either if MS or IOs are moves or both, the Rx. signal amplitude will be changed.

At 2.4GHz, a 10cm movement can cause to change from constructive to destructive signal combining or vice versa.

At cellular, one step can cause to lost the signal or recover the signal
Fading: is deviation of the attenuation that a signal experiences over certain propagation media.

Small-scale Fading: refers to the fast changes in signal amplitude and phase that can be experienced as a result of small changes (as small as half wavelength) in the spatial position between transmitter and receiver, and is frequency dependent.

Large-scale Fading: due to path loss of signal as a function of distance and shadowing by large objects. This occurs as the mobile moves through a large distance, and is typically frequency independent.
CONT.

Non Fading Environment

Fading Environment
2.1.2 Intersymbol Interference

**ISI**: is a form of distortion of a signal in which one symbol interferes with subsequent symbols.
2.1.2 Intersymbol Interference

- ISI is essentially determined by the ratio between symbol duration and the duration of impulse response of the channel.
- ISI cause irreducible errors which mean even if TX. power increased, the errors will be remain.
2.2 Spectrum limitations

- Since it is limited and regulated, it must be used in a highly efficient manner.
- ITU/UN, 3 annual conference,
- FCC-USA/MTIT-PS
- CB/Pager/Analog Cordless < 100MHz
- Radio/TV → 100-800MHz
- Some cellular & tracking radio → 400-500 MHz
- Several cellular → 800-1000 MHz
- ISM/WLAN/PAN/Microwave oven. → 2.4-2.5 GHz.
- Satellite TV → 11-15GHz (14-14.5 Uplink/11.7-12.2 downlink).
Important note:

Low frequencies propagate more easily than high frequencies.

So;

pager, FM, AM, … etc are very suitable to lower frequencies.

Is cellular systems also suitable for lower frequencies??
**Frequency reuse Concept**

- **Frequency reuse concept** come from fact that the signal power will be decay with the increasing in the distance.
- So, if we decrease power to specific level, we will can reuse the spectrum.
- **Interference Level must be acceptable to reuse the frequency** will be act as interference in the new location where the frequency reuse done.
Since it is a regulated band, the operator must have its own plan to have a minimum level of interference with a maximum level of frequencies reuse (max. # users)
2.2.3 Freq. reuse in unregulated spectrum

Unregulated Spectrum

- many services and many operators
  - i.e. WiFi/Bluetooth.
  - Have a strong interference from many operator and many services.
  - **Possible solution:**
    - Design a RX can face this interference, it is a complex process.
- one service but many operators
  - i.e. Cordless service.
  - Have a strong interference but its structure is known.
  - **Possible solution:**
    - Dynamic Frequency assignment.
    - Design a RX can face this well known interference, it is simple.
To have a small energy consumption systems:

- **PA in the TX.** have to have high eff. (larger than 50%, class C/Class F)
- **DSP** must be done in an energy saving manner (CMOS not ECL)
- **The RX. at BS.** need to have high sensitivity (-100dBm to -80dBm, cause 200g to 20Kg if same run time required)

To be W.Comm. (no power wire, rechargeable batteries) to have customer satisfaction.
2.4 User Mobility

- Mobility is an important required feature in W. COMM.
- This feature implies many technical challenges:
  - Complex physical layer design.
  - The need to have the location of MS. at any time.
  - The need to maintain the call.
- Cellular case study:
  - HLR: Home Location Registry.
  - VLR: Visitor Location Registry.
  - Hand Over mechanism.