



**Universidade do Minho**  
Escola de Engenharia



**UMINHO**  
**cmems**  
CENTER FOR MICROELECTROMECHANICAL SYSTEMS

Master's in Industrial Electronics and Computers Engineering

University of Minho

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# 5S Drifter

Sensoring System for Surface Sea Streams

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Integrative Project in Industrial Electronics and Computers

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## Acronyms

**UART** Universal asynchronous receiver/transmitter

**LTE** Long-Term Evolution

**ADC** Analog to Digital Converter

**IMU** Inertial Measurement Unit

**PCB** Printed Circuit Board

**CMEMS** Center for Microeletromachanical Systems

**STM32**

**DMA** Direct Access Memory

**IoT** Internet of Things

**GPS**

**JSON**

**DB** Data Base

# Chapter 1

## Project Plan

This chapter will briefly talk about the 5S Drifter project motivations as well their function as a product developed by the Minho's University under supervision by the professors Luis Gonçalves and Sérgio Lopes.

### 1.1 Introduction

Under the course unity of Integrative Project in Industrial Electronics and Computers the students must apply for professors projects in order to integrate under their respective laboratories and start to understand the pace demanded on the Master's final paper.

This project, given by the professor Luis Gonçalves and Sergio Lopes under the CMEMS laboratory, has the main purpose to create a drifter for data acquisition. As a multi-themed project, this report will explore multiple areas, as the PCB design for hardware and firmware manufacture, software design under the idea to optimize the execution allowing for better performance. The main goal is to have the final product afloat at the end of the semester.

#### 1.1.1 Problem Statement

The ocean is one of the man greatest mystery even before the written history. Humanity made the world ours over the water, from the Portuguese greatest discoveries, braving the raging ocean to the newest oil tanker demanding ever newer technology in order to tame the sea for safer and smoother sailing.

Nowadays scientists believe only 20% to 26% of the ocean is discovered with the actual technology which means that humanity know as much about our so great sky as our own seas. 5S ocean drifter is a equipment made to acquire data from superficial sea streams and expand the oceanographic knowledge about it.

Better knowledge of the ocean lead to further development in diverse areas. Granting safety, security and efficiency.

5S, an acronym for Sensing System for Surface Sea Streams is a low-cost, low-power solution to acquire said data with the focus to last autonomously for the longest time possible. The drifter has to attain its GPS coordinates in order to track its current and average velocity, alongside with the water temperature and a accelerometer information to gather information about the wave intensity. All this data will be stored locally and transmitted by a protocol, yet to be defined, with a JSON format in order to be received by a database that already is implemented.

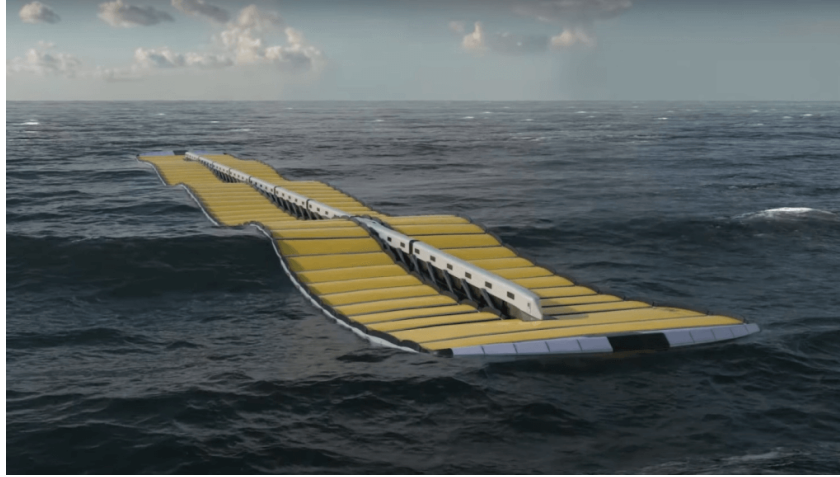


Figure 1.1: The Design of a Wave Energy Converter to Electricity

## Transport

Sadly, it isn't uncommon to see transport accidents being reported, and even worse, for it to be a gigantic problem. Some of these accidents are caused by poor mapping of sea conditions, tankers spilling oil, fishing vessels capsizing, leading to financial problems and even loss of life. Even when there are no accidents, poor knowledge of tides results in higher energy consumption when routes are set against the currents.

A solution would be to create optimized shipping routes, minimizing accidents and improving energy efficiency while traversing the waves. Oil tankers could follow currents with lower fuel consumption. Fishing routes could become more efficient, as their target species may swim with the tides based on temperature and speed. This would ease the workload, making the activity less reactive and more predictable, aligning expected catch rates with reduced time and energy consumption.

