

The projects **address key challenges in precision arable and livestock farming** through the integration of:

- Satellite-based remote sensing and IoT sensor technologies
- Artificial intelligence and data analytics in livestock farming
- Ground-based environmental monitoring

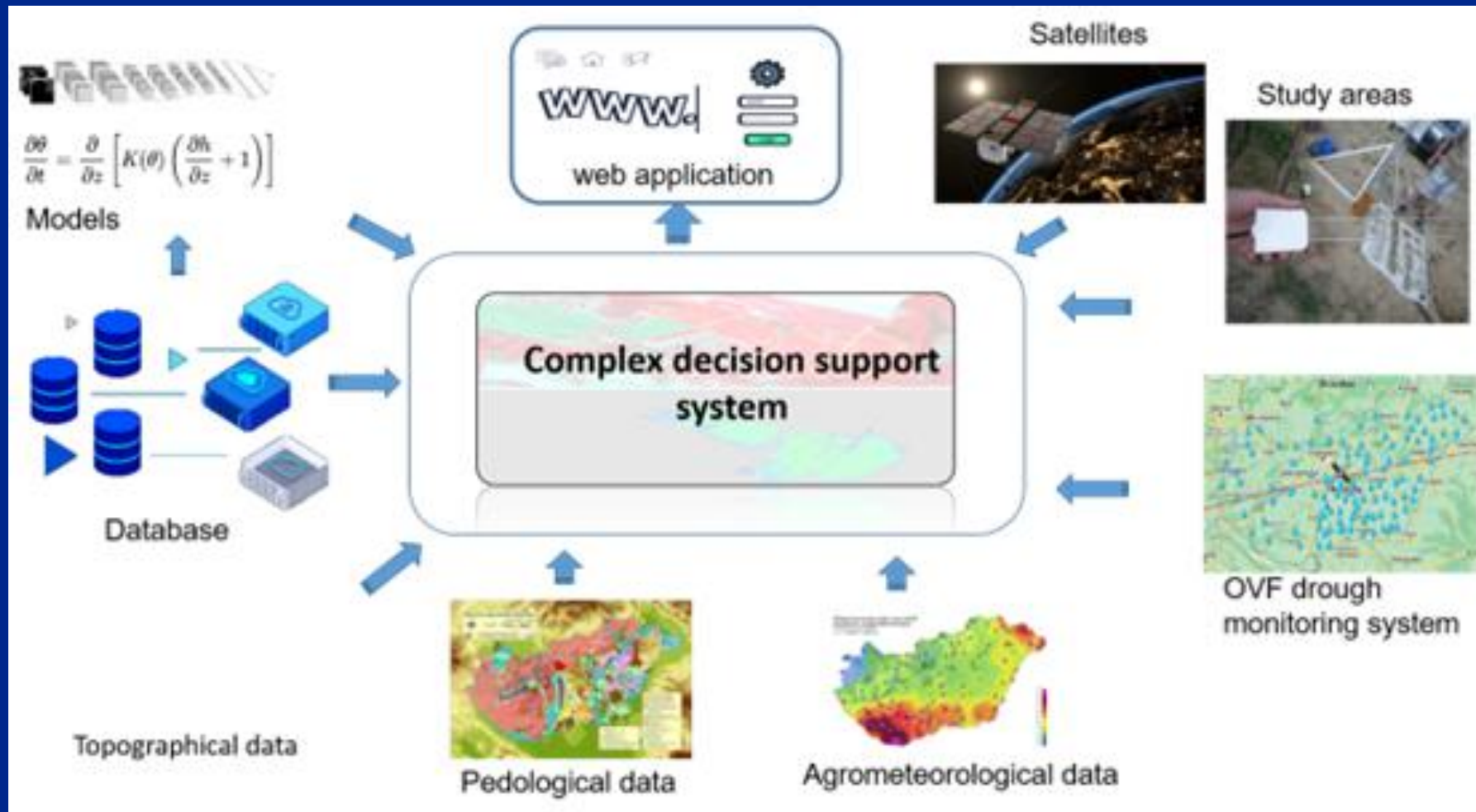
The presented solutions **aim to support data-driven agricultural decision-making, improve resource efficiency, and enhance climate adaptation strategies** in modern farming systems.

Key results:

- Development of precision agriculture research programs
- Applied data science solutions for livestock farms
- Strengthened university–industry collaboration
- Educational programs (BSc, MSc, PhD)

WREN Water Resources in Efficient Networks

(GINOP PLUSZ-2.1.1-21)



The aims of the project

- ✓ facilitates **climate change adaptation**,
- ✓ drought damage prevention and **drought forecasting**,
- ✓ is able to **enhance the spatial and temporal resolution** of the current drought monitoring system through a fusion of RS and local data, using **mathematical models** based on **artificial intelligence**

The components of the system are: (1) the custom satellite (2) the numerical models that convert satellite data to soil water content distribution (3) the computing infrastructure designed for this purpose and (4) the web application and the associated public API that deliver results to users.

