

# MMA MODEL 2

Pametna kaciga za bicikliste

Voltmates MMA

L U M E N   E N G I N E E R I N G   2 0 2 5 .

# UVOD

- **Tema natjecanja:** Originalna i inovativna izvedba pametne zaštitne kacige za bicikliste
- Prva pametna kaciga – Livall BH60 (2015.)
- Divljem svijeta više od 1 milijarde bicikala u upotrebi - veliko tržište
- Rastuća važnost sigurnosti biciklista
- Pametne kacige: spoj sigurnosti i tehnologije

# NAŠA IDEJA

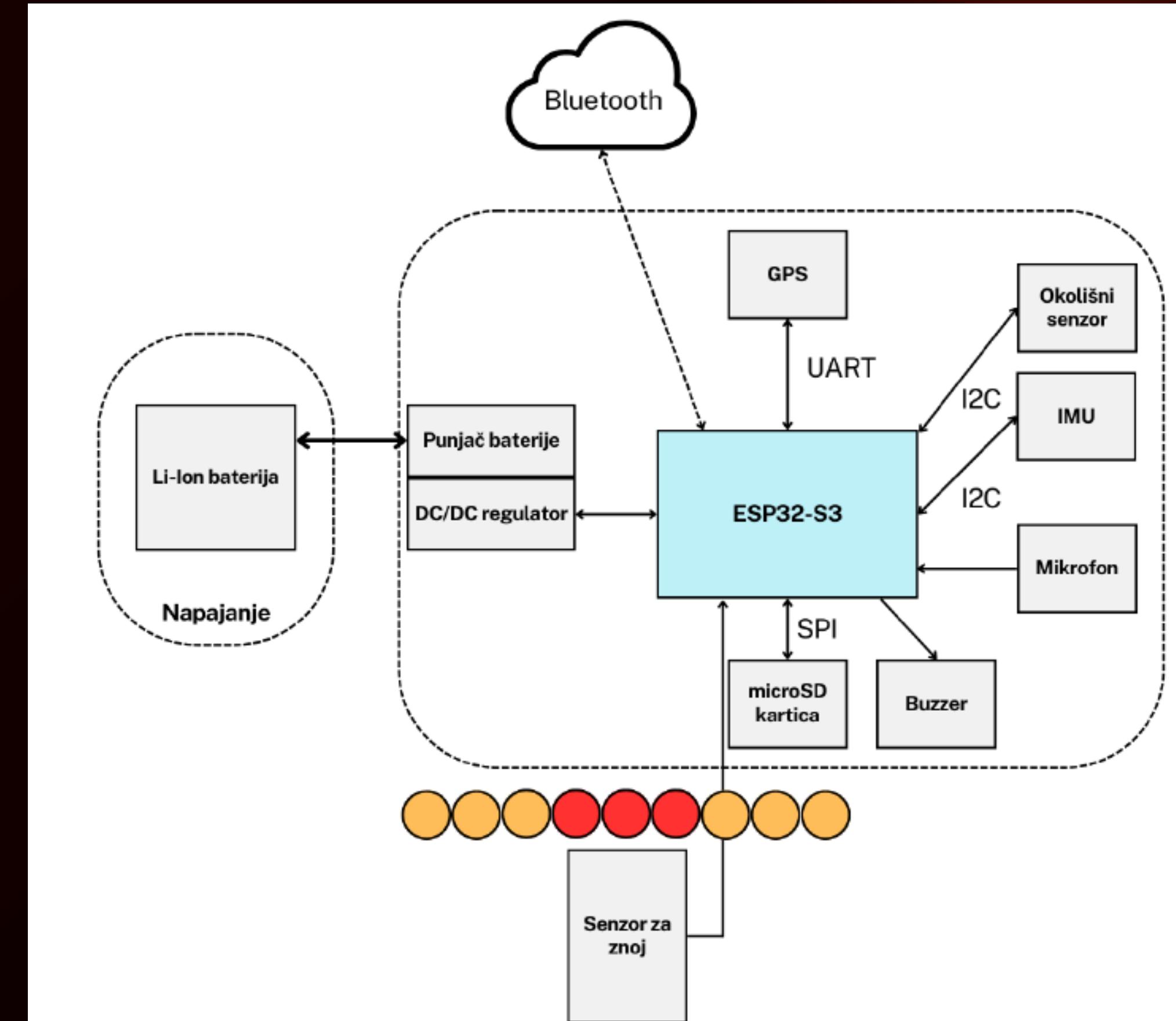
- Razvoj pametne nadogradnje za biciklističke kacige
- Fokus: sigurnost + analiza treninga
- Namijenjeno rekreativcima i profesionalcima

## Inovativnost:

- Univerzalna **nadogradnja** – neovisna o modelu kacige
- Senzor **znoja**
- Frekvencijska analiza (**FFT**) **terena** putem akcelerometra

# SUSTAV

- Mikrokontroler
- Izlazni uređaji
  - LED svjetla, buzzer i microSD kartica
- Senzori
  - GPS, okolišni senzor, IMU, mikrofon i senzor znoja
- Baterijsko napajanje