A well-known example of a hazardous area is the Nazaré Canyon, where its unique shape creates enormous waves. Avoiding these waters is crucial for safer navigation.

## Ecology

### Habitats

The placement of wave energy converters, a growing field under the energy generation, is one of the main problems the technology faces. A good positioning improves the efficiency

Renewable Energy

## Oceanography

Better understanding of the Iberian Poleward Current (IPC)

## Geology

Know where the sedimentation is leading to



## Sports

### 1.1.2 Problem Statement Analysis

As a first step into solving this project, an initial construction of the demands is requested. Here will be presented, following the waterfall approach and UML standards, the solutions to the individual problems presented by the project.

#### 12324

vila do conde + ou - 10km mar adentro 2g 4g  
mapa de alcance na costa  
atenção ao clima  
latencia / sampling / tamanho do cartão sd  
autonomia de NO MINIMO 50 DIAS  
consumo médio max 5mA  
distancia da antena e da água  
IMU caso tenha espaço para o consumo  
SD memoria local  
ADC a bateria  
sensor de temperatura  
database mongo db

## Threads

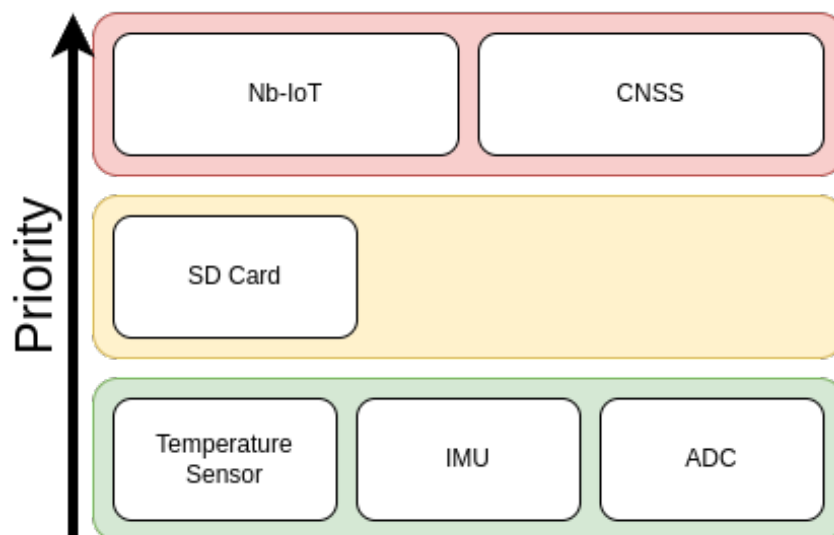


Figure 1.2: Thread Priority Stack



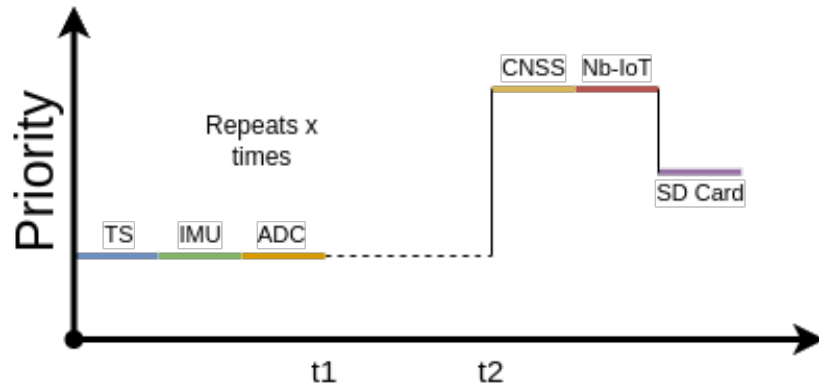


