PIC Project — Meeting 1 Minutes

Emergency Water Supply System

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1. Communications Department

An update was provided regarding **external contacts currently in progress**.

Contact	Status
Civil Protection	Response received — **meeting scheduled in Monsanto**
Águas de Portugal	Contact in progress through **vice-director connection**
Fire Department	**No email response yet**

Proposed Alternative

To facilitate communication with firefighters:

- Contact a **member with connections to the military sector**, who may help establish communication channels.

2. System Architecture

2.1 Basic Unit — Tank

The **tank** is the fundamental building block of the system. Each tank operates as an **autonomous module** integrating:

- Energy supply
- Sensors
- Actuators
- Local control

Energy System

Each tank will include:

- **Solar panel**
- **Power Management (PM) system**
- **Battery**

Power Management Responsibilities

The PM system will charge the battery and power the microcontroller.

Battery Requirements

The selected battery should be **AGM deep-cycle**, **12 V or 24 V**. For the **prototype**, a **motorcycle battery provided by the professor** may be used.

Microcontroller (1 per Tank)

Two microcontroller options are under evaluation: **STM32** and **ESP32**. Evaluation criteria include:

- Energy consumption
- **Availability of GP10 pins**
- Architecture advantages and limitations

Microcontroller Responsibilities

The microcontroller will manage the **UV system**, **all sensor readings**, and communication with the **Raspberry Pi**.

Sensors — RS485 Communication

All sensors will communicate using the **RS485 protocol**. Planned sensors:

- Turbidity sensor
- pH sensor
- Conductivity sensor
- Temperature sensor
- Ultrasonic sensor (water level measurement)
- ATP sensor *(Adenosine Triphosphate)* for biological contamination detection

Actuators

The system includes the following actuators:

- **Ball valve**
- **Hall-effect flow sensor**
- **Water circulation pump**
- **Carbon filter** (sealed system with limited lifetime)

Power Control

Actuators will be controlled using a **Gate MOSFET**. The microcontroller sends a logic signal; the MOSFET switches the required power. Further investigation is required for MOSFET dimensioning and voltage/current requirements.

UV Disinfection System

Two possible implementations were discussed:

Submerged Spike Lamp

- Installed directly inside the tank
- **Simpler to implement**
- Possible limitation in **water circulation**

Flow-Path UV Lamp

- Installed in a **water flow passage**
- Water circulation naturally ensures exposure over time

For the **prototype**, the **submerged spike solution** will be implemented due to its simplicity. A remaining research topic is determining the **maximum time water remains safe without UV exposure**. The UV system is considered **optional** and may depend on **field deployment conditions**.

2.2 Phase 2 — Microcomputer and LoRa Communication

Each tank will include a **Raspberry Pi**, responsible for network communication and additional processing. The Raspberry Pi connects to the **microcontroller** and the **LoRa module**.

LoRa Integration Options

- **LoRa HAT** *(preferred solution)*
- **USB interface** *(prototype alternative if cost is high)*

LoRa Use Cases

- Tank-to-tank communication
- Tank-to-gateway communication
- Data transmission to the **central database**

Why 4G Was Discarded

- Higher energy consumption
- Additional operational cost
- Redundant compared to LoRa

Energy Dimensioning

A **dimensioning spreadsheet** will be created to analyze energy requirements for **24 hours**, **36 hours**, and **72 hours**, covering all system components for proper sizing of battery capacity and solar panel area.

Display

Each tank will include a **dot matrix display** providing **system status information** and **instructions for the user**.

3. User Authentication

The **fingerprint solution** was discarded due to sensor degradation in outdoor environments, hygiene concerns, limited flexibility, and possible legal implications.

Authentication Options Under Study

RFID

Users receive an **ID via SMS before a disaster** or download an **access token**.

NFC

Use of **NFC chips** as an authentication medium.

Phone Wallet Card

Users download a **digital card to their phone wallet** when the system is deployed. The final decision will be based on technical feasibility, ease of deployment, and implementation cost.

For the prototype we will use the **Técnico Card**.

4. Macro Architecture — Tank Network

The system will consist of a **distributed network of interconnected tanks**, organized through **gateways and intelligent nodes**.

LoRa and Gateways

LoRa communication will support tank-to-tank and tank-to-gateway communication. Each gateway includes an antenna system and a **mini-server managing nodes in its geographic area**.

Possible Deployment Locations

- Generators
- Fire departments
- Civil protection facilities
- Military installations

Tanks periodically send **status updates**, which are collected by the gateway and forwarded to the **central database**.

Intelligent Node

An **intelligent node** may manage a **cluster of tanks** (e.g., six tanks). Users authenticate at this node and are directed to a specific tank.

Example instruction:

> *Go to tank 2, 3, or 4.*

Problem — Network Failure During Disaster

During catastrophic scenarios, a **gateway may lose internet connectivity**, creating the risk that a user may withdraw water from **multiple tanks without central validation**.

Solution — Local Distributed Ledger

A **local distributed ledger** was proposed. Operation flow:

- User requests water (e.g., **3 L**)
- Gateway checks the **local ledger**
- Ledger validates the request
- User quota is updated

Gateways **synchronize ledgers through LoRa communication**. When internet connectivity returns, **synchronization with the central server** occurs.

Maintenance Minisite

A **local maintenance minisite** will be hosted on a gateway, allowing a maintenance worker to access:

- Water quality per tank
- Amount of water withdrawn per user
- Network-wide water availability map

5. Tasks and Next Steps

External Relations

- Prepare the **meeting with Civil Protection**
- Publish the **meeting minutes with LAIST** on the project blog

Software Engineering

- Search for a suitable **LoRa Gateway**
- Acquire a **Raspberry Pi** for prototype integration
- Analyze **partner models (copy department)**
- Publish a **blog post announcing that the website is operational**

Statistics

- Analyze **water rotation without UV**
- Calculate **solar panel area requirements** for 24 h, 36 h, and 72 h

Geography

- Select **specific locations for tank installation**

- Choose **two pilot parishes** to study the network topology

Hardware and Communication

Components to be investigated and selected for the prototype:

- Ball valve
- Sensors
- Dot matrix display
- ATP sensor
- Solar energy system
- Microcontroller
- AGM battery
- Circulation pump
- Gate MOSFET
- Carbon filter
- Flow sensor

End of Meeting Minutes — PIC Project