

CSC 4255 – IoT System Design and Implementation

Course Overview
Georgios Bouloukakis

Winter 2024 - 2025

Internet of Things (IoT) definitions

*“The Internet of things (IoT) describes **devices** with sensors, processing ability, software and other technologies that connect and exchange data with other devices and systems over the Internet or other communications networks.”*



WIKIPEDIA

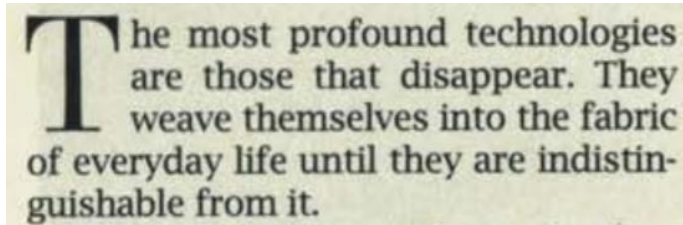
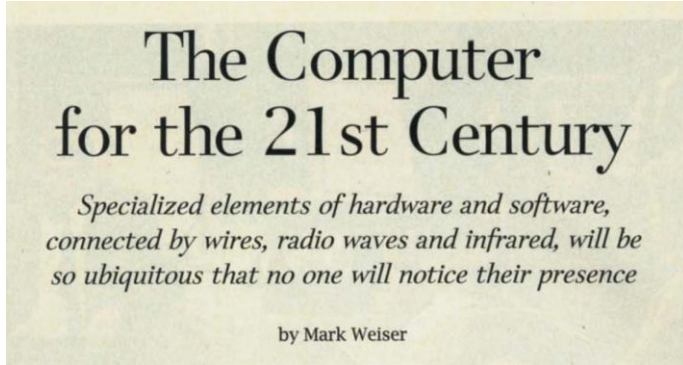
“The term IoT refers to the collective network of connected devices and the technology that facilitates communication between devices and the cloud, as well as between the devices themselves”



*“The IoT refers to a network of physical devices, vehicles, appliances and other physical objects that are **embedded** with sensors, software and network connectivity that allows them to collect and share data.”*



A long long time ago... 1991



That future is **here** and **now**
(for already some years)

“Coined by the Xerox Palo Alto Research Center’s (PARC) Computer Science Laboratory (CSL), [Ubiquitous Computing] describes **a vision of the future**. {...}

PARC scientists envision a future where mobile computational devices will be {...} transparent. Potentially numbering the 100s per person **these devices are nothing like those you use today**. They are **mobile**. They know their **location**, and they **communicate with their environment**”

IoT as a term?

“I could be wrong, but I'm fairly sure the phrase "Internet of Things" started life as the title of a presentation I made at Procter & Gamble (P&G) in 1999. Linking the new idea of RFID in P&G's supply chain to the then-red-hot topic of the Internet was more than just a good way to get executive attention”

History [\[edit \]](#)

By the late 1990s and the early 2000s, the idea of connecting home appliances to the internet ([Internet of Things](#)) had been popularized and was seen as the next big thing. In June 2000, [LG](#) launched the world's first internet refrigerator, the [Internet Digital DIOS](#). This refrigerator was an unsuccessful product because the consumers had seen it as unnecessary and expensive (more than \$20,000).

K. Aston



Henry Holtzman

“Internet of things was used internally at MIT Media lab no later than 1998”