Figure 1.3: Thread Temporal Graph

## Block Diagram

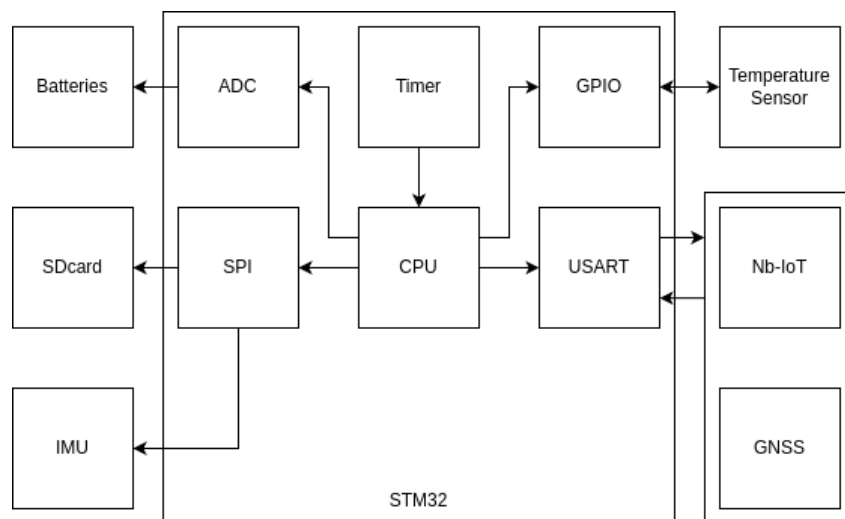


Figure 1.4: Block Diagram

## Use Case

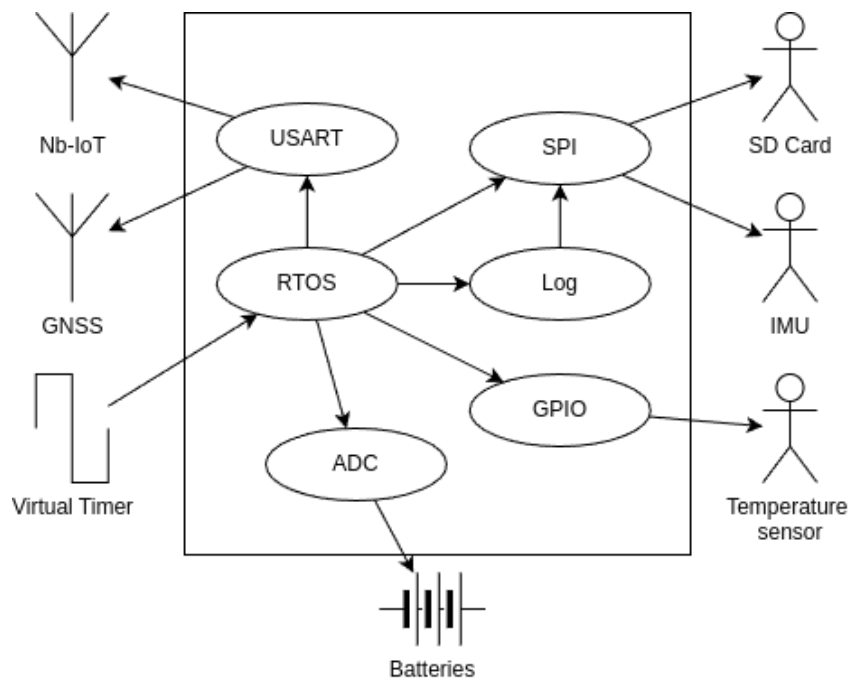


Figure 1.5: Use Case Diagram

## Sequence Diagram

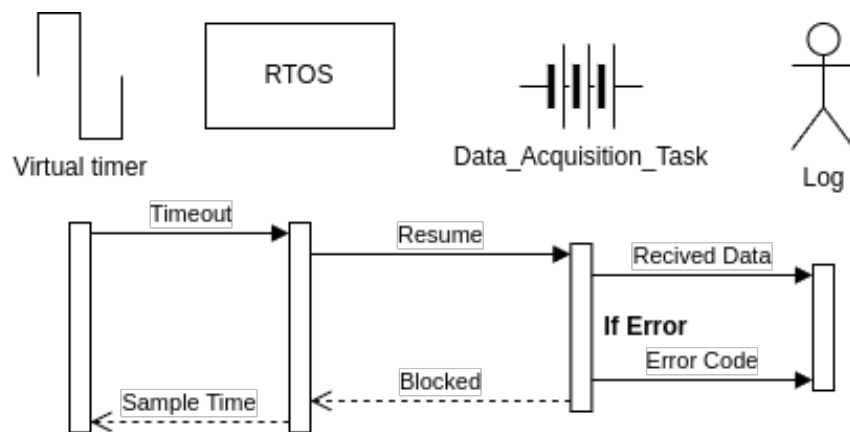


Figure 1.6: Thread Priority Stack

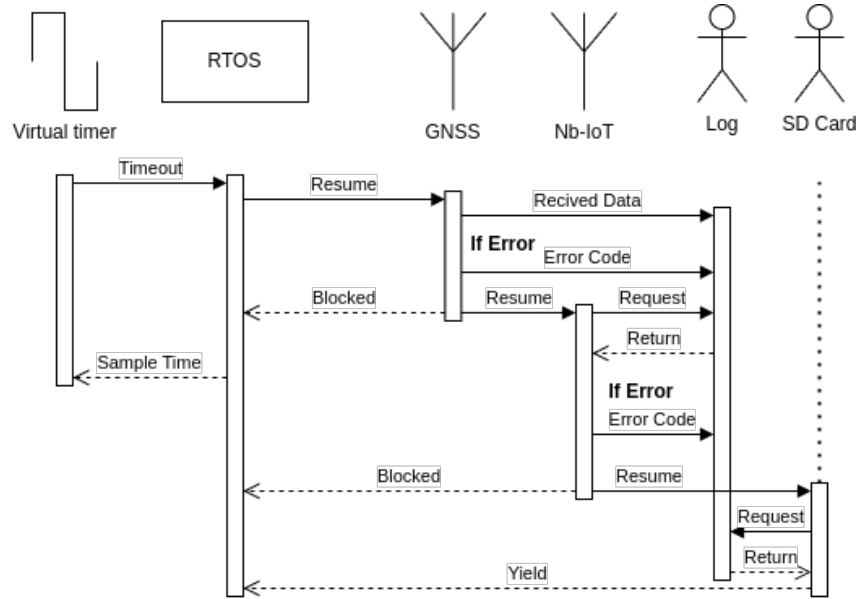


Figure 1.7: Thread Priority Stack

# Chapter 2

## Analysis

### 2.1 Requirements and Constraints

#### 2.1.1 Requirements

- Search and selection of hardware components.
- Software design.
- PCB design.
- 5S outer shell 3D design.
- Actual product realization.
- Laboratory tests.

#### 2.1.2 Constraints

- The project must be presented for avaluation within deadline.
- The project has to be valitated at the ocean.
- The pretended autonomy has to be of a mouth at minimum.

### 2.2 State of the art

#### 2.2.1 Economy

#### 2.2.2 Ecology

#### 2.2.3 Sports

### 2.3 Market Research

### 2.4 System Architecture

# Chapter 3

## Design

### 3.1 Analysis Review

### 3.2 Hardware Consumption

Here will be discussed wight hardware is best sued for the task. The hardware will be evaluated by their autonomy, the communication protocol

#### 3.2.1 Autonomy

As for the autonomy there are two main factors to consider, the batteries and the board consumption

