ETSI The Standards People

IoT Conference 2023

Towards a Low Cost Modular Telemetry System and Navigation Aid for Sailing Vessels

Presented by:

UNIVERSITAS STUDIORUM UTINENSIS

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UniUD Sailing Lab

Lab Village Module M6

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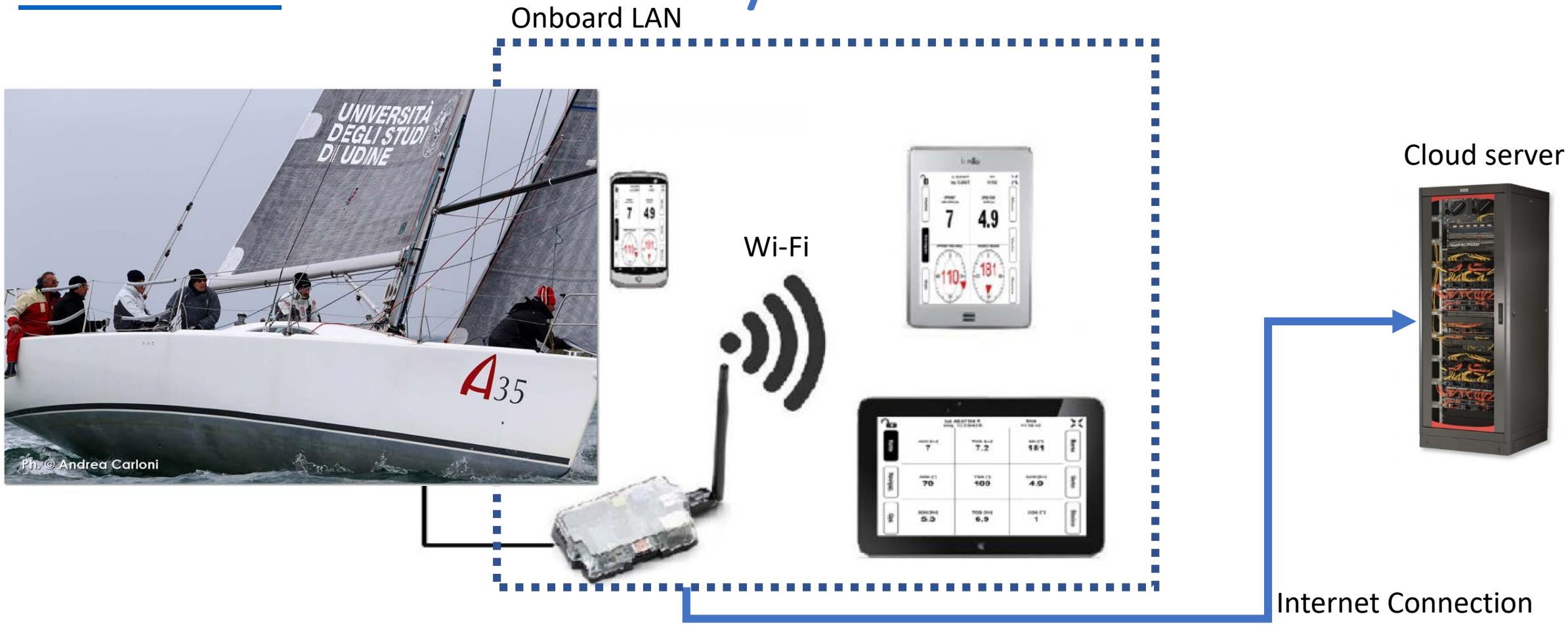
UniUD Sailing Lab