JESSIE SCANLON 02.01.00 12:00 PM

THE THING NETWORK

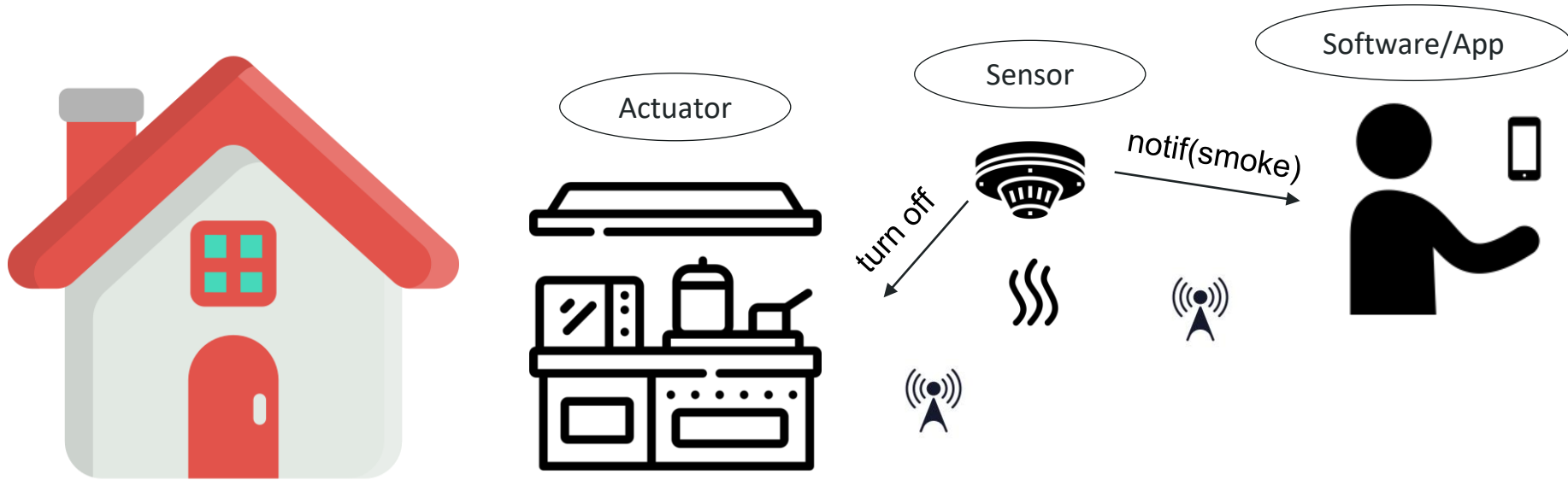
SHARE



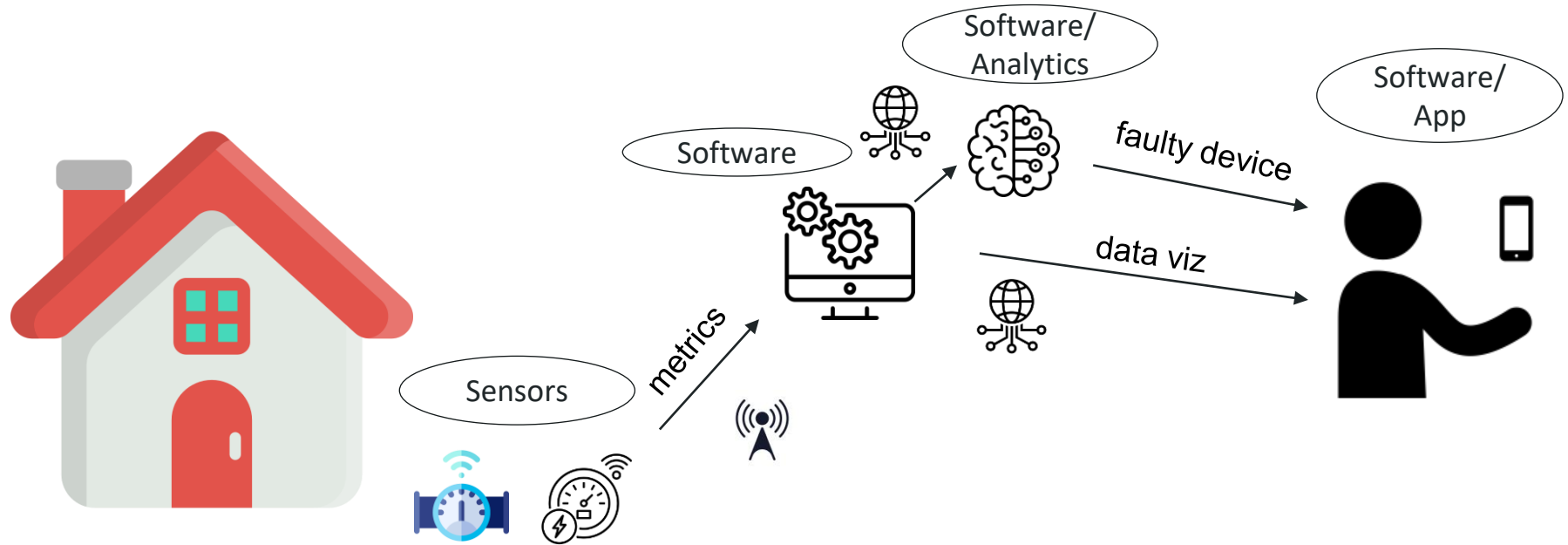
CONNECTIVITY

Forget Net objects. Henry Holtzman dreams of an Internet in which everyday objects are the key to online interaction. In Holtzman's pervasive-computing vision, if you hold an empty pill bottle up to your PC, it will call up prescription information. A child's toy will trigger