

EE108 - Wireless Communications.

Lecture 1: Introduction

Wireless communications are present in many services:

- cellular telephone
- WLAN
- paging
- cordless phone
- broadcast
- sensor networks
- ad hoc networks
- body area networks
- smart devices & IOT
- home area networks.

These services have different requirements in terms of:

- data rate
- range and number of users
- mobility
- energy consumption
- use of spectrum
- quality of service: outage, latency.

However, they share a common set of technical challenges:

- multipath propagation and fading
- limited spectrum
- limited power/energy
- user mobility
- noise and interference.

This course provides the theory of wireless communications.

- understanding wireless propagation and channel models
- examine the capacity of wireless communications.
- study techniques to combat fading
- study MIMO techniques with multiple antennas
- study multiple access techniques, particularly OFDMA
- examine modern wireless systems with multiple users

The course focuses on a theoretical foundation of wireless communications, but students also have opportunities to work on experimental hardware if they choose to.

An overview of cellular generations and standardization.

- 1G (Analog system): First introduced in US in 1983.
 - Voice only system.
 - AMPS (Adv. Mobile Phone System) uses FDMA at 800 MHz.

- 2G (Digital): TDMA & CDMA (introduced early 1990s)
 - mainly voice
 - can send text messages
 - GSM is based on TDMA at 900 MHz, 1800 MHz.
 - IS-95 is based on CDMA at around 1800, 1900 MHz.

- 2.5G: ◦ adding more features to 2G systems. (1995)
 - allow packet-switch operations (GPRS/EDGE)
 - more digital services

- 3G (Digital): UMTS (WCDMA) and CDMA 2000
 - UMTS: Universal Mobile Telecommunications Services
 - Support multimedia services.

- 4G: 3GPP-LTE (Long Term Evolution) around now.
 - high data rate (LTE-A upto 1 Gbps).
 - convergent standard for 4G.
 - use OFDMA / OFDM with MIMO and QAM.

- 5G: slated for 2020.
 - include higher spectrum (mmWave)
 - lots of ideas floating around now
 - massive MIMO
 - new modulation / waveforms? OFDM vs. FBMC vs. UFMC
 - FBMC - filter bank multi-carrier
 - UFMC - universal filter - multi-carrier
 - demonstrated 7.5 Gbps with auto mobility (100 km/h)

Emerging systems / ideas:

- cognitive radio
- SON - self organizing network
- inter-vehicular networks
- the smart grid
- biomedical networks.

An overview of wireless LAN: (WiFi)

- follows IEEE 802.11 standards
- operates in free ISM band (around 2.4 GHz and 5 GHz)
- different versions with varying speed, range
- 802.11n: high throughput, use MIMO.
- 802.11ac: Gbit speed, 802.11ad: moving to 60 GHz.
- usually low mobility
- 802.11ac: MU-MIMO, operate at 5 GHz