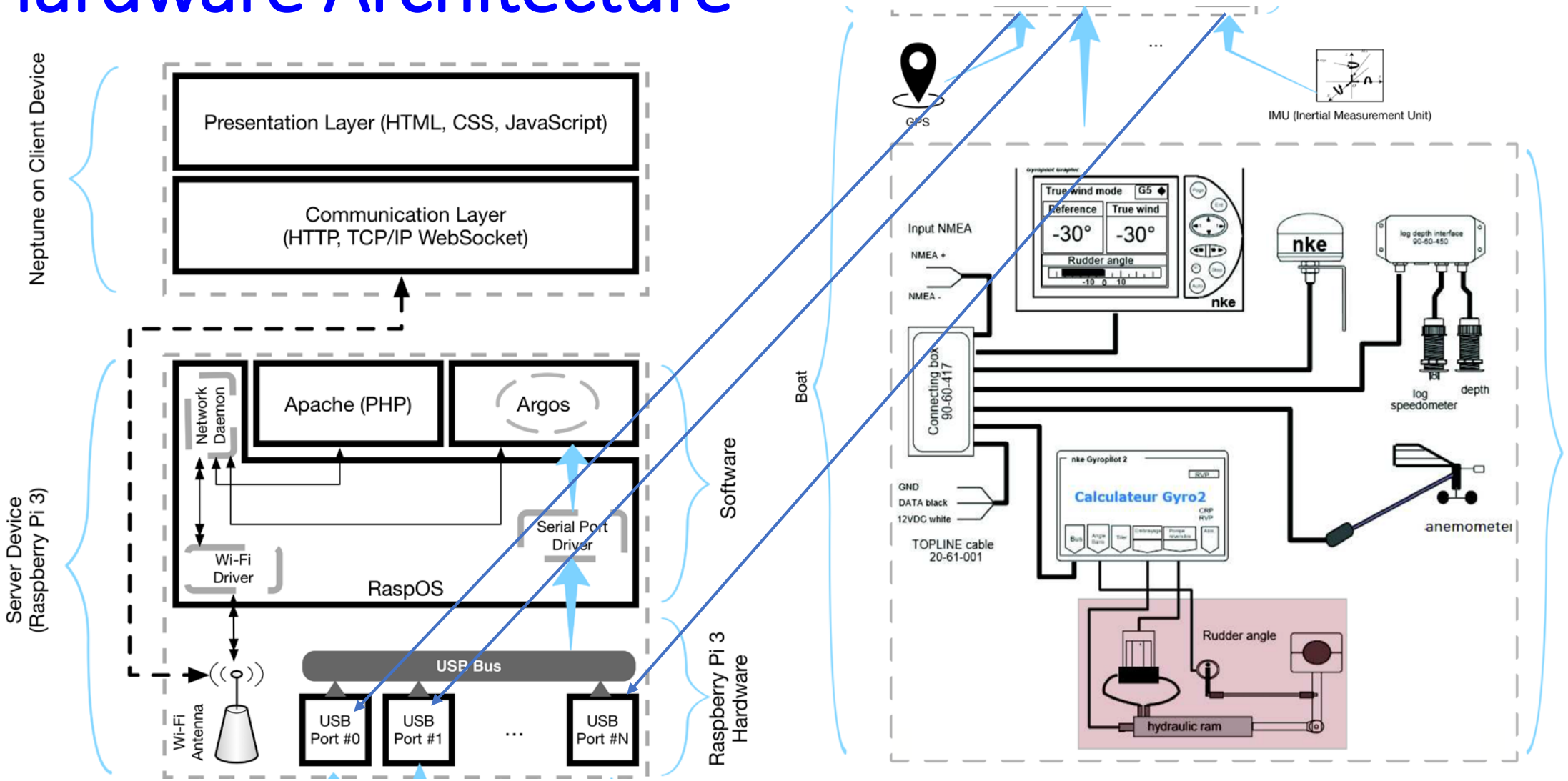
- The Uniud Sailing Lab is a **multidisciplinary** laboratory promoting studies, design and experiments devoted to **improving sailing performances** and **safety** on board.
- Main research topics involved in the lab:
  - electric and electromagnetic compatibility on board;
  - electronics and sensors;
  - computer science (IoT programming, data storage & analysis, user interfaces);
  - hull reverse engineering;
  - development of biocomposite materials.

Oceanus: the onboard system



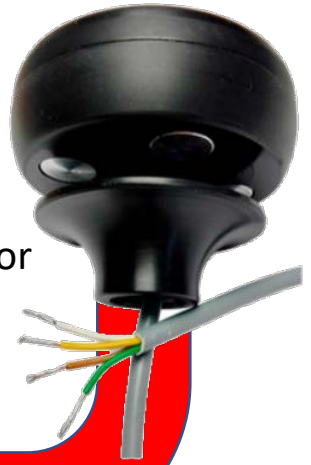
- Harvesting, processing and publishing data
- User interface (web client for smartphones, tablets, PCs, etc.)
- Online and offline navigation data analysis

Hardware Architecture



Argos: monitoring and logging (in real-time) onboard sensors data

Differential sensor of pressure on sails (designed and built in-house)