online games or link to related sites. Walk into a Starbucks, flash your card in front of a reader, and you'll get your usual, charged to your account.

IoT system definition: smart kitchen



IoT system definition: smart metering

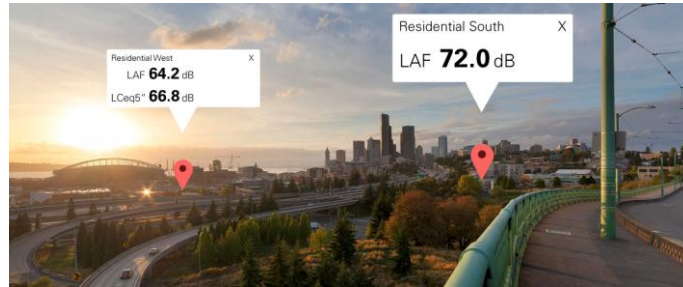


- IoT systems that require complex hardware/software infrastructure

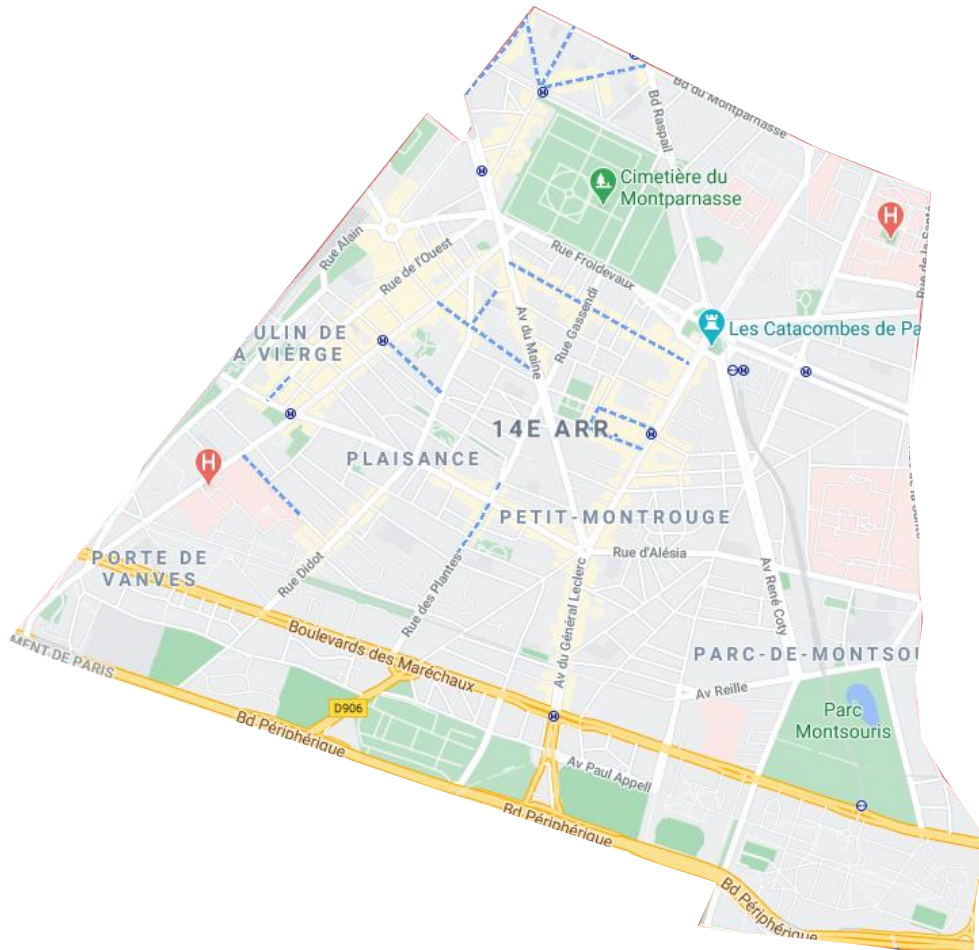
IoT deployments for numerous application domains



