Project IELS3010 - Portable Environmental Mapper (Thingy:91 Two-Node BLE setup)

1. Objective

Design and implement a two-node portable environmental measurement system using two Nordic Thingy:91 boards. Each team (2 students) will build a system that measures temperature, humidity, and GPS data on one node (Node A), transmits it via Bluetooth Low Energy (BLE) advertising, receives and logs it onto a second node (Node B), and sends it through UART to a laptop for visualization on a map and time-series dashboard.

2. Learning Outcomes

By completing this project, students will:

- Understand BLE roles, advertising, and data exchange.
- Design and implement a simple wireless protocol.
- Integrate sensors, GPS, and UART communication.
- Visualize environmental data spatially and temporally.
- Communicate technical design and troubleshooting clearly.

3. System Overview

Node A (Peripheral / Beacon):

- Measures temperature, humidity, and GPS.
- Encodes values into a Data payload.
- Broadcasts the payload every 2-5 seconds via BLE advertising.

Node B (Central / Receiver):

- Scans for Node A's advertisements and decodes payloads.
- Adds a timestamp and forwards data via UART as JSON lines.
- Example JSON output:
{"ts":1699970123456,"seq":184,"t_c":22.31,"rh":48.9,"lat":59.9139,"lon":10.7522,"src":"team3"}

Visualization (Laptop):

- Receives serial data.
- Displays map, live plots, and exports CSV files.

4. Deliverables

1. Working two-node BLE system with UART data output and visualization.

2. Project Report (5–6 pages) including the following sections:

- Introduction – motivation, context, and objectives.
- System Architecture – describe hardware, BLE roles, and data flow.
- Communication Protocol – explain packet format, timing, and parsing.
- Firmware Implementation – highlight and explain key parts of your code.
- Results & Visualization – include plots, heatmaps, and CSV data analysis.
- Discussion & Conclusion – summarize findings, BLE performance, and issues encountered. If something did not work as planned (e.g., GPS fix problems, BLE range, code bugs), clearly describe the symptoms, possible causes, and what was attempted to solve or work around them.
- Appendix – optional extra figures or code listings.

5. Tools & Resources

- Nordic nRF Connect SDK (Zephyr)
- nRF Connect SDK Fundamentals: https://academy.nordicsemi.com/courses/nrf-connect-sdk-fundamentals/
- nRF Connect for Desktop / Mobile (BLE testing)
- GitHub or zip for code submission
- Excel, Python, or Google Sheets for data analysis
- Tutorialpackage. Thingy 91 X and Cellular IoT https://academy.nordicsemi.com/courses/cellular-iot-fundamentals/
  A solid start will be the lecture "Cellular IoT fundemantals". You willl also find a lot of videos about the Thingy 91 X on YouTube
- And here's the Thingy 91 X documentation: https://docs.nordicsemi.com/category/thingy91x-category
- https://devzone.nordicsemi.com/
- Questions: TA's Erik and Christian. Or Johan: johan.suarez@ntnu.no