# TIJEK RAZVOJA

## 1. Osnovni sustav (moduli na protoboardu)

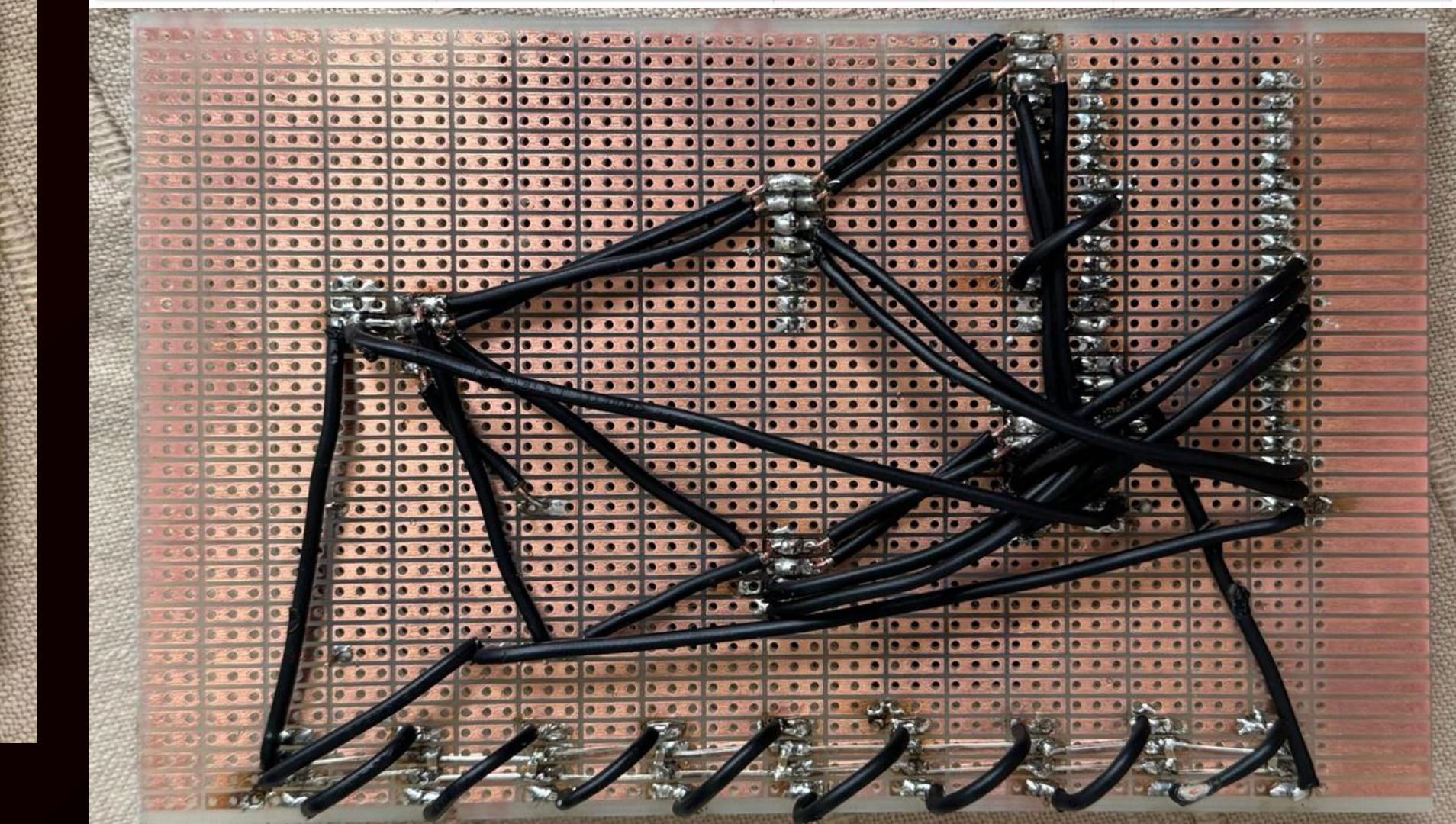
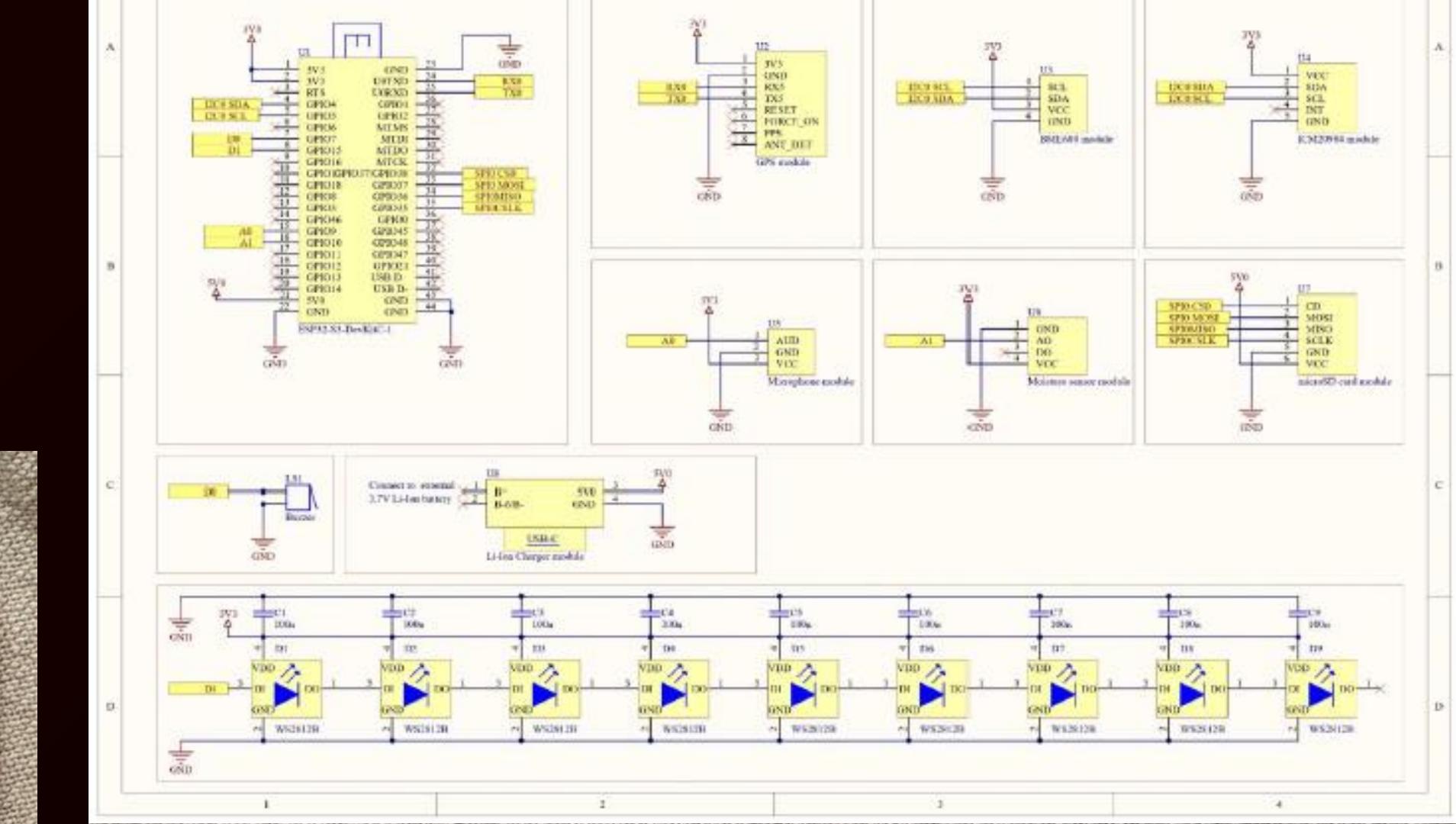
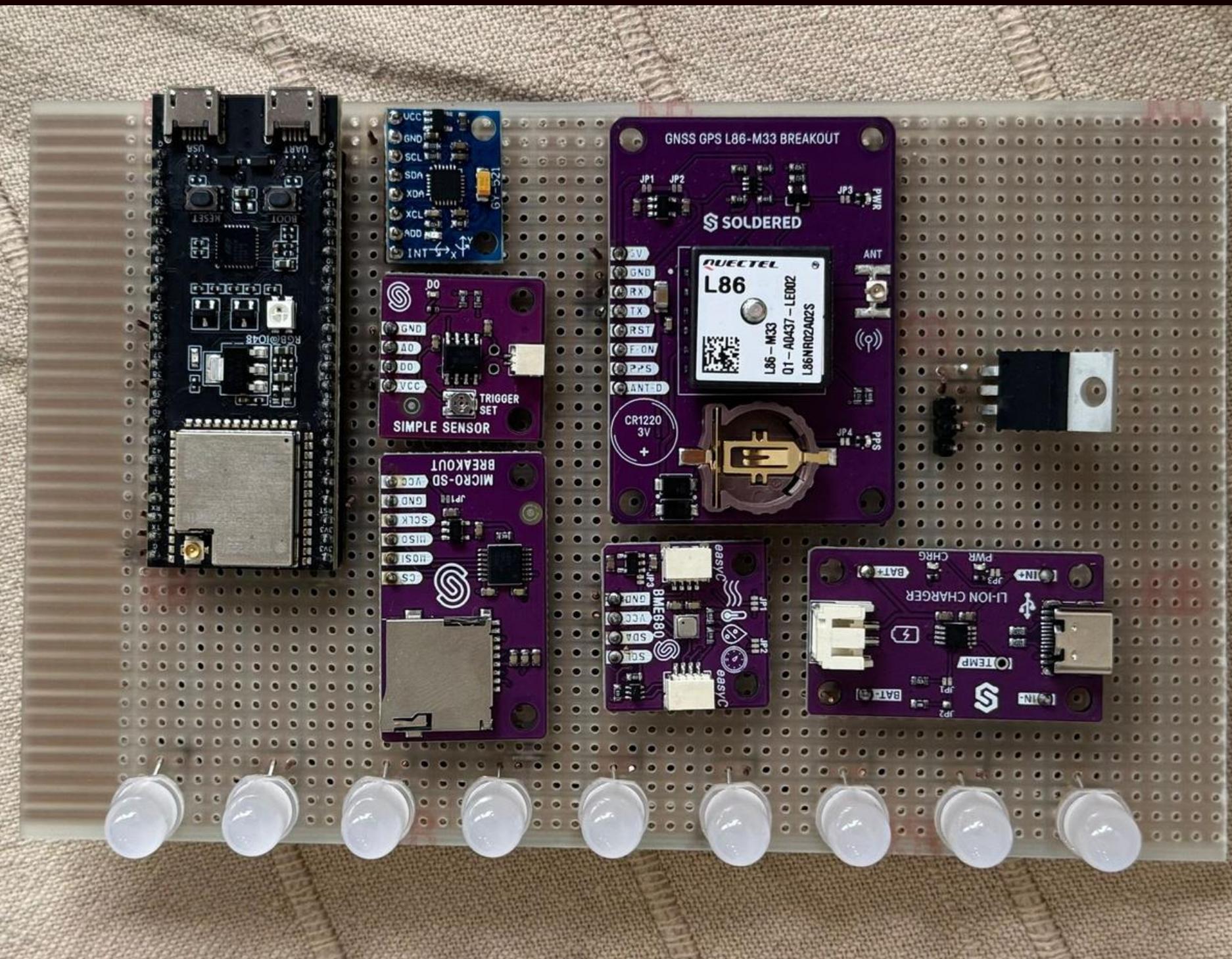
- za testiranje i pisanje vlastitih drivera