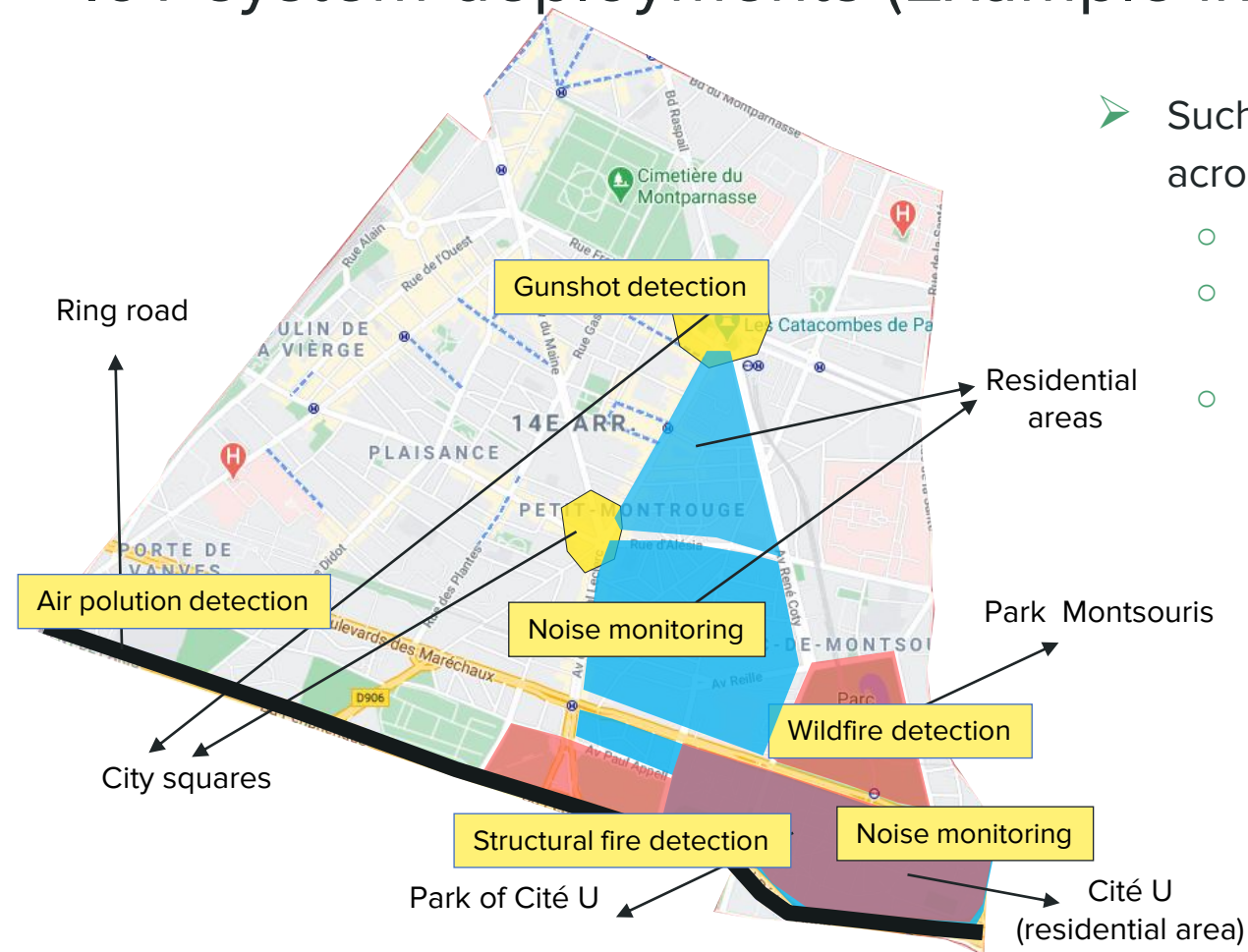
IoT system deployments (Examples)



