ENERGY FOR CONNECTED OBJECTS

Teacher: Gaël Loubet

Introduction to the Topic

The course "Energy for Connected Objects" explores various methods for powering connected devices and embedded systems. It consists of four theoretical lessons and two practical lab sessions. The objective is to analyze available energy sources, storage methods, and innovative approaches like wireless energy transfer. These insights help to better understand the challenges related to powering connected systems and choosing solutions tailored to specific needs.

Course Content

Energy Sources

We studied the different ways to supply electricity to a connected system. Three approaches were discussed:

- **Wired sources,** effective but spatially limited.
- **Batteries,** useful in portable or mobile environments.
- **Energy harvesting from the environment** (thermal, mechanical, light, or electromagnetic), ideal for systems requiring low energy but dependent on environmental conditions.

Energy Storage

The use of capacitors for energy storage was a key topic. These components play a critical role in ensuring stability and efficiency, especially when the energy source is intermittent or weak.

Wireless Energy Transmission

Finally, we explored the principles of wireless energy transmission. Although this method remains limited in terms of power and range, it can be useful in specific cases, such as powering hard-to-reach objects.

Practical Lab Sessions

The lab sessions allowed us to apply theoretical concepts through three main activities:

1. **Introduction to Supercapacitors**
   We studied the functioning of supercapacitors, components capable of storing and releasing energy quickly. Calculations focused on determining the minimum required capacity and associated losses to select the best options based on system needs.
2. **Characterization of an Unknown Capacitor**
   Each group received a system with an unknown capacitor to characterize. Using tools like GNU Radio (signal generation) and Waveforms (data visualization), we measured the voltages generated at specific frequencies. This allowed us to identify the capacitor's characteristics and understand its interaction with various frequencies.
3. **Application to Wireless Transmission**
   We analyzed the impact of different antennas (dipole, Yagi, patch) on energy transmission. This activity highlighted the challenges of wireless power: losses increase with distance, and antenna selection greatly influences transmission efficiency.

Analysis of Key Lessons

This course emphasized the importance of selecting the most suitable power solution for connected objects. Key takeaways include:

- **Wired or wireless choice:** For maximum efficiency, wired power remains the best option. However, for systems requiring mobility or independence, alternatives like batteries or energy harvesting are more appropriate.
- **Energy harvesting:** Though dependent on specific conditions (strong vibrations, thermal variations, etc.), this method can extend the lifespan of low-consumption systems.
- **Wireless transmission:** While limited in power, it provides interesting flexibility for isolated or hard-to-reach objects. When combined with capacitors, it can stabilize power in certain situations.

Conclusion

This course provided an in-depth understanding of the challenges and solutions related to powering connected objects. Whether it involves selecting a suitable capacitor, choosing an optimal frequency, or using antennas for energy transmission, each decision must align with the system's specific requirements. Finally, while wireless energy transfer has its limitations, it offers promising potential for certain applications as a complement to traditional approaches.