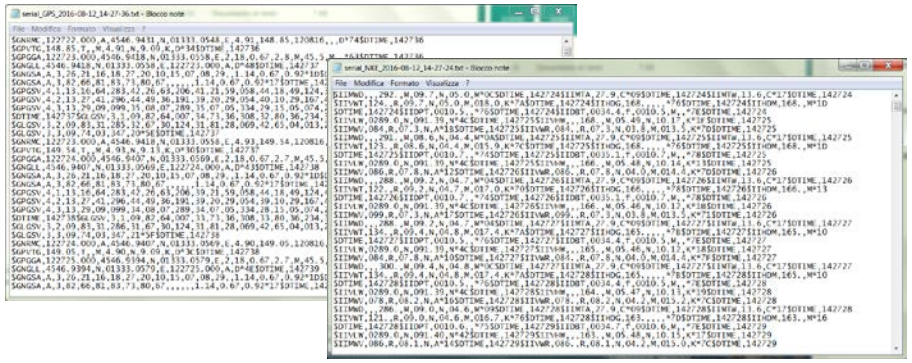
Ultrasonic wind sensor

Raspberry Pi 3 Mod. B+

+

IMU: accelerometers, compass, gyroscopes

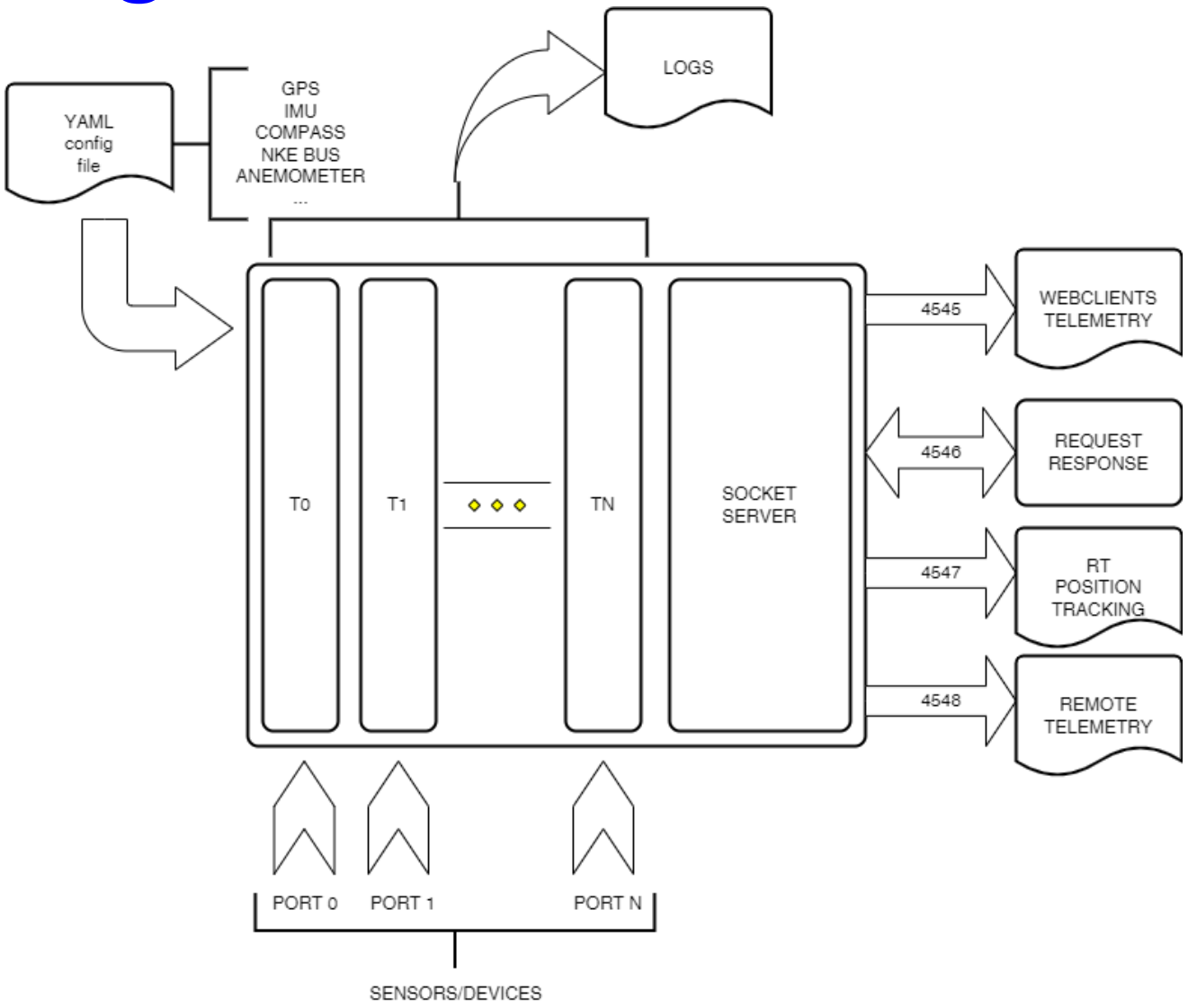
GPS



NMEA log files

Built-in boat sensors

Argos: software architecture



- **YAML config file**: system configuration (connection parameters to sensors/devices);
- **PORT0, PORT1, … , PORTN**: connected devices and sensors
- **T0, T1, … , TN**: concurrent threads: each one handles a sensor/device (PORT0, PORT1, … , PORTN)
- **LOGS**: log file
- **SOCKET SERVER**: it handles network communications:
  - **4545**: telemetry publishing socket for the Neptune web interface;
  - **4546**: socket for dealing with request/response connections;
  - **4547**: socket used to communicate to the land server the GPS coordinates of the boat;
  - **4548**: socket used to communicate to the land server the telemetry of the boat.