IoT system deployments (Example in 14th arr. of Paris)



IoT system deployments (Example in 14th arr. of Paris)

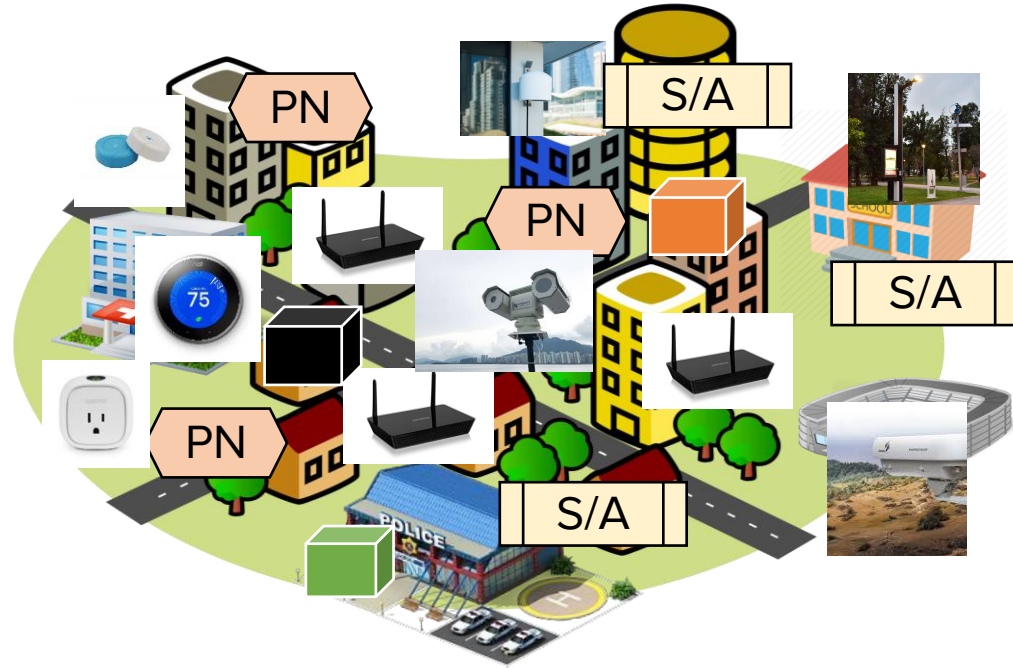


- Such applications include devices across multiple layers:
 - **device-layer:** sensors and actuators
 - **middleware-layer:** processing nodes, mediators, message brokers
 - **network layer:** access networks & access points (APs)

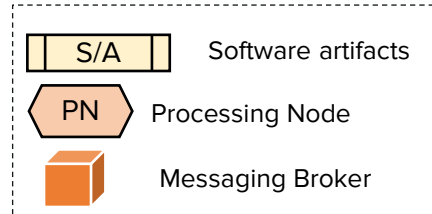
How to design and implement an IoT system?

IoT systems require:

1. IoT devices (sensors/actuators)
2. APs for network access
3. Processing nodes (PNs) for IoT Analytics
4. Software artifacts (S/A) for interoperability
5. Messaging systems (e.g., Broker) for Data Exchange



➤ **Manual, “by experience” & complex process !**



CSC 4255 Main Objective

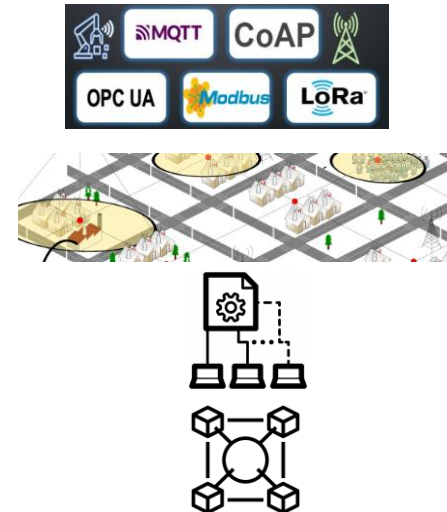
- Acquire skills for prototyping end-to-end IoT systems
 - starting from the real IoT device, to the actual application



How?