## 2. Integrirani sustav (vlastiti PCB)

- Ideja - identične funkcionalnosti -> različit stupanj integracije

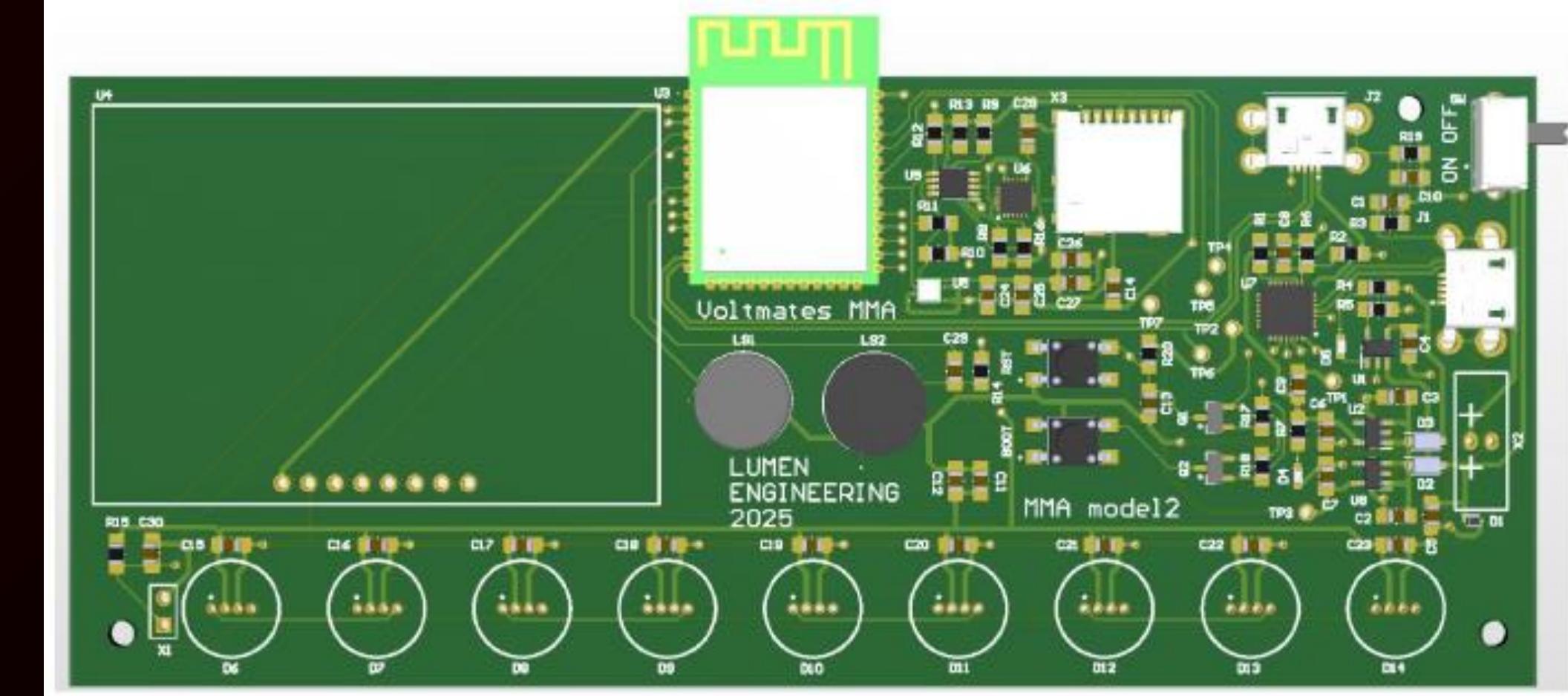
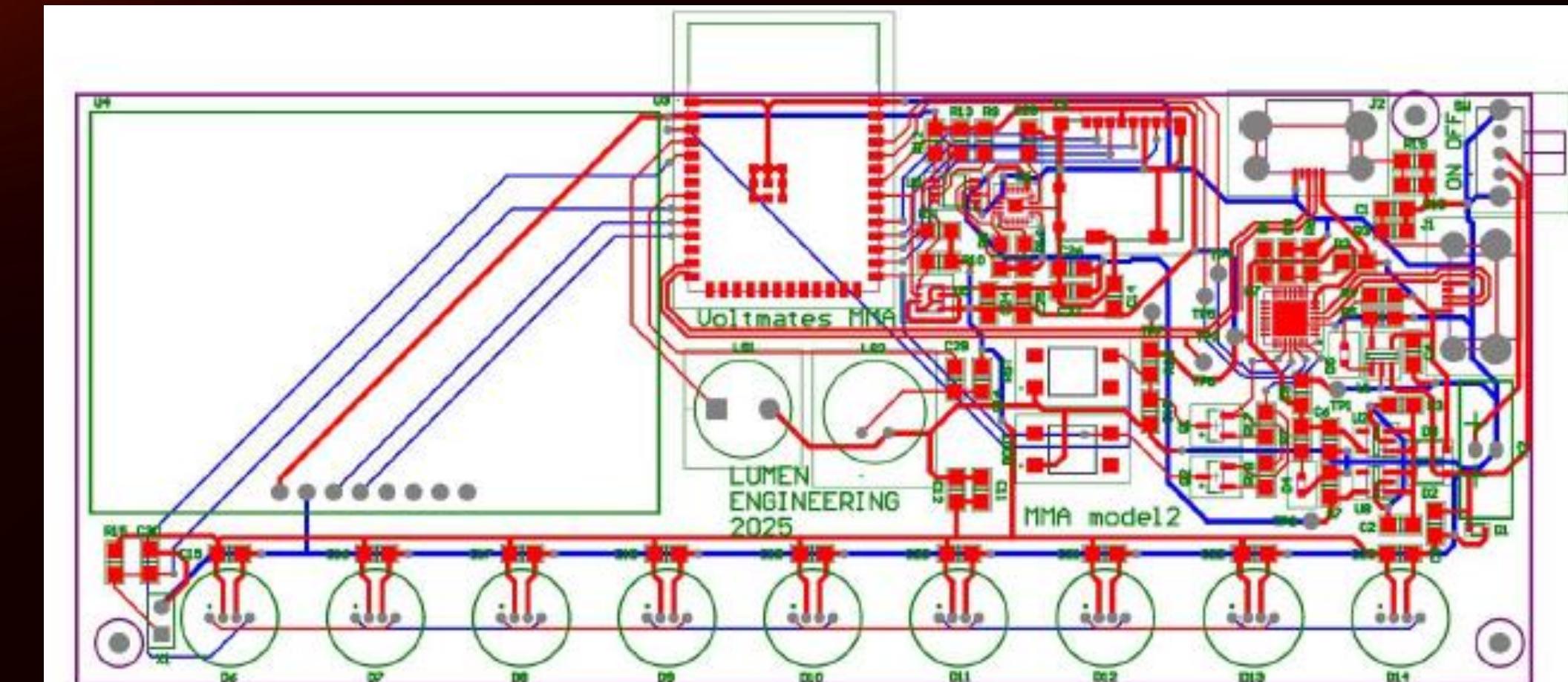