##### Batteries

google sheets

##### Board Consumption

possible solar energy solar penel AEM10941 SM111K06L  
table

SIM7600 table 6 and 34 (pg 20 and ) same voltage 2 SIM7020 peak 2A 20u in sleep mode  
150mA

SIM7000 (GPS por NB-IoT e 2G fallback) Consome: 11mA

SIM7080G - Nb-IoT Quectel BG77

Quectel BG95-M3

GPS MAX-M10S

tele2

IMU BMI088 IMU Sensor accelerometer 15uA / and Gyroscope 2.7mA ISM330BX 0.19mA  
/ 0.6mA activate BDU

BMI270

Unix Steptime

#### 3.2.2 Communication protocol

table EVKITST87M01-1 nb-iot SIM7600 2g 3g 4g LTE CAT4

simbase chip availability

europe coast 2g 4g



	Portugal	2G	3G	4G	5G	LTE	NB-IoT
Meo		V	V	V	–	–	–
Nos		V	V	–	–	–	–
Vodafone		V	–	V	V	V	–

### 3.2.3 Conclusion

## 3.3 Case Construction

Diagram

## 3.4 Hardware Specification

### 3.4.1 SDCard

### 3.4.2 STM32

STM32L010K4T6 microcontroler ADC UART SPI ONEWire

### 3.4.3 BMI088 IMU Sensor

gyroscope and acelerometer

### 3.4.4 SIM7600E-H

The module SIM7600E-H, developed by SIMCom, is a 4G/3G/2G LTE module that communicates via UART commads using an intern parser described on the module datasheet. The waveshare Board with the module, comes with a set of extra functionalities for extra support to the module normal usage.

The following image, taken from the Waveshare board datasheet, lists the hardware features.

