



Tube Monitoring System

Team 11

Introduction

Project Statement: The current methods to detect high pressure leaks are expensive, time-consuming, and in some cases, require specialized training.

- Constraints:**
- The power source of sensors unit will run out after a while because the unit will be powered by a battery.
 - The bandwidth limitation of Bluetooth (the theoretical maximum distance is 240m).
 - Tubes have different diameters which will limit the size of sensors unit.
 - Heat from the surrounding could damage the device.
 - Powering of the sensors for extended periods of time.
 - Compatibility of different standard

- Deliverables:**
- A device that detects high frequency leaks via microphones.
 - A device that is installed easily on the tube and can endure high temperatures.
 - An easy to use application that has user-friendly interface.

SPECS

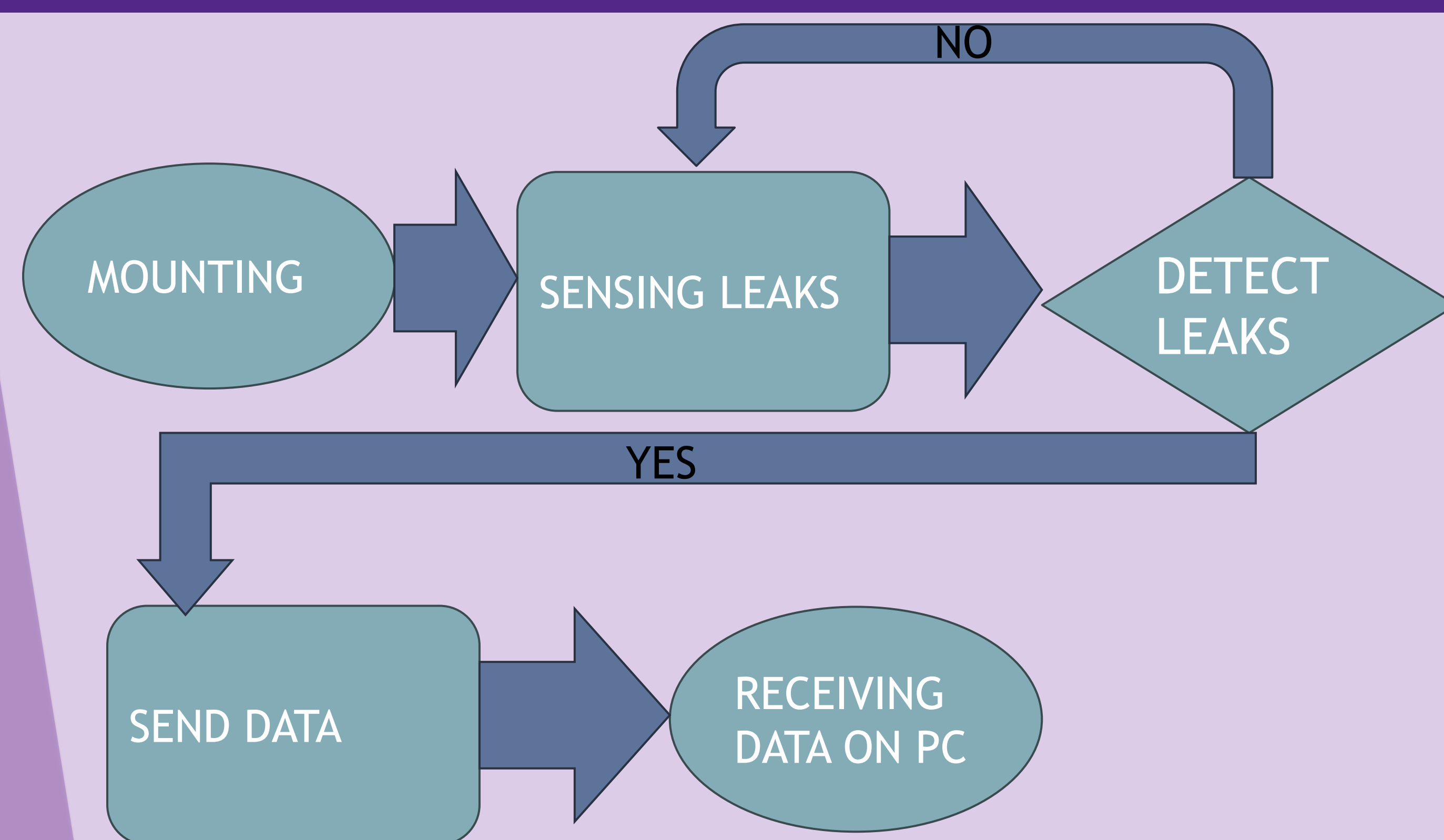
The system must be compatible with both copper and PEX tubes.