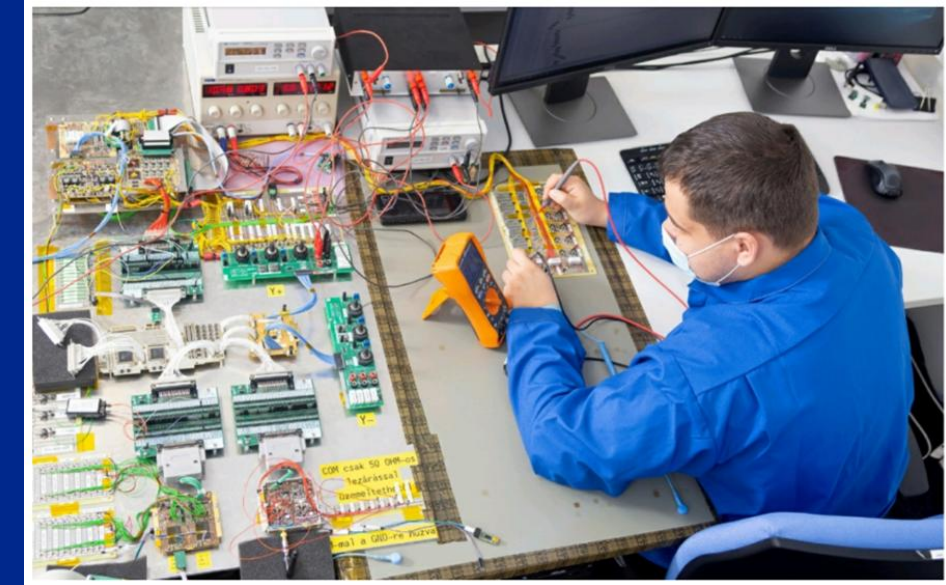
Challenges in the design of the CUBESAT

Subject of Research and Development

- Design of the satellite, including its on-board equipment and operational functionality

About the Satellite...

- Design and construction
 - The C3S aerospace company was responsible for the design and construction of the satellite
 - OU was responsible for satellite technical parameters and data preprocessing



WREN-1

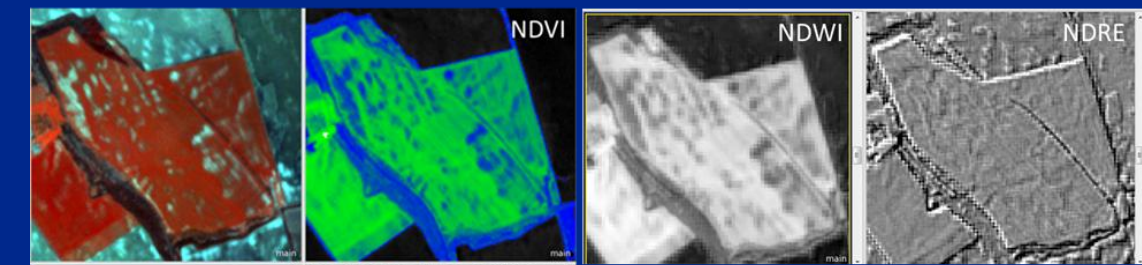
Challenges in the project.....

Determination of suitable RS-based methods for soil moisture estimation

- Database construction
- Regular soil moisture measurements
- Analysis of currently available satellite data
- Development of RS-based models for soil moisture estimation
- RS-based drought monitoring system, using mathematical models based on artificial intelligence.