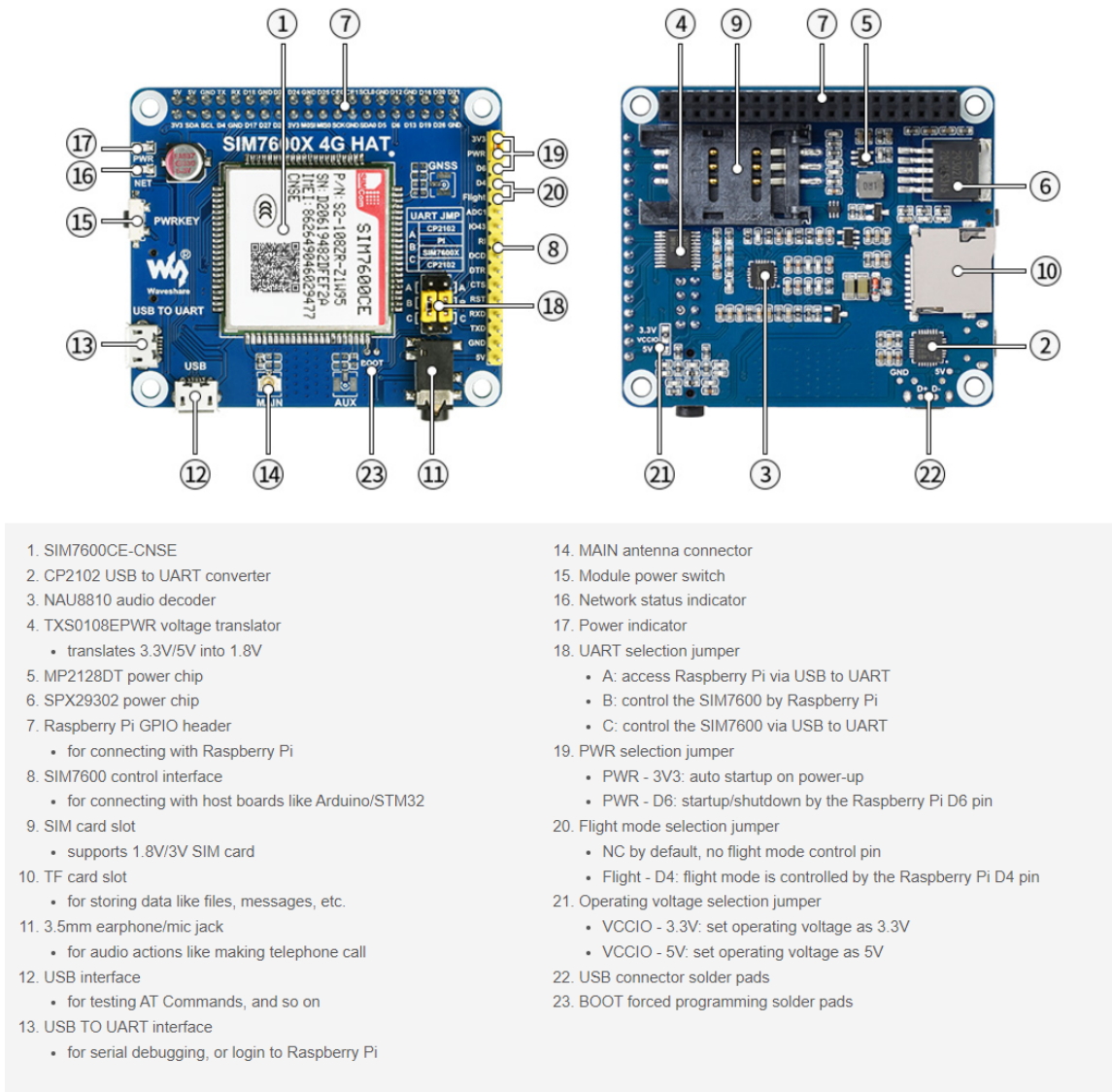


Figure 3.1: SIM7600 datasheet

The hardware configurations, as indicated on the datasheet should follow the leading steps.

As for the UART communication, the list of commands are listed on the datasheet. As for better flow, here are listed the commands used along the project and their functionalities.

### 3.4.5 Temperature

DS18B20



## 3.5 Tools and COTS

### 3.5.1 Tools

### 3.5.2 COTS

GPS and 4G module

Inkscape

draw.io

STM32 CUBE<sub>mx</sub>

L<sup>A</sup>T<sub>E</sub>X

## 3.6 Software Specification

## 3.7 Theoretical Concepts



## Chapter 4

# Implementation

### 4.1 Hardware

### 4.2 Software

use DMA to sample without using the cpu  
separar funções do IMU e GNSS para não atrapalhar um ao outro.

#### 4.2.1 DataBase Communication

Mongo db

JASON

## Chapter 5

# Conclusion

### 5.1 Gantt Diagram

### 5.2 Bibliografy

### 5.3 Special Greatings

At last it's important to add the support from the CMEMS labs personal as well of the professor Tiago Matos for his support with hardware decisions and previous knowledge from similar projects.