Argos: harvesting and publishing data

```
UNIUD  SAILING  LAB
Running YAML parser...
CONFIG LOADED: Argos - UniUD Sailing Lab
Loaded params for RUNNING-MODE: -rs232
Loaded params for LOG-FILEPATH: log/
Loaded params for LOG-FILENAME: log_151122_1101.txt
Loaded params for DATA-FILEPATH: data/
Loaded params for SERIAL PORTS module: 1 serials found.
```

Socket 4545

```
{
  "aws" : "16.00",
  "awa" : "-25",
  "lat" : "45.788413",
  "lon" : "13.532613",
  "x" : "1508615.498183",
  "y" : "5754791.763729",
  "sog" : "0.01",
  "cog" : "192",
  "mh" : "103",
  "sow" : "0.03",
  "tws" : "16.2",
  "twa" : "-25",
  "sogp" : "-6.68",
  "togp" : "13",
  "delta_vmg" : "-5",
  "delta_awa" : "2",
  "delta_twa" : "13",
  "delta_vpp" : "-999",
  "vmg" : "0.03",
  ...
}
```

Local Wi-Fi

Socket 4546

```
{
  "command": "polar",
  "tws": "9.7", "twap":
  "124.0", "twas": "-72.0"
}
```

```
{
  "speedp": "7.273267",
  "speeds": "7.167200"
}
```