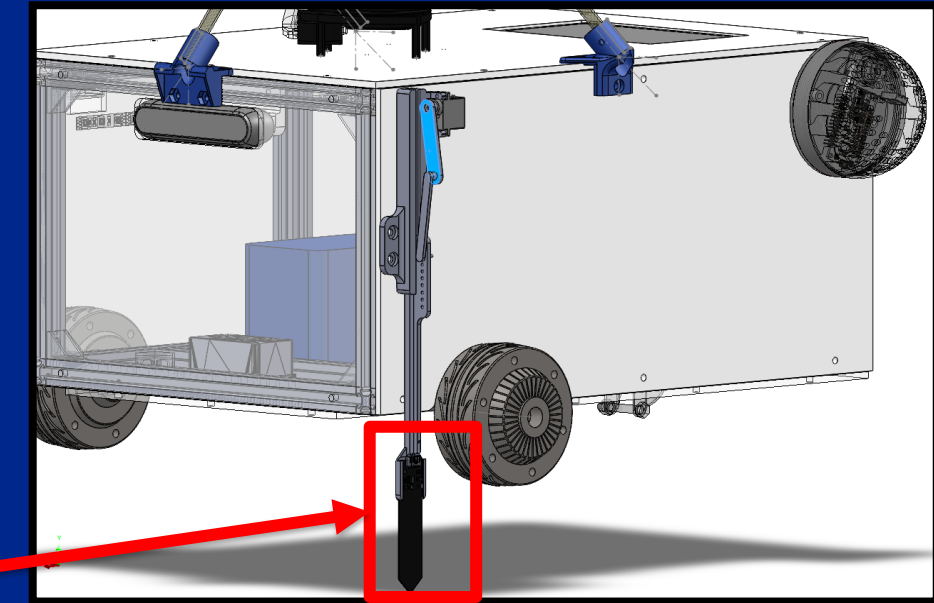
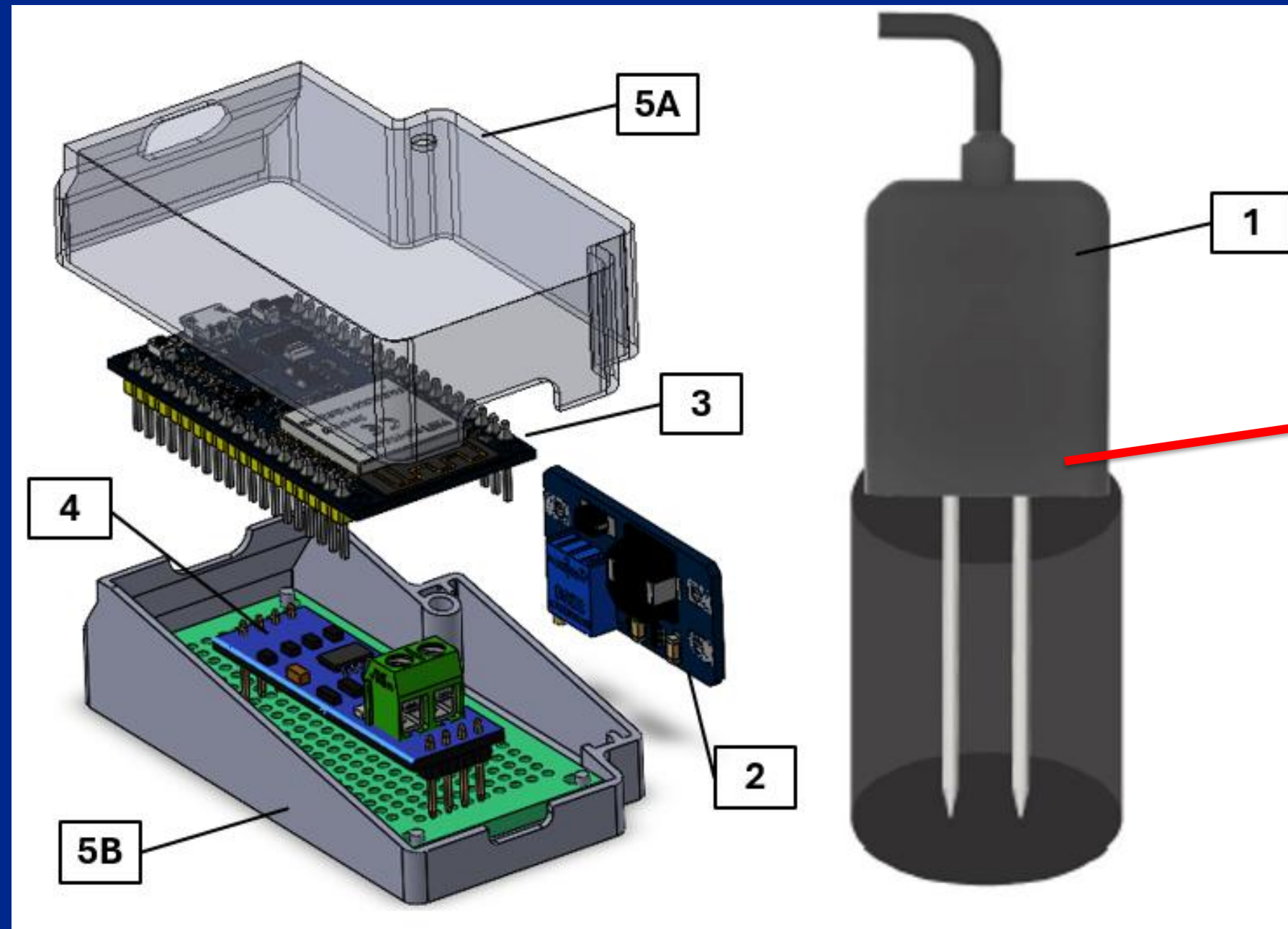


Correlations between in-situ measurements and values derived from satellite imagery were investigated using statistical methods, including correlation and regression analyses. In the current research, various remote sensing-based indices and models were tested.



