Aalto University
School of Electrical
Engineering

ELEC-E7120 Wireless Systems

Homework for Unit 1 (max. 4.5 points)

Released on 8.9.2023
Due date 15.9.2023 (before 10:00 am - Finnish Time)

Guidelines:

- Return the electronic version of your answers before the deadline using the corresponding homework submission folder in MyCourses.
- Homework is individual.
- Some references to do the homework are found in Slide-sets covered in “Lec1” and “Lec2” (@ MyCourses)

Part 1: Short problems.

Problem 1.1 (1.5 point). *Mobile Generations*

- Purpose is to perform a comparison between different cellular technologies (i.e., GSM, UMTS/WCDMA, LTE, and NR). Study of the main characteristics that these technologies have. For this purpose, build a table including the following information:

  1. Name of 3GPP mobile generation of cellular technologies (with enhancements)
  2. Year of introduction (first commercial deployments: Who? Where? When?)
  3. Key technology enablers that were implemented (Multiple Access & Duplexing method, Channel coding, MIMO, etc.) and peak data rate (downlink and uplink)
  4. Radiofrequency band and communication channel bandwidth (give some examples, it does not need to be an exhaustive list)
  5. Most typical use case(s)

- Based on the table and your own knowledge, draw conclusions about the trends observed in this mobile generation evolution. For example, what is the trend observed in the multiple access method? What is the trend observed in the peak data rate? How often is a new generation introduced? What about the radio frequency channel bandwidth and the evolution of use cases?

Problem 1.2 (1.5 point). *Mobile vs Wireless technologies*

- Compare the “nominal” coverages of **wireless** network technologies (WLAN/IEEE 802.11, WMAN/IEEE 802.16, WPAN/IEEE 802.15). Choose one example of technology/standard for each category, describing its purposes through its characteristics such as target service range, use cases, and so on.
- Compare the pros and cons of using **mobile** standards networks (4G/5G) in the relevant applications for wireless networks mentioned in the previous bullet point.
- Do you think that Wi-Fi could be supplanted and disappear in the future by 5G and its evolutions (5G+, 6G, …), based on the prospect that in 5G (and beyond) standards data rate are expected to be much higher and latencies much lower than with Wi-Fi? Justify your answer in a proper way.

Problem 1.3 (1.5 points). *Licensed vs unlicensed wireless system*

- Study if these following wireless communication systems use licensed or unlicensed electromagnetic spectrum: mobile networks (LTE and NR), Bluetooth, GPS/Galileo, Wi-Fi (802.11ac), Globalstar/Iridium/Starlink, RFID, Li-Fi/IEEE 802.11.bb. For this purpose, you can construct a table that includes the following information:

  1. Frequency band of operation (does not need to be an exhaustive list)
  2. Transmission power (in Watts/dBm) (focus on the order of magnitude)
  3. Transmission method (modulation)
  4. Estimated range of operation
  5. Is frequency band for licensed or unlicensed use?

- Based on the table and your own knowledge, draw conclusions about the main differences between licensed and unlicensed wireless systems. Are there any visible patterns among systems that use the same kind of spectrum? Why do you think these patterns exist or not? Justify your answer in a simple but clear way.