The system must allow up to 5 sensors unit at a time

The system must be compatible with tubes from 0.5inch to 3.5inch.

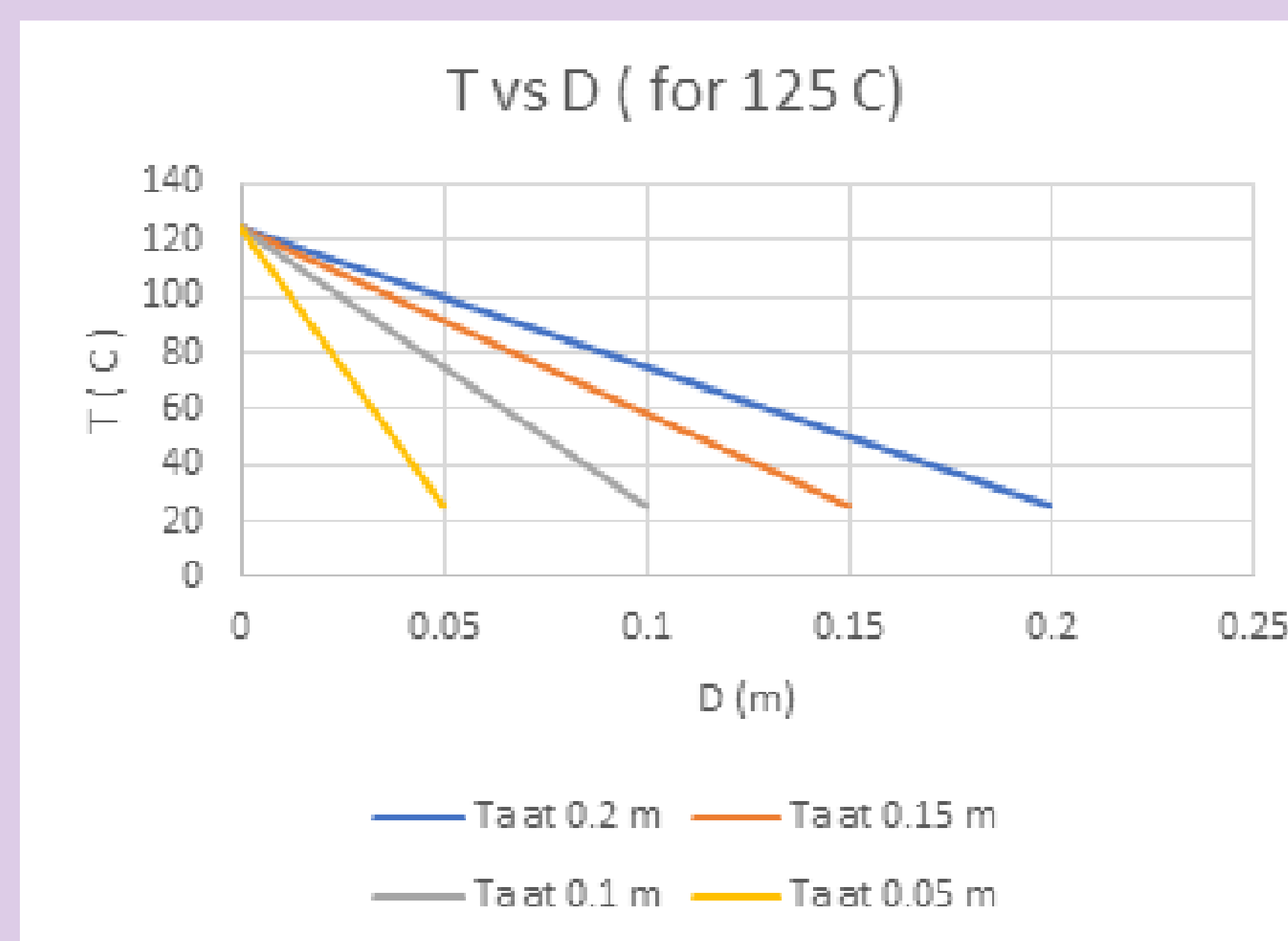
The system must be able to work at a temperature of up to 125C (the temperature of silicon oil)