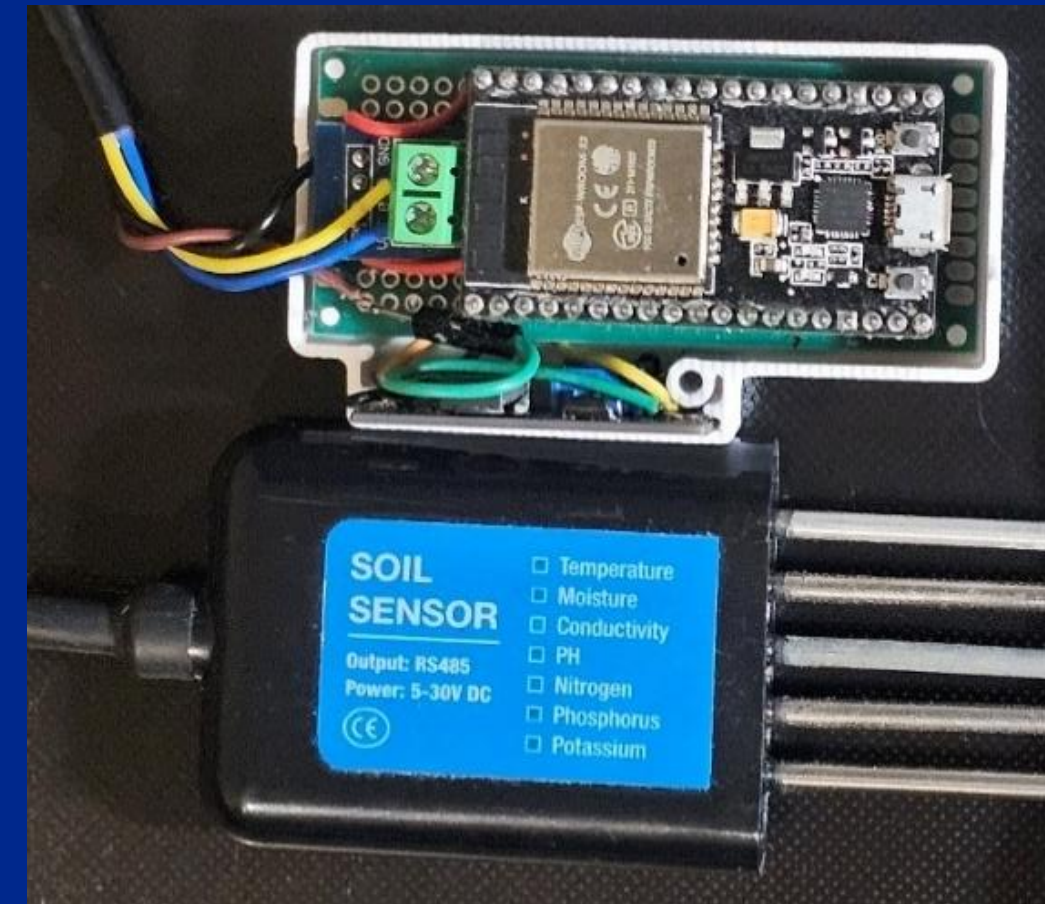
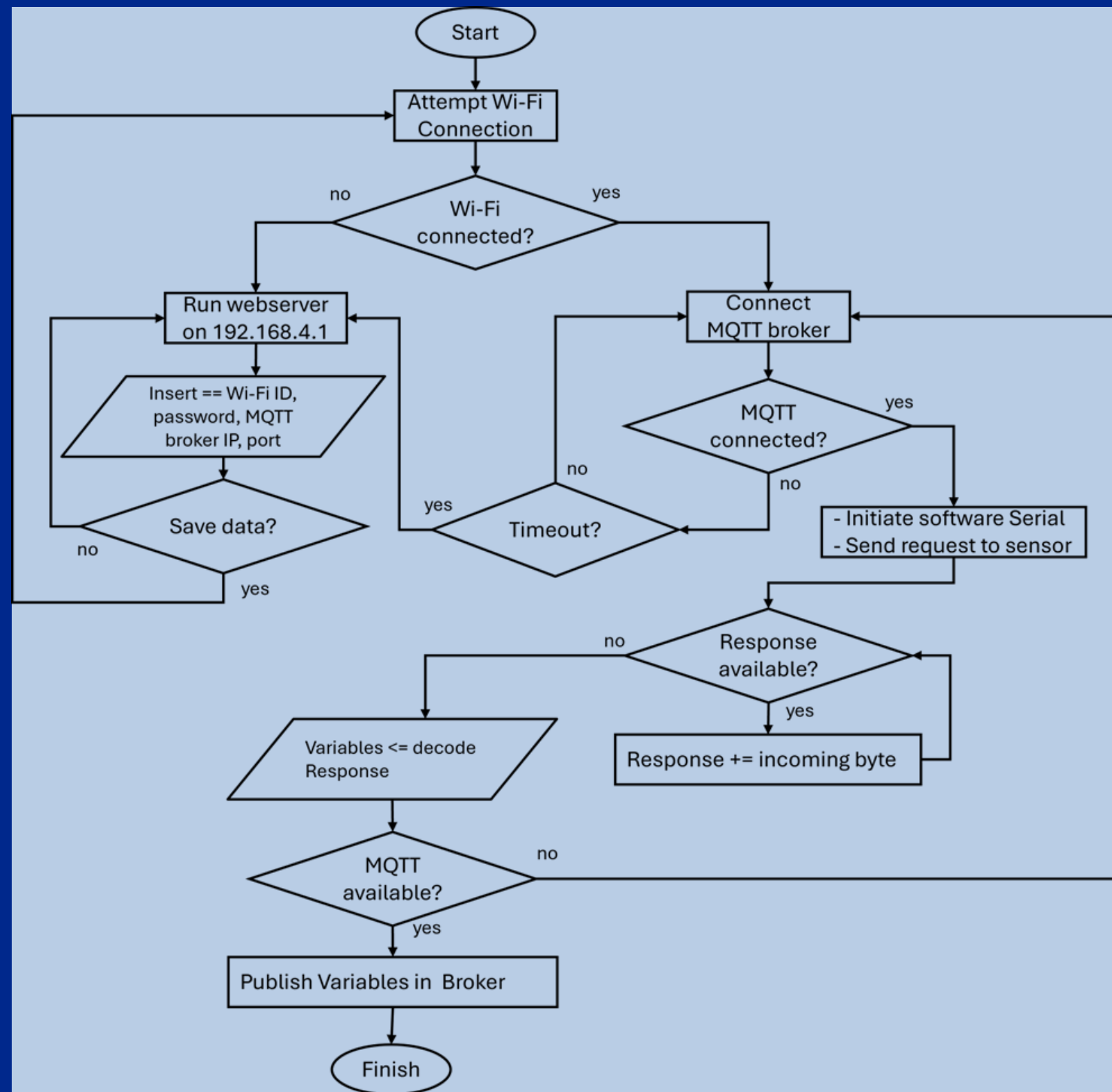
Sentinel 2 (B3, B4, B8), NDVI, NDWI, NDRE