By leveraging:

1. IoT protocols across multiple layers
2. Techniques for IoT device placement
3. Distributed software overlay architectures
4. Existing data models for interoperability



Teaching Team

- Instructor: Georgios Bouloukakis, CS
 - <https://gbouloukakis.com>
- TA:



Nikolaos Papadakis



Material

- IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things
 - by David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry
- Internet of Things: Principles and Paradigms
 - by Rajkumar Buyya, Amir Vahid Dastjerdi, and Shanto Reaz
- **Mainly slides**

Lectures

- Lectures:
 - Schedule online on SI-etudiants & personal website
- One website with access to ALL Lectures:
 - <https://gbouloukakis.com/courses/csc4255-w25/>
- Access to:
 - syllabus, announcements
 - lectures schedule, slides and materials:
 - username: 'csc4255_w25'
 - password: 'iotsystems'
 - IoT project description
 - slides



Labs

- TAs:
 - Nikolaos Papadakis
- The same website for labs:
 - <https://gbouloukakis.com/courses/csc4255-w25/labs/>
- Moodle “messageboard” for Q&A and Announcements:
 - <https://moodle.ip-paris.fr/course/view.php?id=6798>

Communication with the Instructor

- Office hours:
 - D309
 - Wed 14:00-14:30pm
- Do you have questions?
 - Preferred way: **by e-mail**

What to Expect

➤ Content/Lectures:



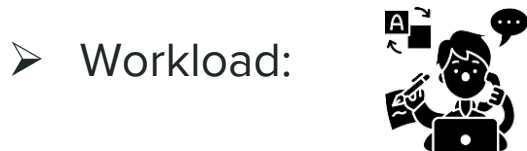
- Sensor properties and network access protocols
- Sensor placement techniques
- Software overlay architectures
- Techniques for data processing
- Context-aware data modeling

➤ Content/Labs:

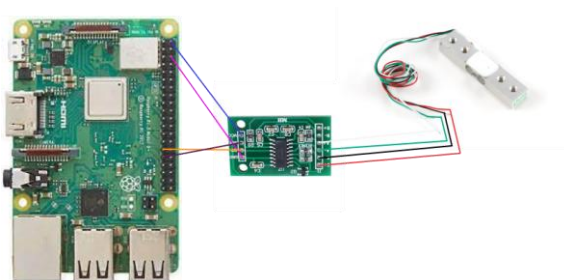


- Sensor deployment and programming using development boards
- Design of APIs for data exchange
- Implementation of virtual sensors and deployment
- Data visualization