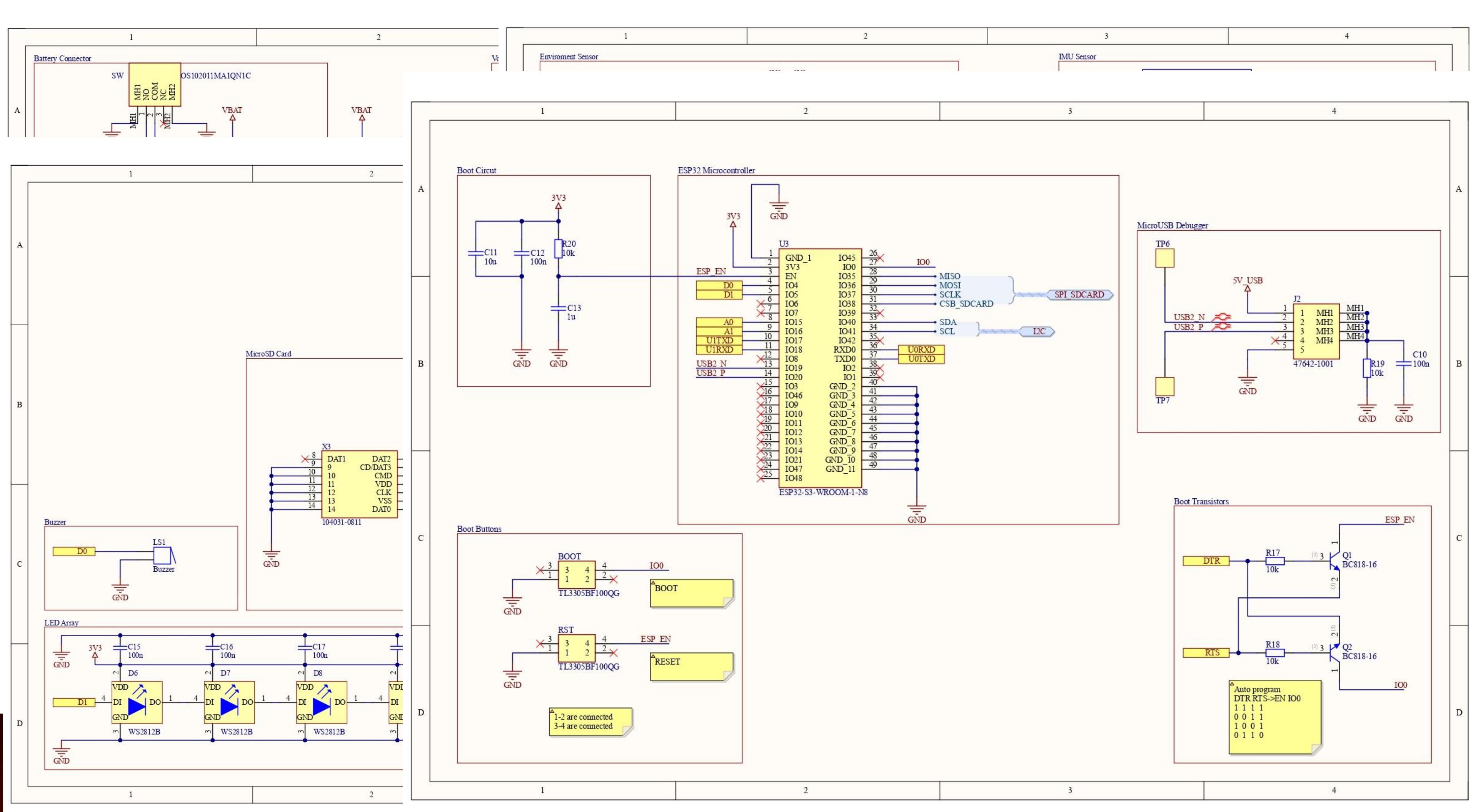
# OSNOVNI SUSTAV

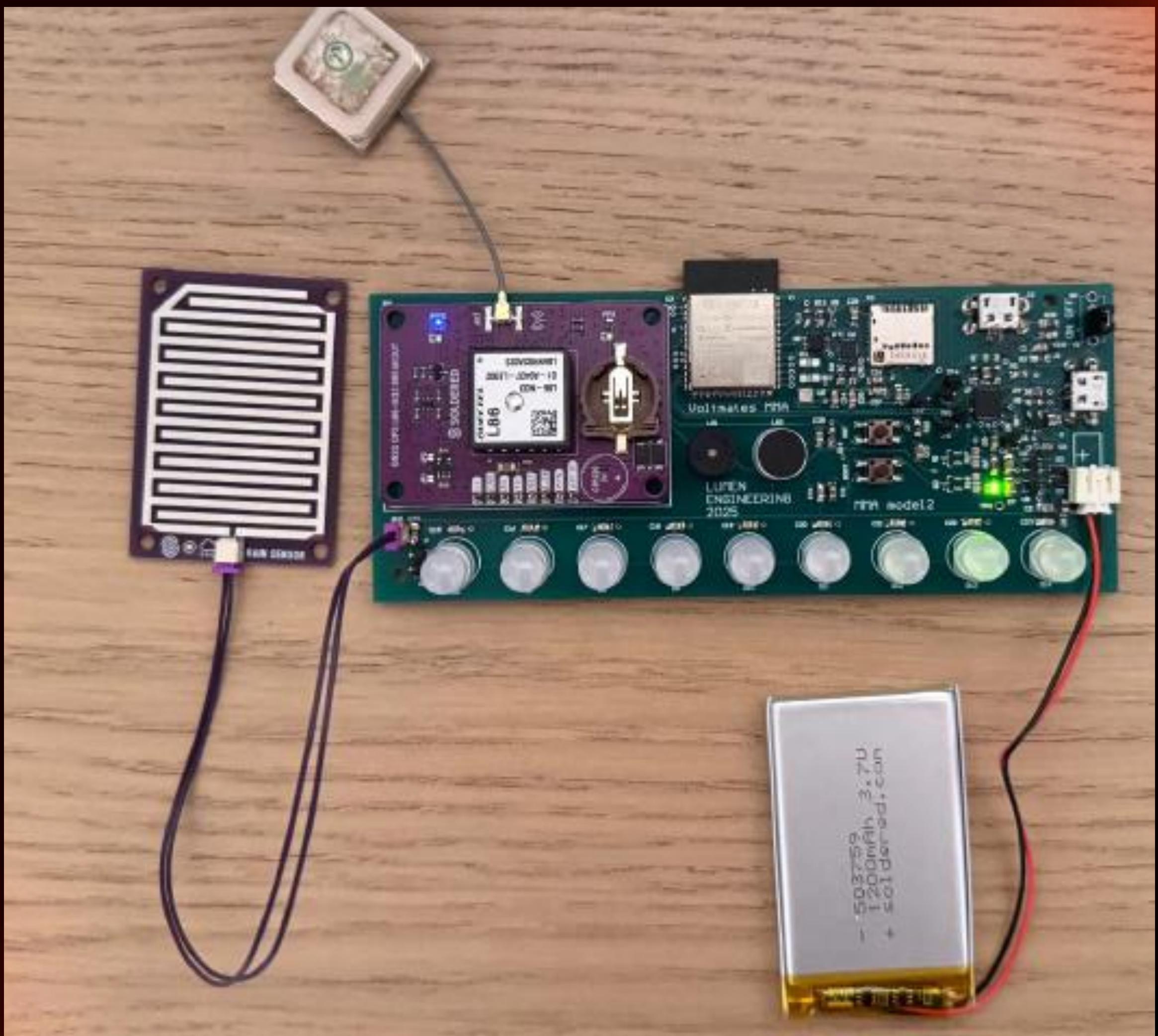


# INTEGRIRAN SUSTAV

- Dvoslojni PCB
  - Vlastita implementacija programatora
  - Punjač za baterije
  - Napajanje preko Li-ion baterije
  - Potpuna integracija mikrokontrolera

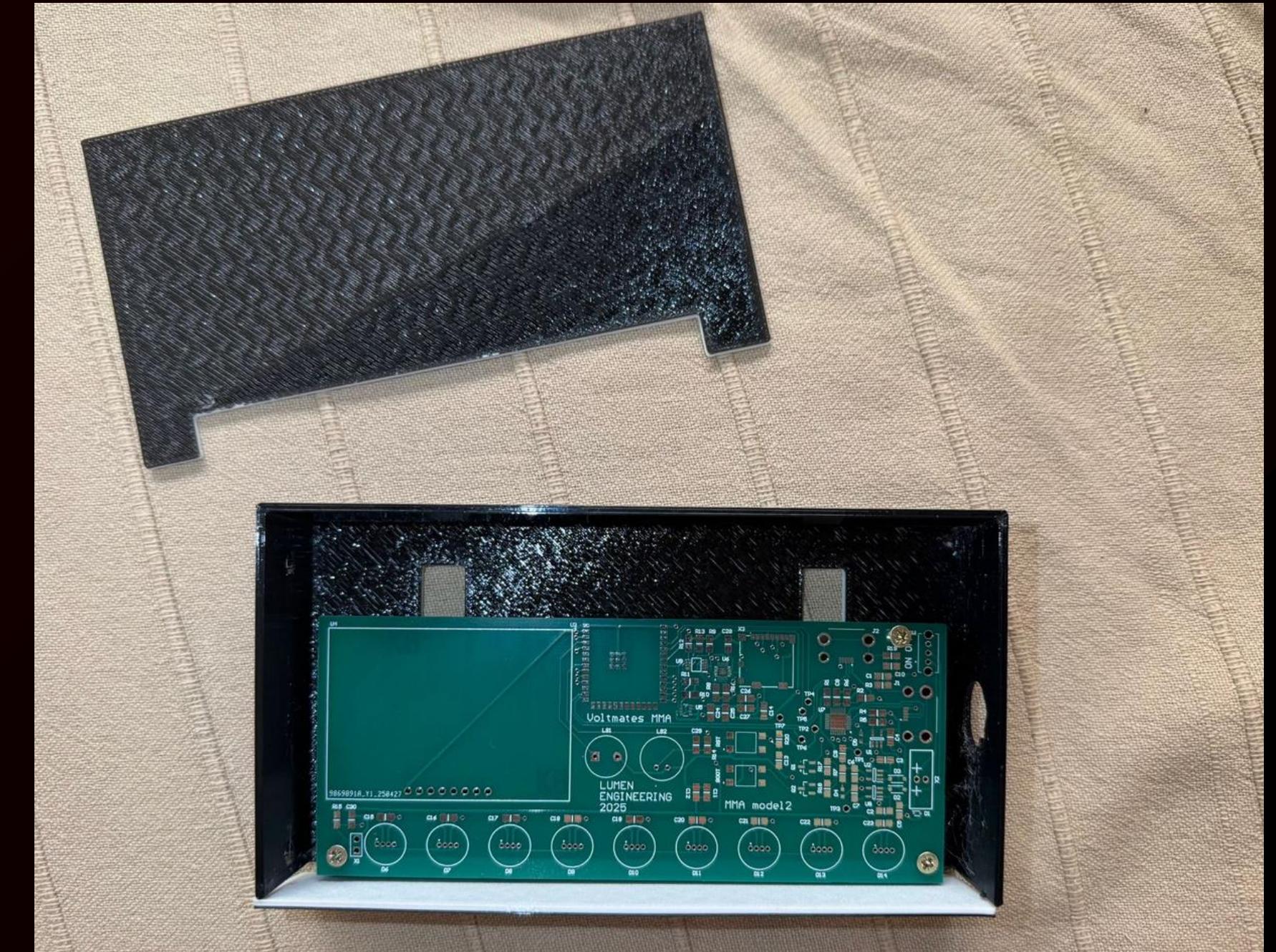
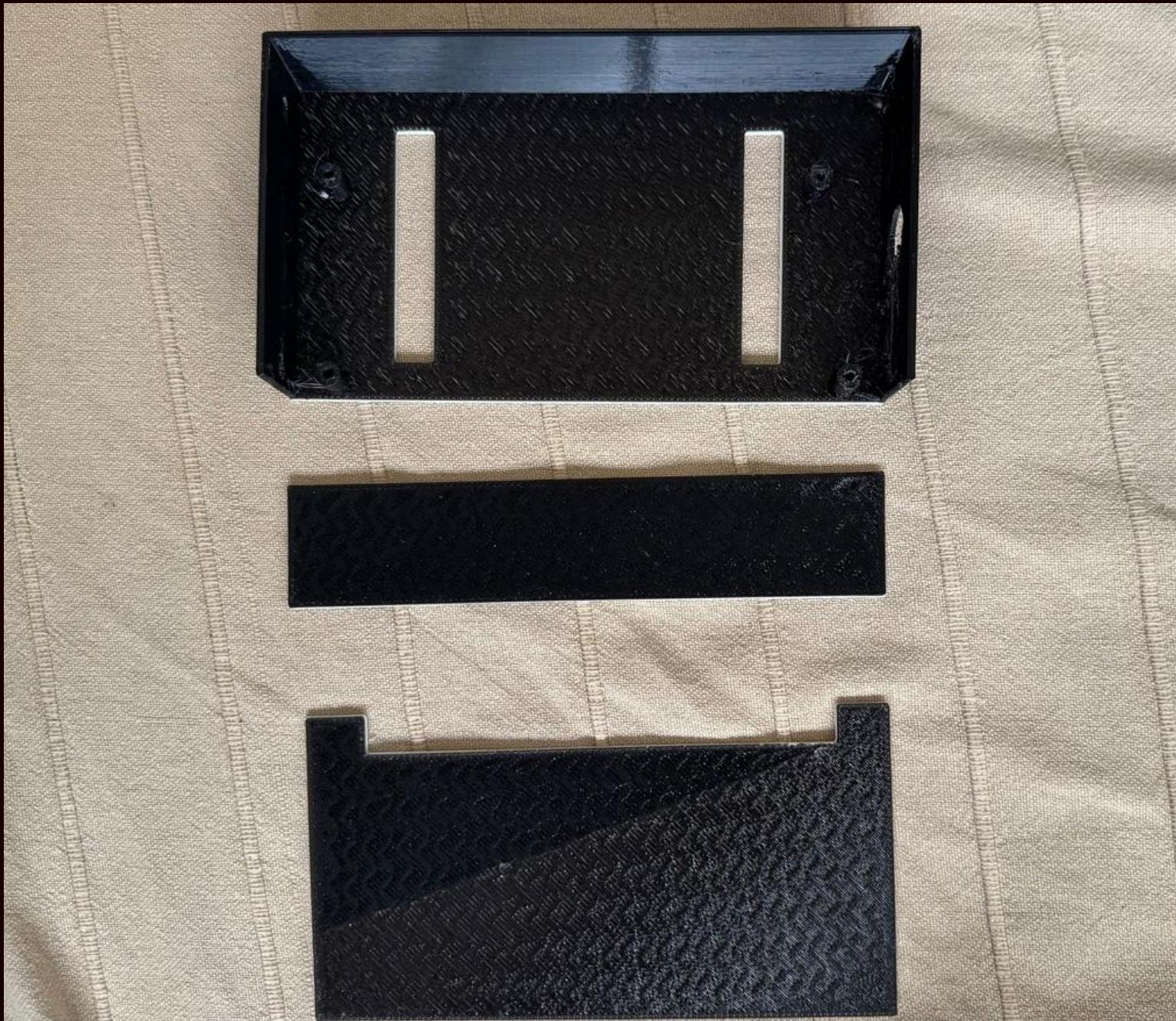