IoT NPK Sensor – Hardware



1. NPK Soil Sensor
2. MT3608-2A
3. ESP32 Microcontroller
4. MAX485 Module
5. (A) 3D printed Case – Top
(B) 3D printed Case – Bottom

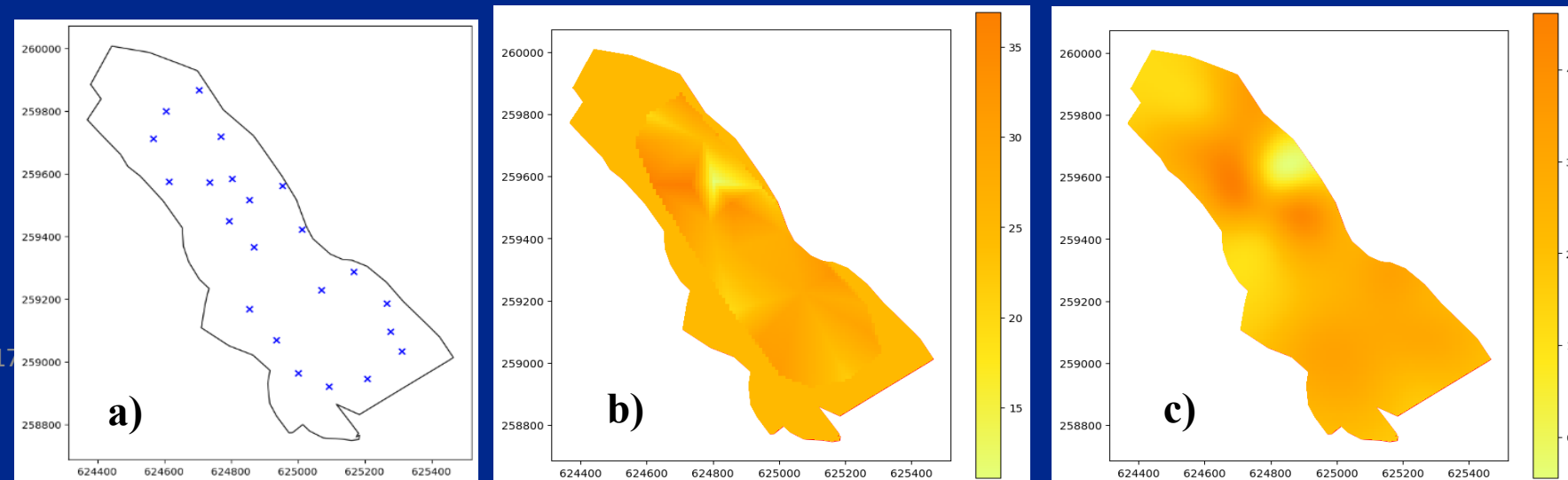
IoT NPK Sensor - workflow



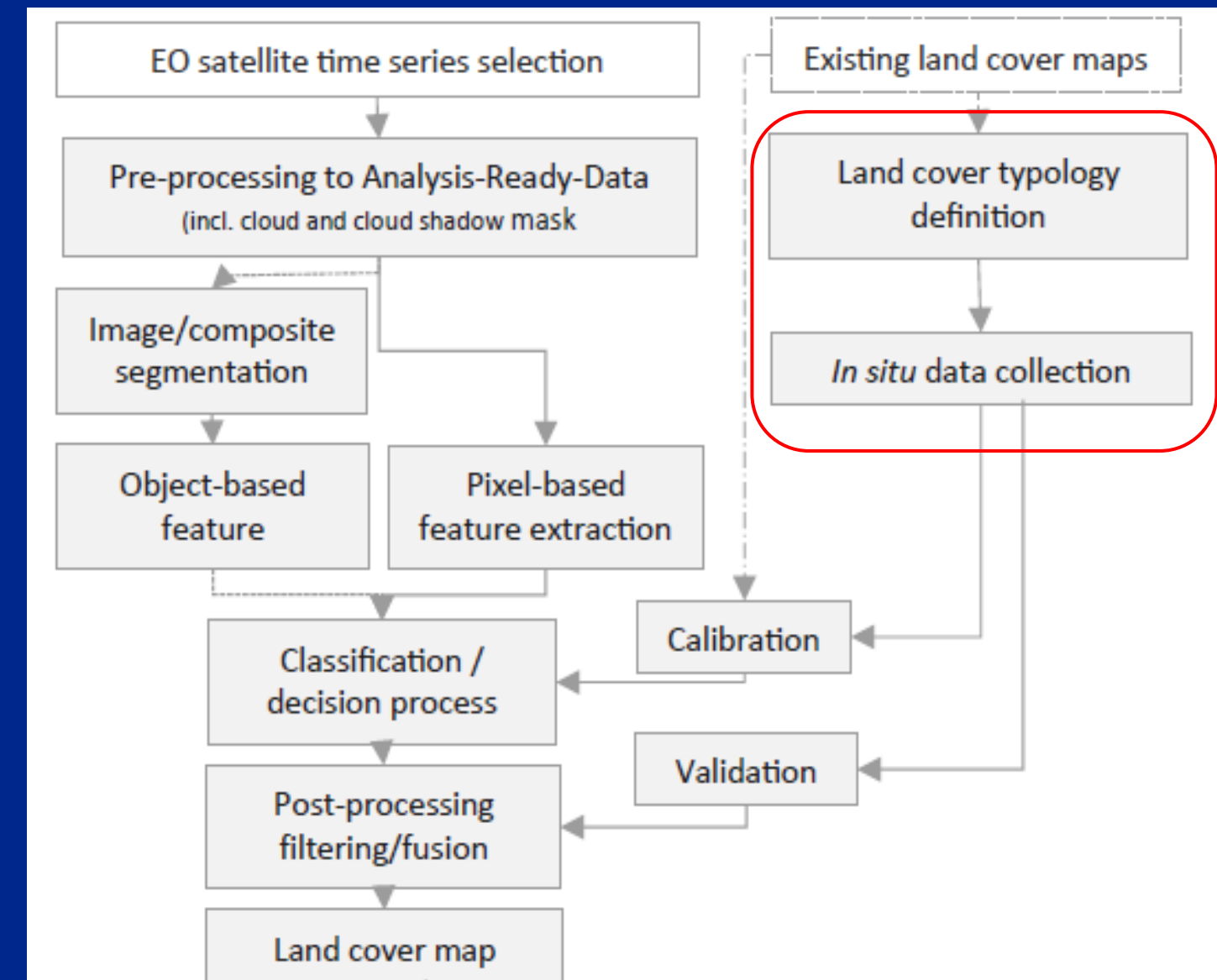
3/17/2026

1. Wi-Fi connection
 - a) Webservice @ 192.168.4.1
2. MQTT communication
3. Request sensor lecture
4. Decode response
5. Publish if MQTT available

The Purpose - Land Cover Maps



(Csolnok) Moisture



Generic workflow for land classification with EO data

AGROPATH PROJECT

Advanced Geomatics and Remote Observation for Precision Agriculture in Higher Education

Grant Agreement: 101238034

Funding Agency: European Education and Culture Executive Agency (EACEA)

Programme: Erasmus+ International Capacity Building

The project focuses on the **creation and modernization of innovative geomatics-related modules, enhancement of laboratory infrastructure, development of human resources, and establishment of an open access learning environment** for precision agriculture education.

Through cooperation between European, Ukrainian, and Moldovan universities, the project supports the introduction of modern technologies and teaching approaches aligned with the European Green Deal, digital transformation priorities, and the needs of sustainable agricultural development.

Dr. Alwahab Dhulfiqar Zoltán: Architecting Cyber-Physical Systems

Bridging academic research and elite industry IT standardisation.