Function of Product



the product monitors high-frequency leaks in tubes through means of microphone sensors mounted on the tube's junctions' points. The product aims to detect these leaks early before they can cause significant damage

Heat and communication



Each line represents the temperature gradient according to the distance in which the ambient temperature is reached. I used a constant heat flux with each line. Naturally, by varying the distance of the ambient temperature, the heat flux will be varied as well. With this graph, we have a rough idea about how far from the pipe's surface the device should be placed



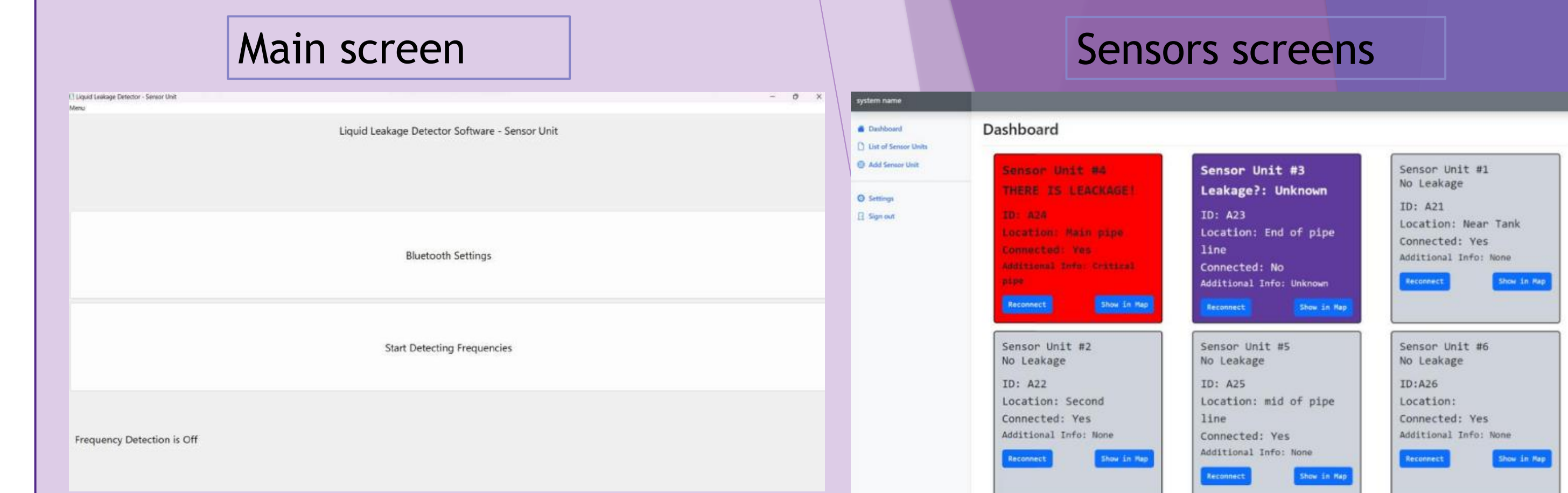
- Our product leverages Bluetooth 5 Low Energy to achieve an extended range while maintaining high compatibility. Additionally, by utilizing PCIe Gen3 and up, we can support up to 10 units on a standard single-socket server and up to 6 units on a standard ATX motherboard. Our product is compatible with Mac, Windows, and Linux operating systems.

mounting Details

Thanks to our innovative mounting design that utilizes a simple metal ring, we are able to mount our device on tubes ranging from 0.25 inches to 3 inches in diameter while maintaining control over the distance to the tube. Additionally, our case provides protection for our device and allows us to mount the microphone on the case itself.



Interface and testing Testing



• One of the primary advantages of our system is its user-friendly interface. Our innovative software for detecting sensor units has allowed us to further declutter the interface, making it even simpler to use.

• We conducted two primary tests. The first test involved creating a few leaks in a PEX tube and measuring the frequency in a 30-decibel noise floor room. The second test involved implanting a factory by having an iPad play a video of a transformer factory while a phone was playing high-frequency sound (the leak sounds)



Conclusion

• We are currently working on improving our product to enable independent device connectivity, regardless of the host. Our design research and prototypes incurred a total cost of 2313.54 SAR. The production unit is expected to cost 400 SAR, while we plan to sell it for 3000 SAR. This pricing strategy will make our device highly competitive in the market.