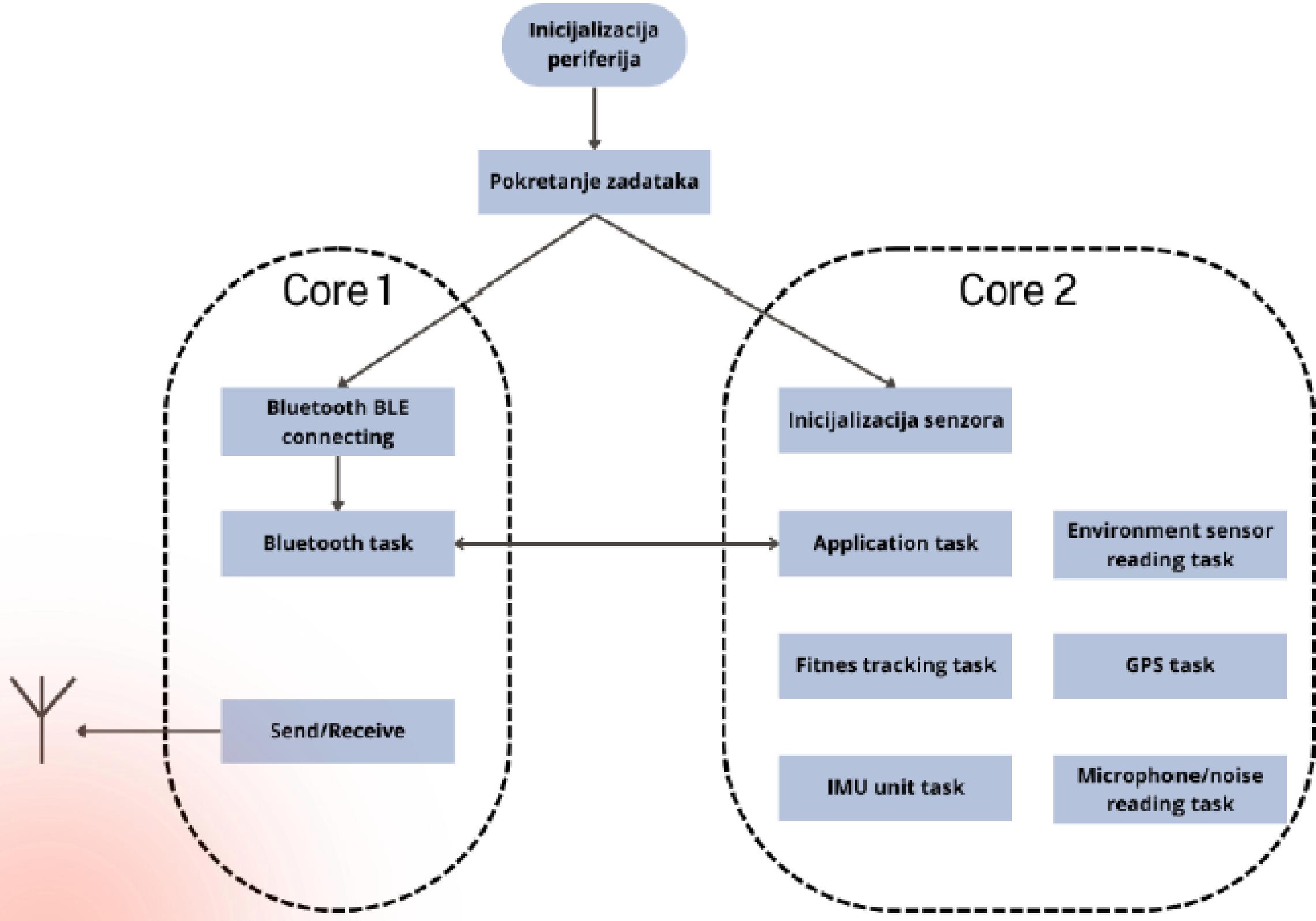


# KUĆIŠTE

- Izrađen model po mjeri za PCB
- 3D printano



# PROGRAM I DRIVERI



The image shows a file explorer interface with two panes. The left pane displays a list of components under a 'components' folder. The right pane shows the structure of a 'main' project, which includes source files for various tasks and configuration files.