Internet Connection

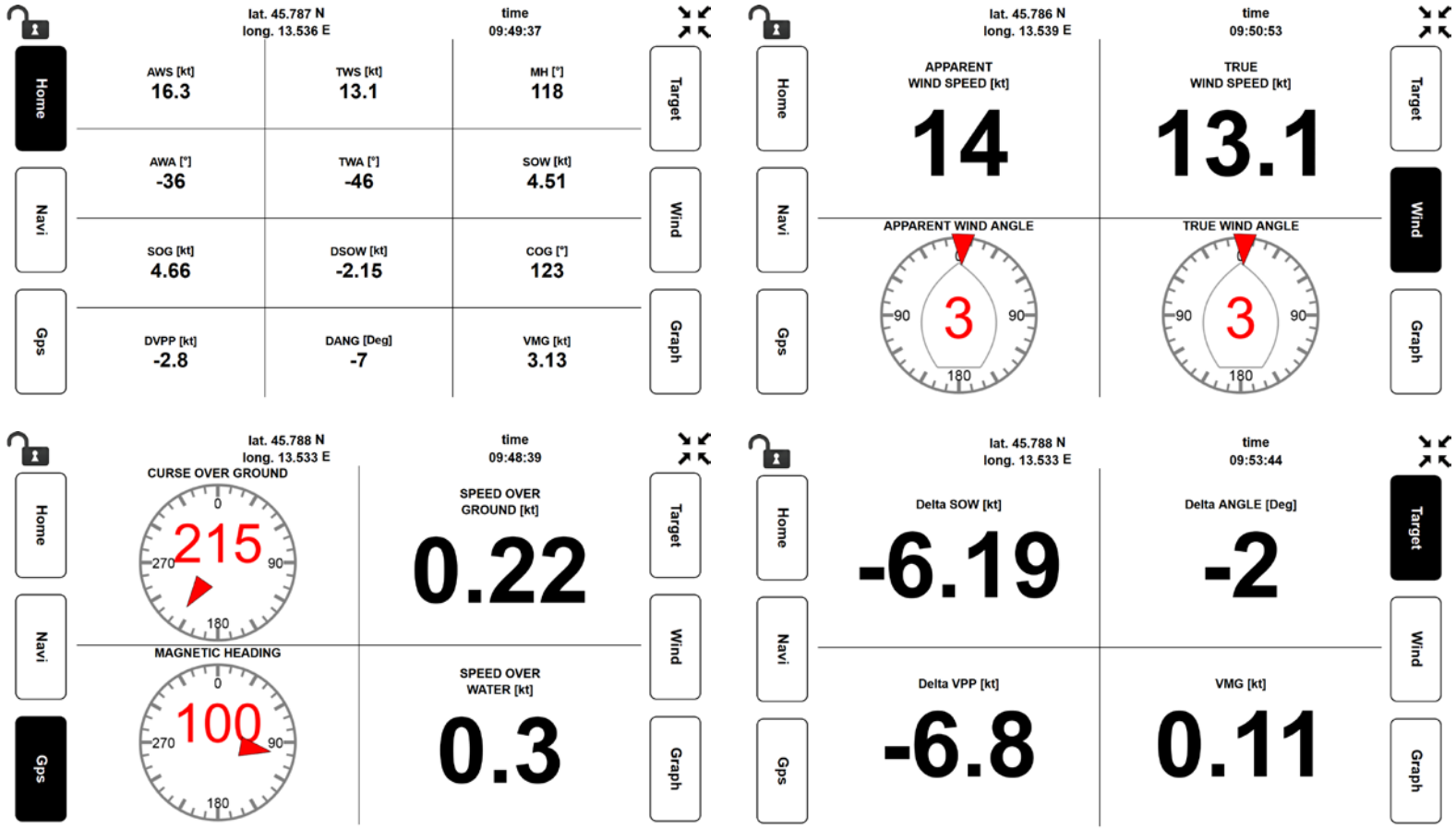
Socket 4547

Socket 4548

Land Server

Neptune: user interface

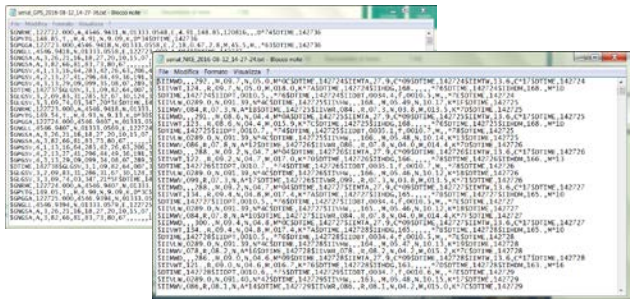
- The user interface is a web application (written in **PHP** and **JavaScript**) which can be used on a **Kindle** (in order to be visible under the direct sunlight).
- It can be fruitfully used on every **browser** supporting basic JavaScript on every OS.
- The browser connects to the **Apache** web server running on the **Raspberry Pi** on the local Wi-Fi network.