Role: Associate Professor

Institution: Óbuda University

Faculty: John von Neumann Faculty of Informatics, Cyber-physical Systems Institute

Degree: PhD in Computer Networks and Information Systems



Full Cisco Accredited Instructor
(DevOps, Network Security,
Linux, Python, CCNA, CCNP)



**Huawei Academy
Instructor**



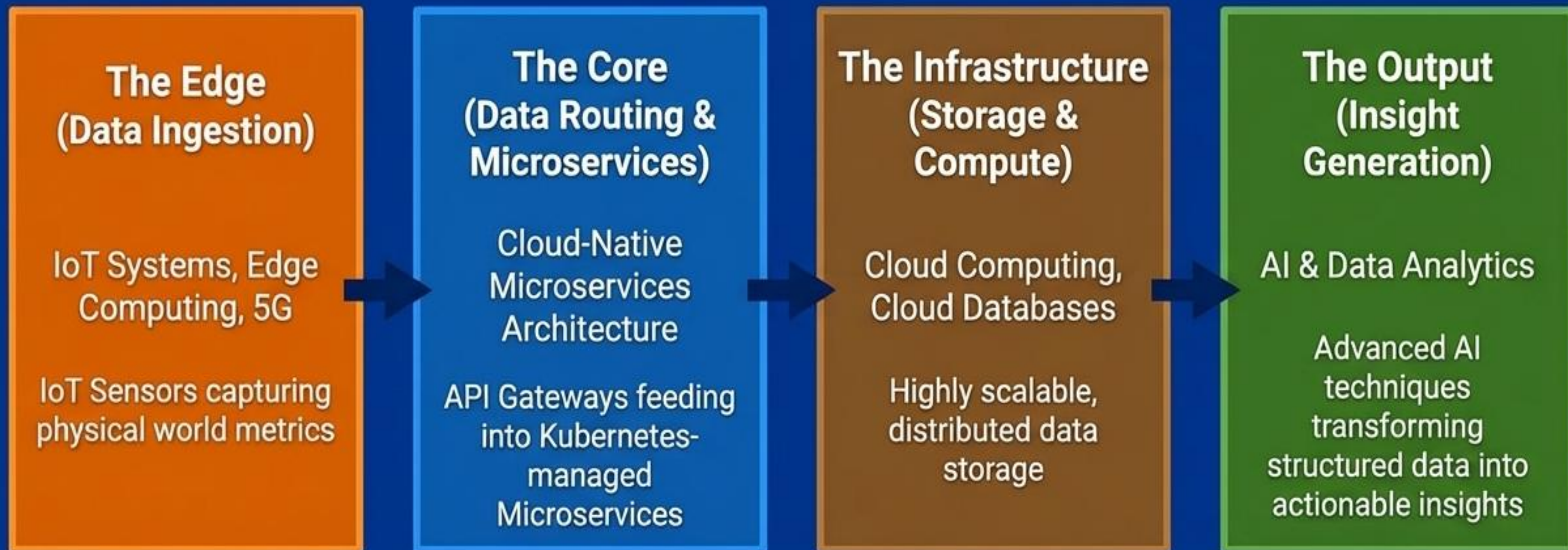
**AWS Academy
Instructor**



IC3 Instructor

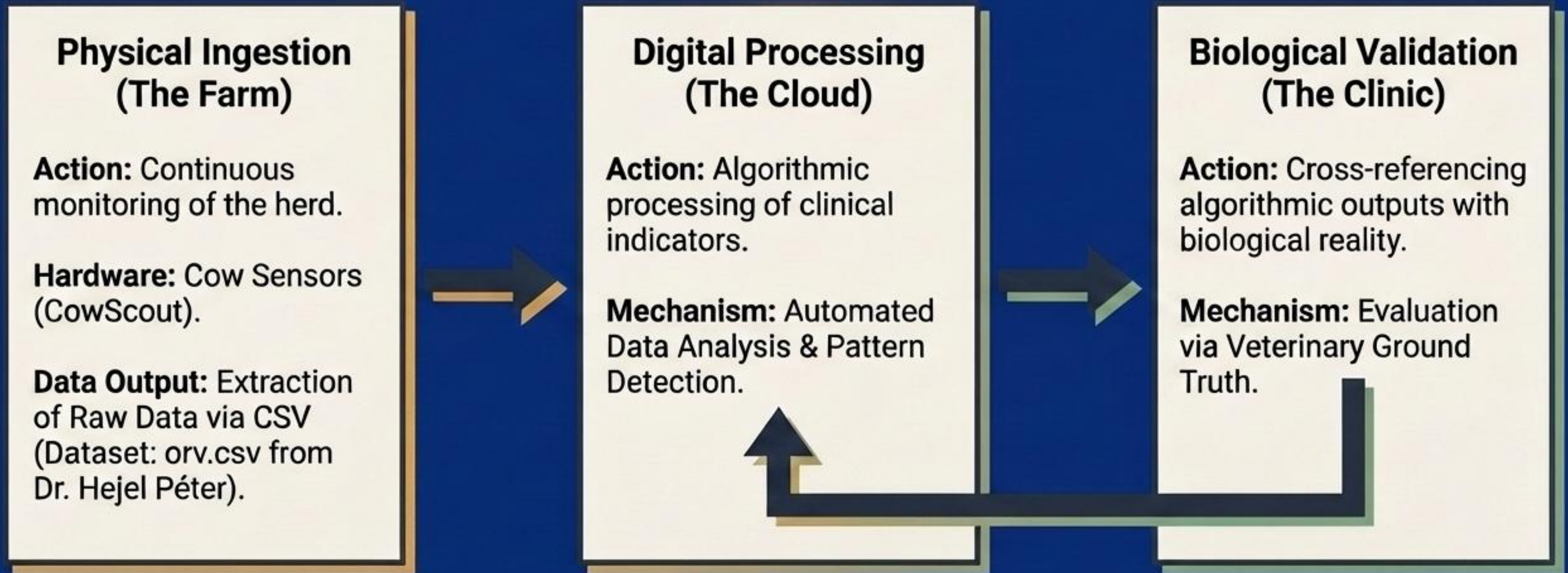
A Unified Cloud-Native Architecture

Research ecosystems powering the next generation of data-driven systems



Bridging IT and Agriculture: The PLF Pipeline

A precision livestock farming architecture that translates raw sensory input into veterinary validation.

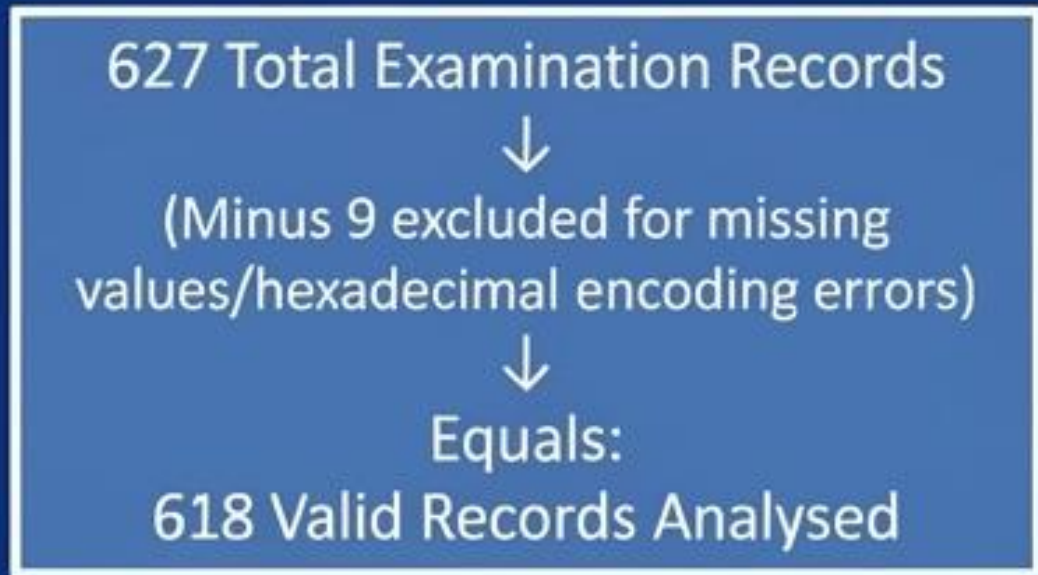


This work is with Angyalné Dr. habil. Alexy Márta.

Translating Infrastructure into Biological Insight

Body Condition Score (BCS) Analysis Report: 17 November – 22 December 2025
with Angyalné Dr. habil. Alexy Márta.

Diagnostic Comparison Matrix



Category	Biological Interpretation	Herd Finding
Low BCS (< 2.5)	Herd long its ta yets, enctting productive tmpositions.	Low andvers and endrogetic oppontance is reading from the meppra.
Optimal BCS (2.5 – 3.5)	Optimal bcs raction of markials send and production ei.mals.	Elift all BCS cohort hn and significant for anmetinghlig in cord costs.
High BCS (> 3.5)	High bcs nutritional managelability of reduceend health efficiency.	High BCS cohort called herd sirke. & reporting metabolic disorders and

Key Takeaway Insight Box

Management Directive:

While the herd remains generally stable (51.46% optimal), the significant 41.58% High BCS cohort indicates a risk of metabolic disorders and reduced production efficiency. Targeted nutritional management strategies are required to mitigate long-term health risks.

Designing for Uncertainty

Lessons from Computer Vision based Weight Estimation System in Large-scale Poultry Farming

Gergo Toth and Marta Alexy PhD

The Core Problem

Accurate models can still produce unreliable decisions

The system estimates livestock weight from camera observations.

However, the cameras only capture a portion of the flock. If the observed animals are not sufficiently numerous or representative, the estimated population weight may be biased or uncertain.

- Prediction accuracy is not enough
- Sampling and coverage determine reliability
- Uncertainty must be detected and flagged



How We Handle Uncertainty?

Reliable estimation requires more than averaging

Uncertainty is addressed through concentration bounds for assumption-light error control, sequential sample-size estimation for target gram-level precision, distribution-adaptive inference when Gaussian assumptions are not justified, and effective sample-size analysis based on unique-animal coverage and temporal dependence



Managing Risk, Not Eliminating It!



Uncertainty management is constrained by cost. Stronger assumptions reduce sample requirements but increase model risk, while distribution-free guarantees are safer but may be infeasible at high confidence. The practical goal is not zero error, but explicit and optimized risk.

Thank you for your attention!



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