**components**

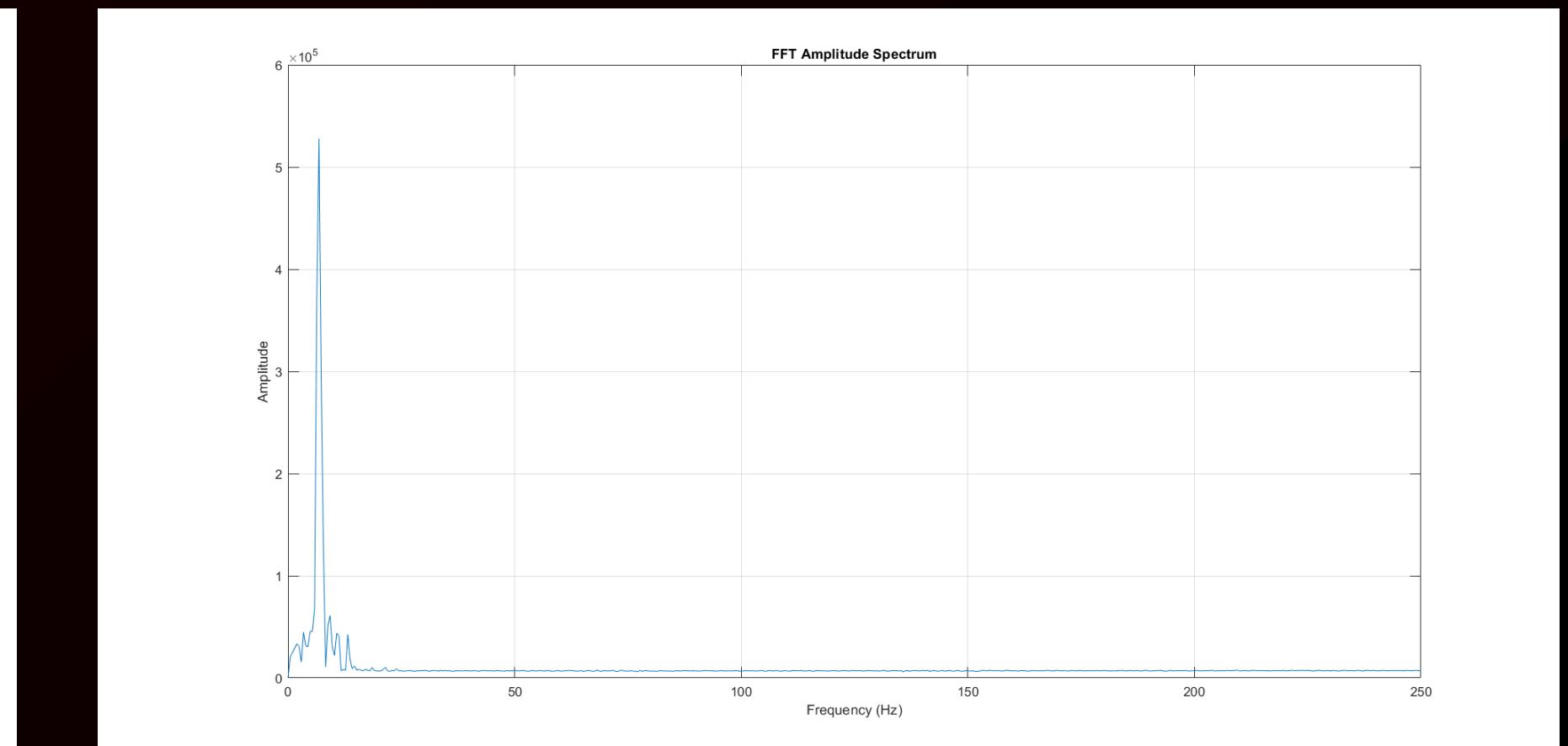
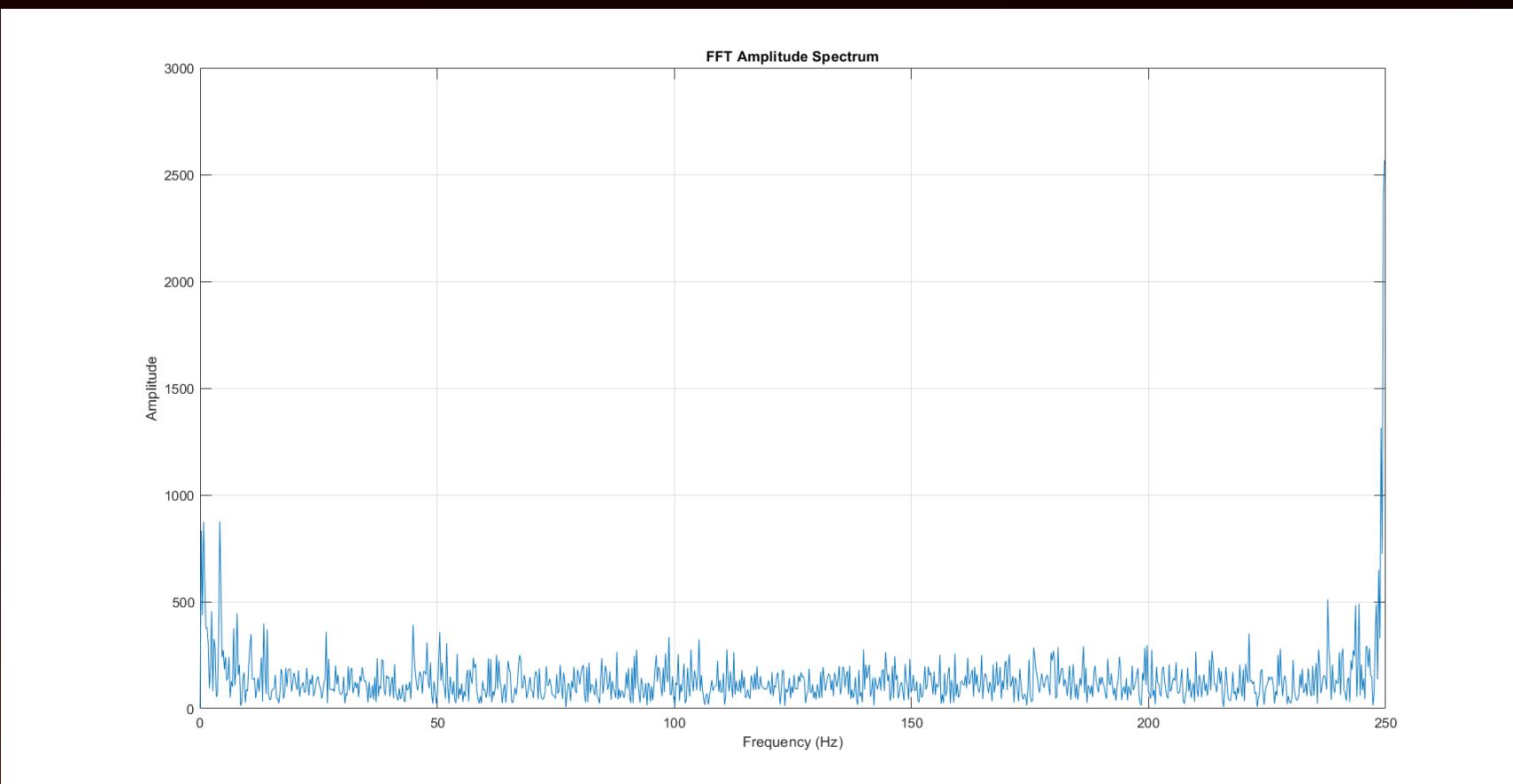
- > accel
- > accelGY
- > adc\_drv
- > ble\_com
- > bme68x
- > data\_queues
- > gps
- > i2c
- > led\_rgb
- > led\_strip\_encoder
- > microphone
- > pwm
- > sdspi
- > sweat\_sensor

**main**

- > inc
- < src
  - C accel\_task.c
  - C accelGY\_task.c
  - C ble\_task.c
  - C bme\_task.c
  - C gps\_task.c
  - C mic\_task.c
  - C sdcard\_task.c
  - C sweat\_task.c
- CMakeLists.txt
- idf\_component.yml
- C main.c

# KORIŠTENI SENZORI

- **IMU** – fast sampling
  - Detekcija kočenja -> stop svjetla
  - Nagnutost glave -> indikacijska svjetla
  - Frekvencijska analiza (FFT) -> prepoznavanje terena



# KORIŠTENI SENZORI

- **GPS – GNSS** podaci
  - Geografska širina i dužina
  - Brzina, visina i lokalno vrijeme
- **BME680** – okolišni senzor kvalitete zraka
  - Temperatura, vлага, tlak, VOC
- **Senzor znoja**
  - Otpornički senzor
- **Mikrofon** – elektretni
  - Mjera buke, računanje energije signala