What to Expect

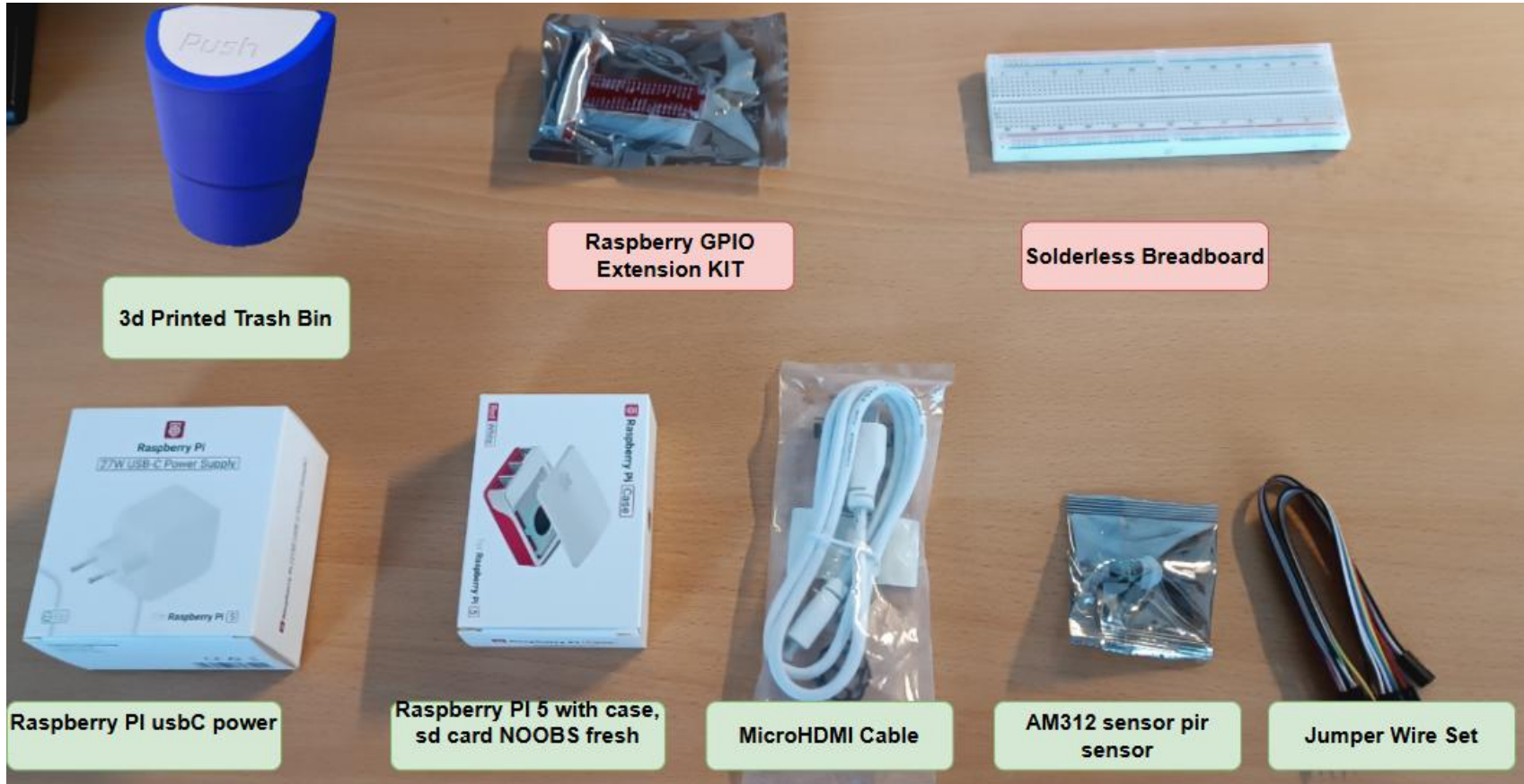


1. IoT project: The **Smart Waste Bin** project



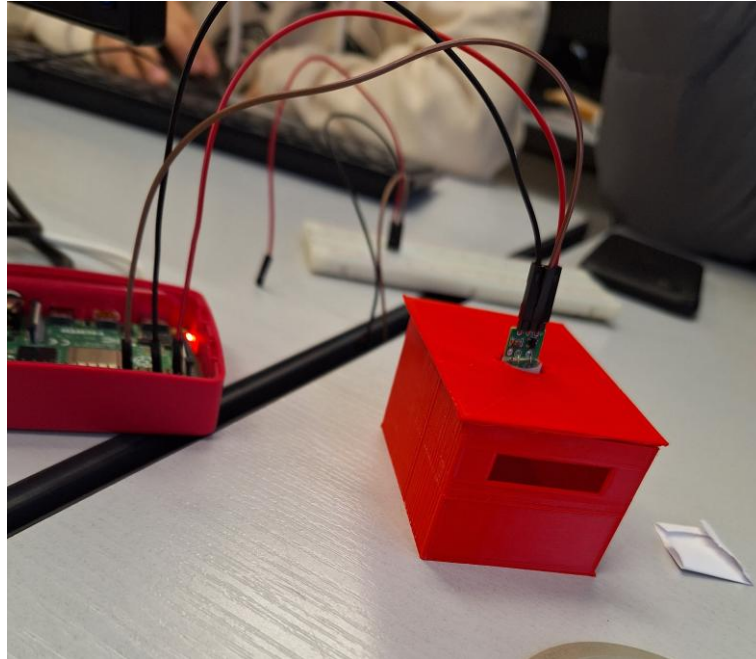
2. Final exam

Your Equipment



Last year's project

- Smart Mailbox project



Evaluation

- Labs and Lectures participation – 10 %
- IoT Project – 50%
 - Design and architectural choices
 - Implementation
 - Final defense including a demo
- Final Exam – 40%

Thank you



<https://gbouloukakis.com/courses/csc4255-w25/>