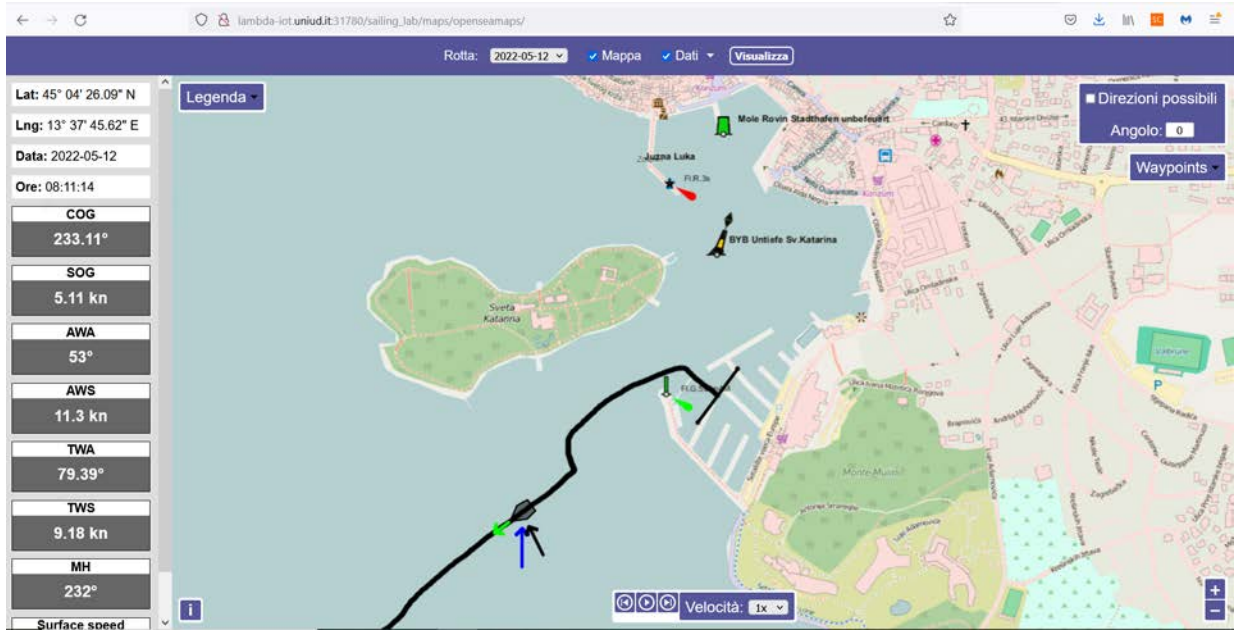
Real-time Race Analysis

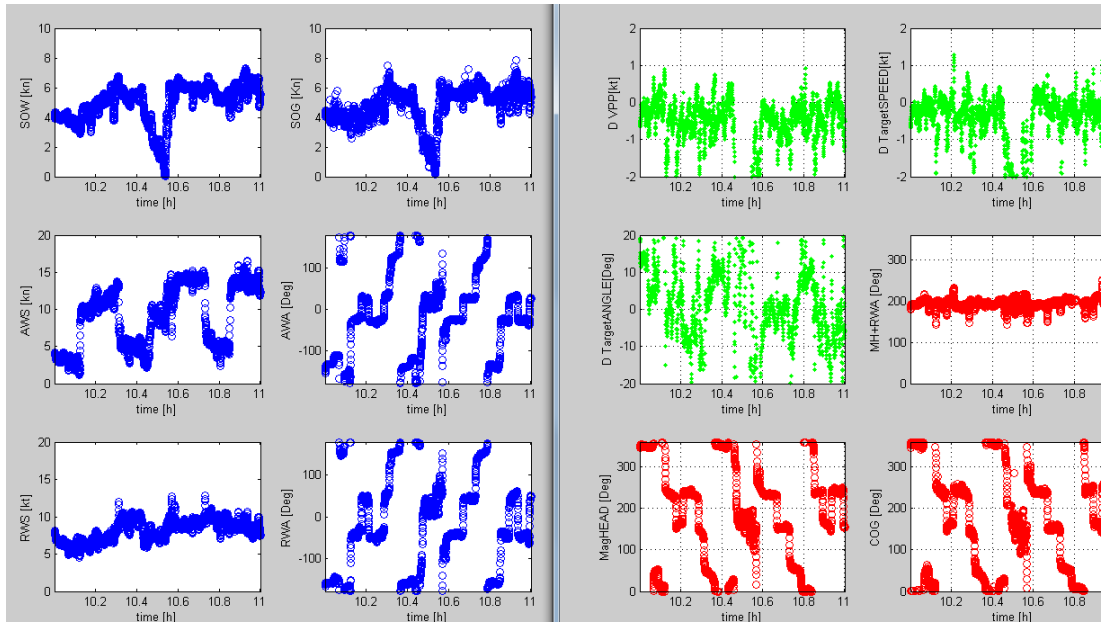
Post-regatta Data Analysis