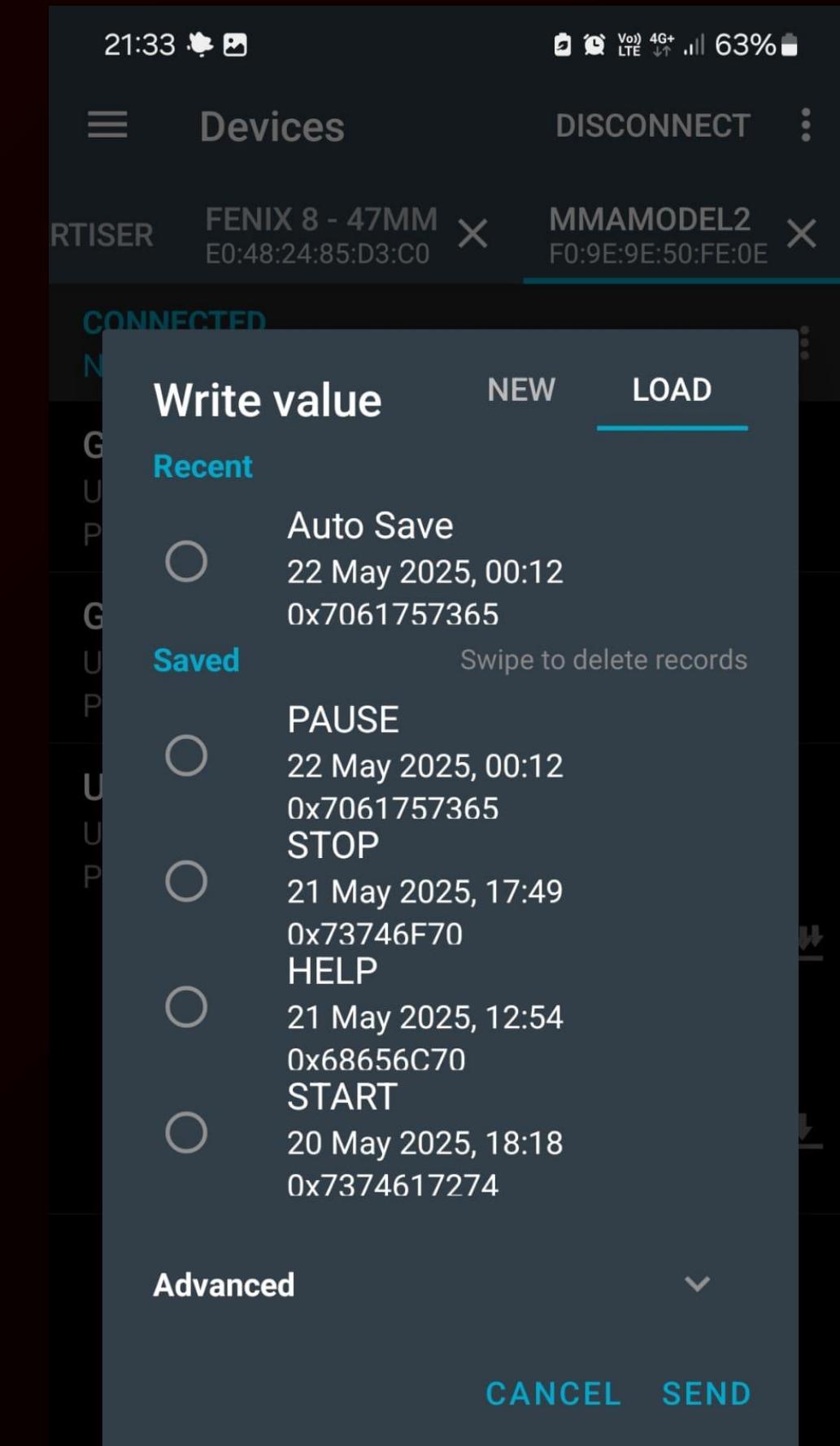
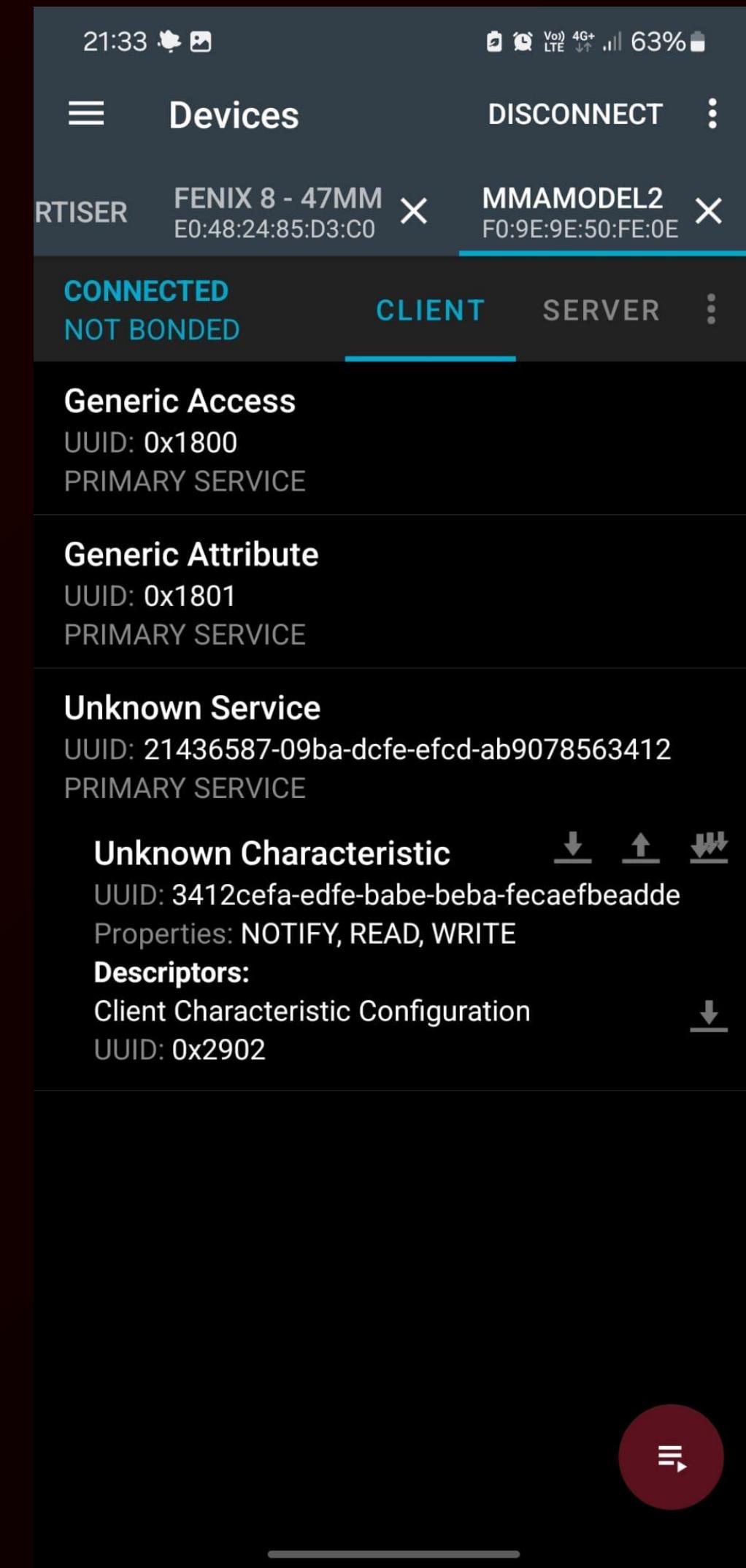
# POSTIGNUTE FUNKCIONALNOSTI

- Potpuna samostalna implementacija drivera
- Analiza tereta preko FFT-a
- Lokacija i brzina preko GPS-a za analizu rute
- Žmigavci i stop svjetlo preko signalizirajućih LED-ica
- Kvaliteta zraka
- Mjerenje razine buke



# PRIKUPLJANJE PODataka

- Start, stop, pause
- nrfConnect aplikacija



# PRIKAZ PRIKUPLJENIH PODATAKA SA SENZORA

- Svi podaci pohranjeni su na SD karticu u .txt file
- Analiza na računalu -> Python skripta
- Pokretanjem skripte stvara se HTML stranica
- Vizualizacija prikupljenih podataka sa svih senzora
- Unos spola, dobi, mase i visine korisnika
- Dodatne mogućnosti su računanje BMI, prosječne potrošnje kalorija i metaboličkog ekvivalenta (MET)

 LOGSTART.TXT
 START.TXT
 WO414.TXT
 WO663.TXT
 WO720.TXT
 WO784.TXT
 WO875.TXT
 WOHVR.TXT
 WOTLU.TXT
 WOVUZ.TXT

# MMA MODEL 2

## Workout & Performance Analysis

Gender  
Female ● Male

Age  
30

Weight (kg)  
70

Height (cm)  
170

BMI = 24.2 (Normal)