Log files

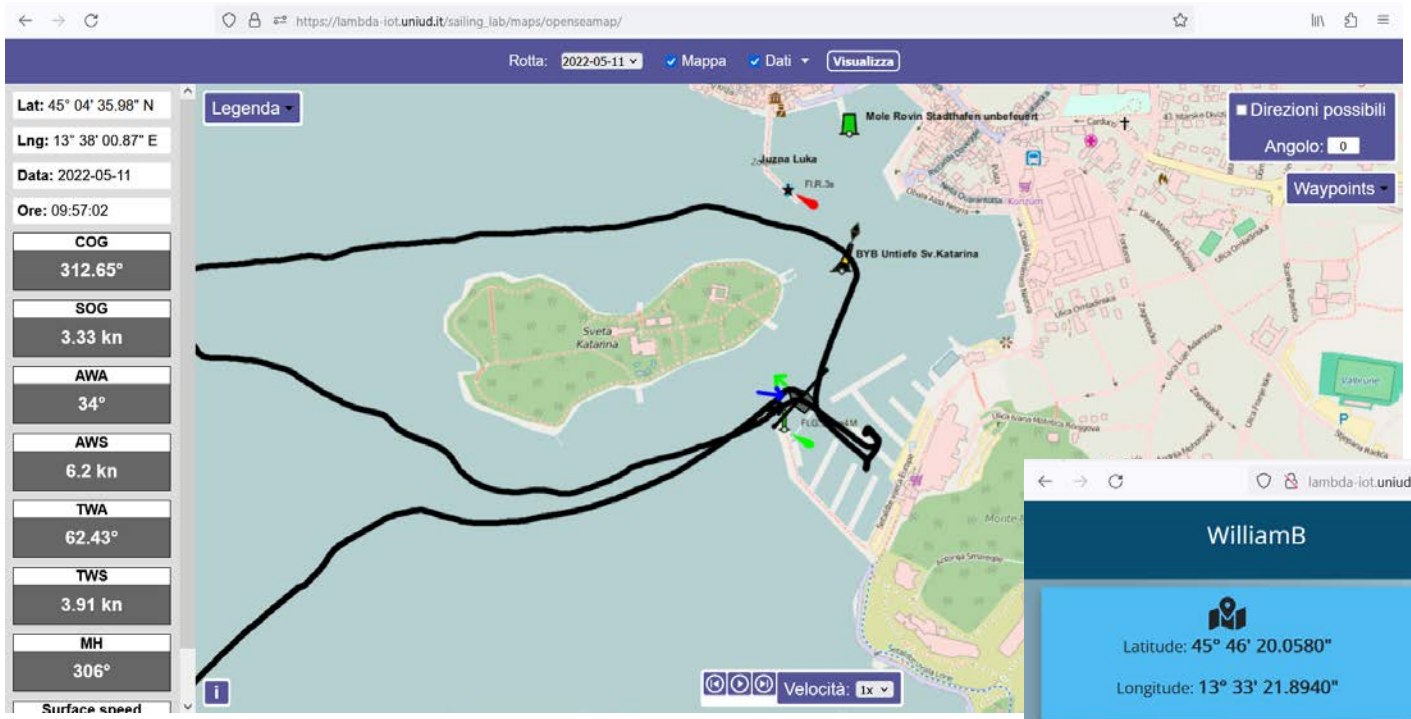


PostgreSQL

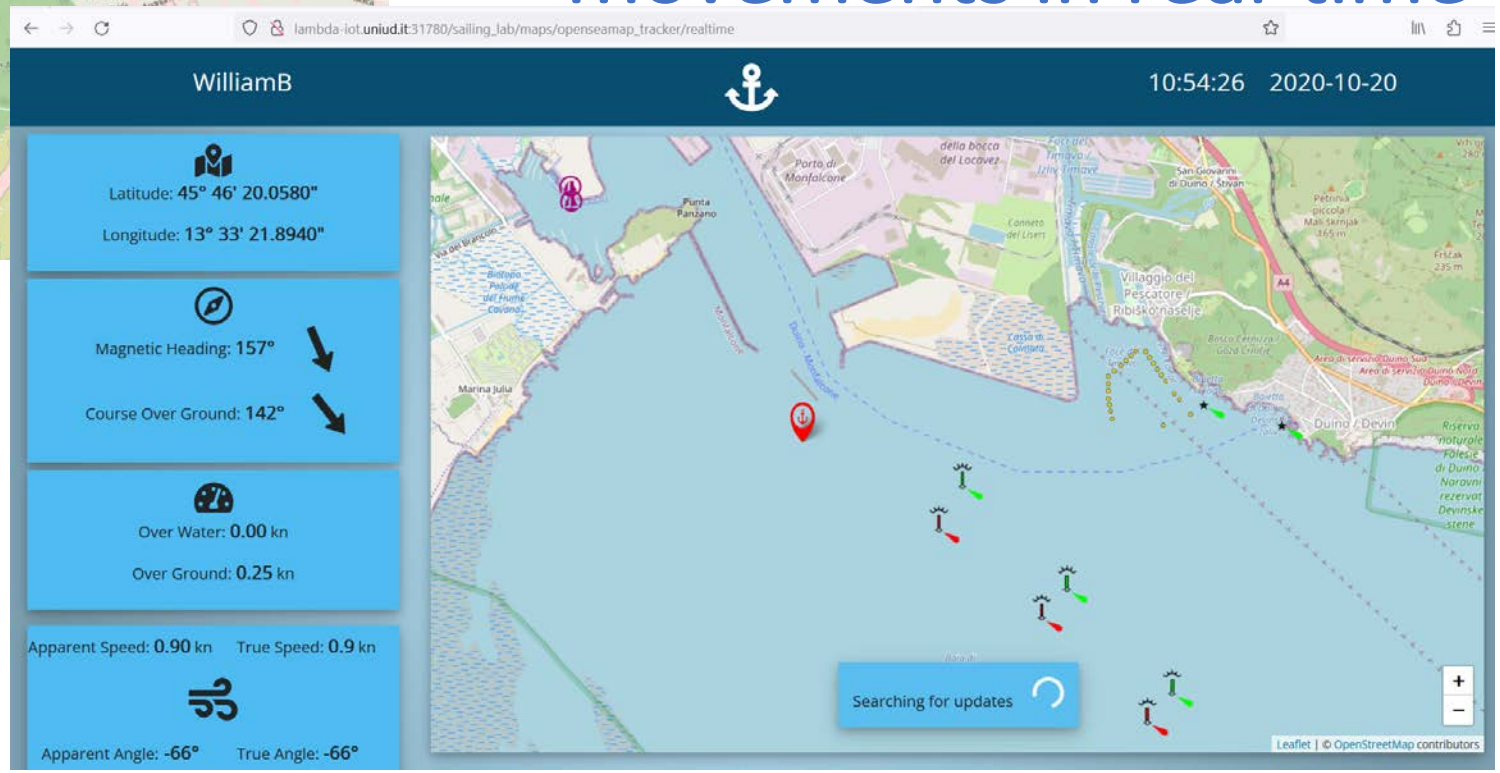