Average Speed: 5.87 km/h

MET (metabolic equivalent of task) ≈ 4.0

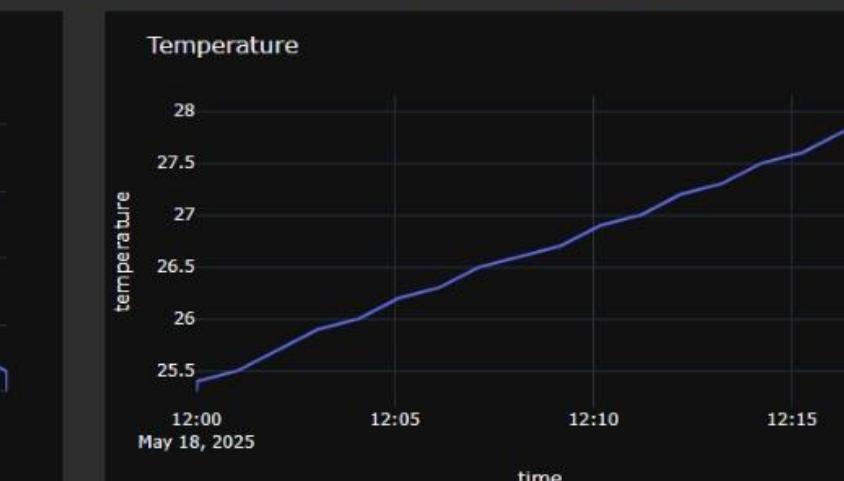
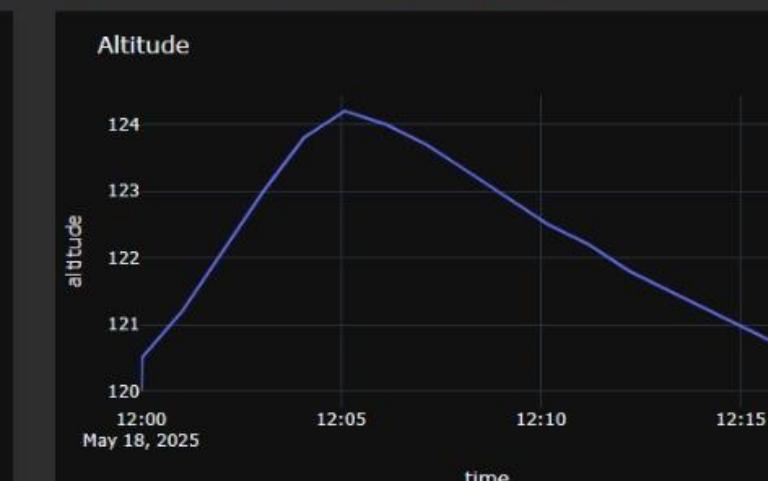
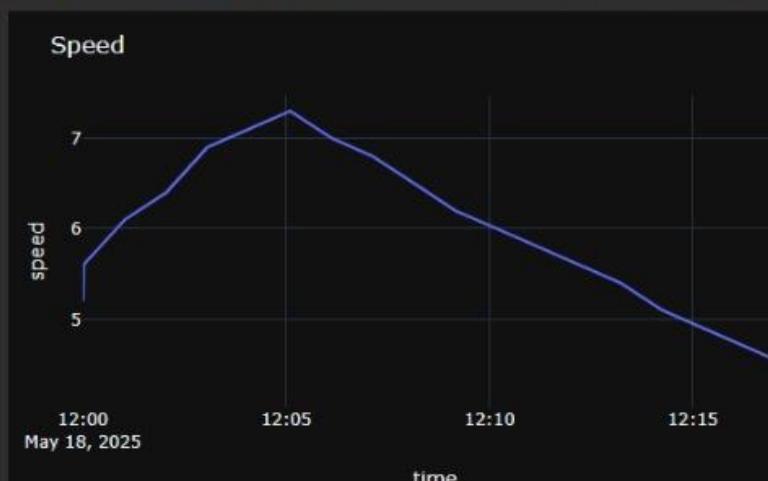
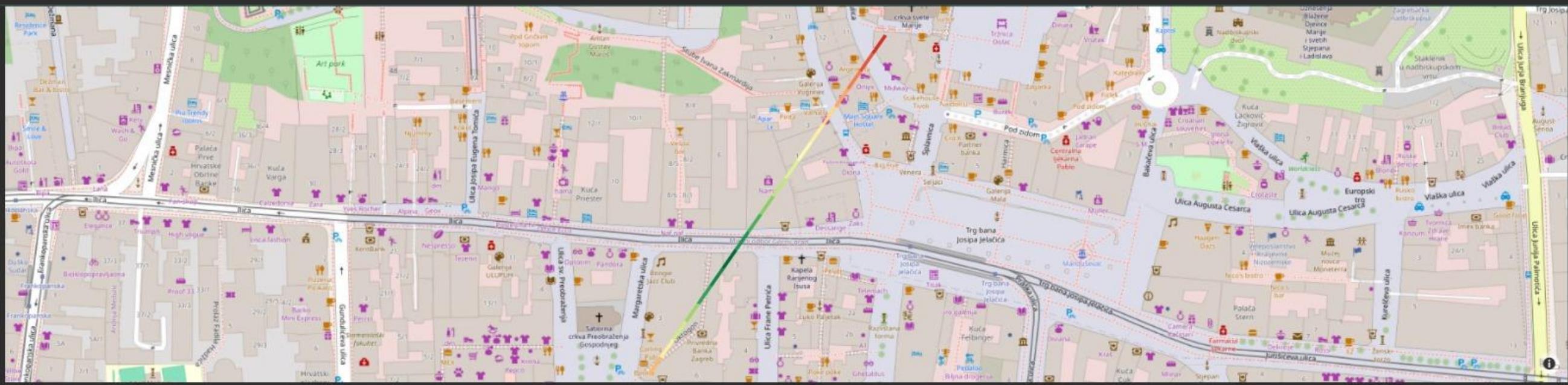
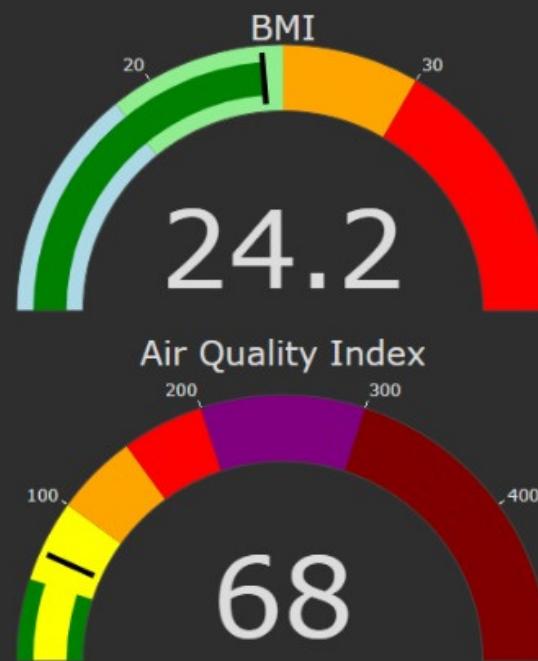
Distance Covered: 1.74 km

Duration: 17.3 min

Altitude Change: 4.20 m

Calories Burned (est.): 81 kcal

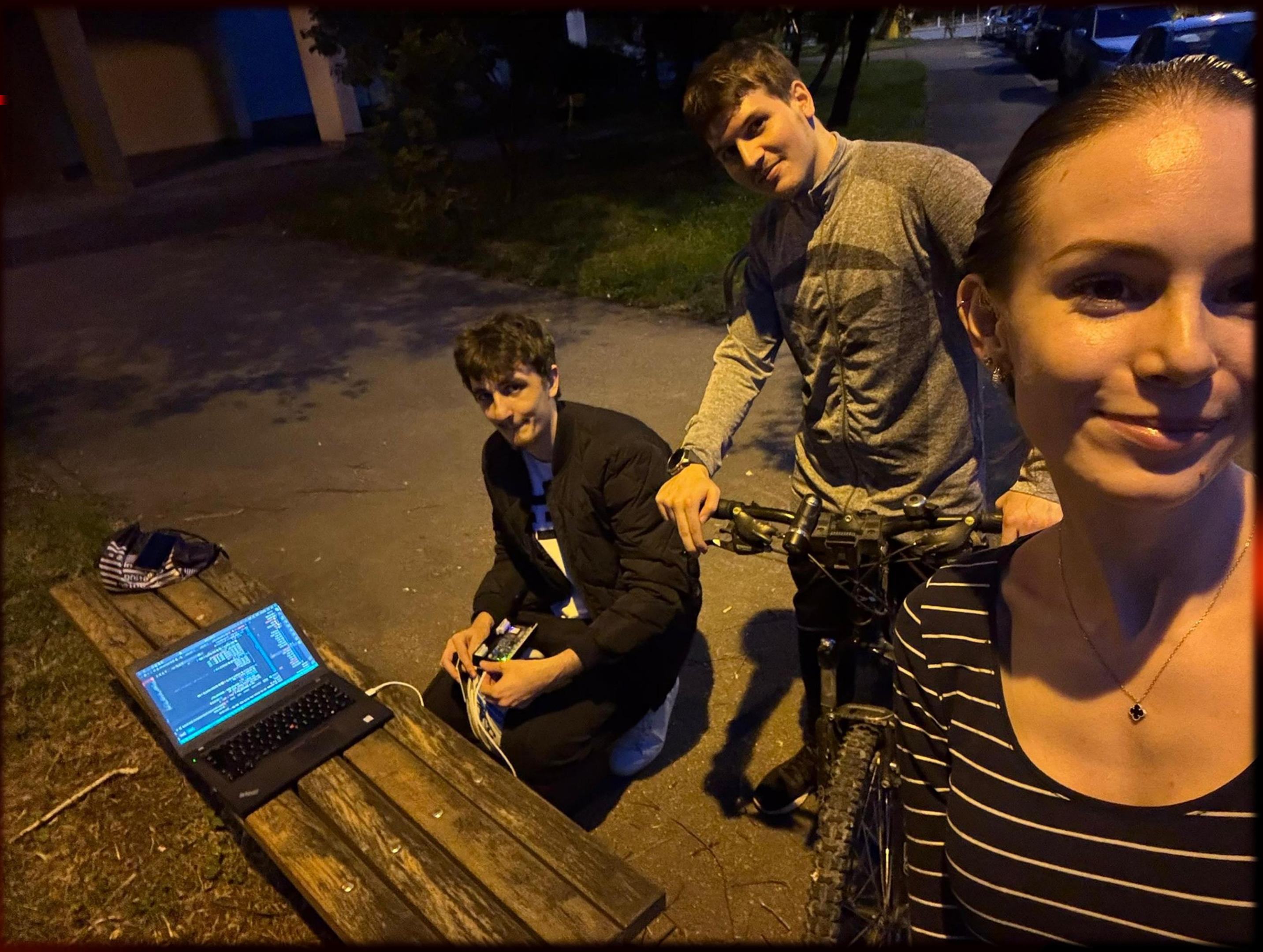
Average AQI: 68 (Moderate)



# ZAKLJUČAK

- Sigurnosni i fitnes uređaj u jednom
- Inovativan korak u unapređenju sigurnosti i praćenju performansi biciklista
- Modularnost: kompatibilno s bilo kojom kacigom
- Mogućnosti daljnje razvoja:
  - glasovne komande, mobilna aplikacija, AI
  - smanjenje samog uređaja
- S obzirom na rastuću potražnju za ovakvim tehnologijama, možemo očekivati da će slična rješenja postati neizostavan dio biciklizma u budućnosti.





HVALA VAM NA PAŽNJI!  
PITANJA?

M A R K O   S R P A K ,  
A N T O N I A   T U R K O V I Ć ,  
M A T E J   P E R K O V I Ć