Revisiting a regatta (OpenSeaMap)



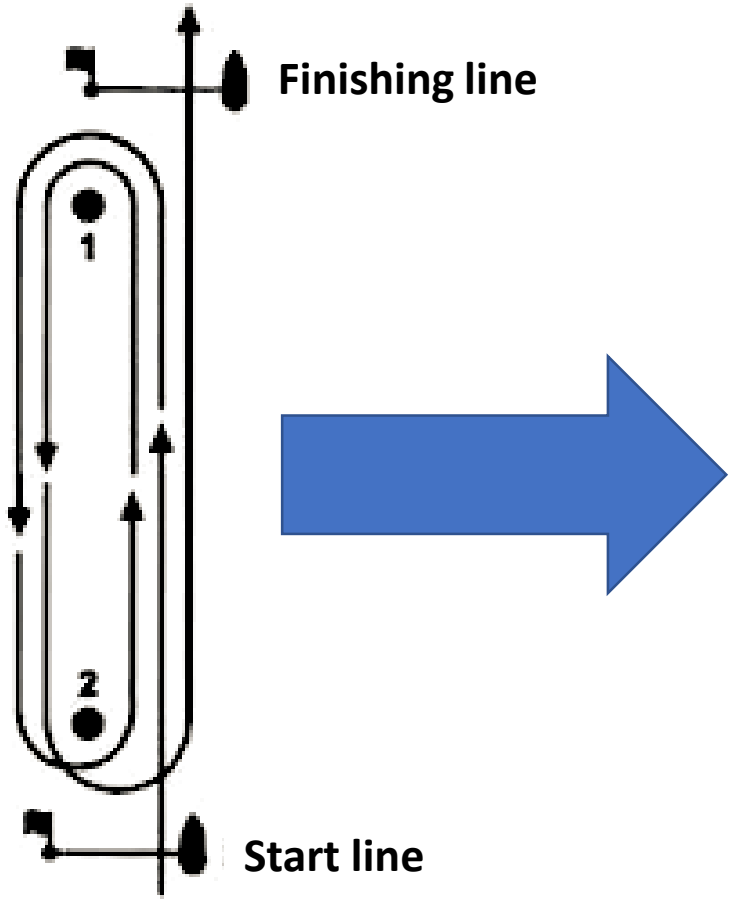
Tracking vessel movements in real-time

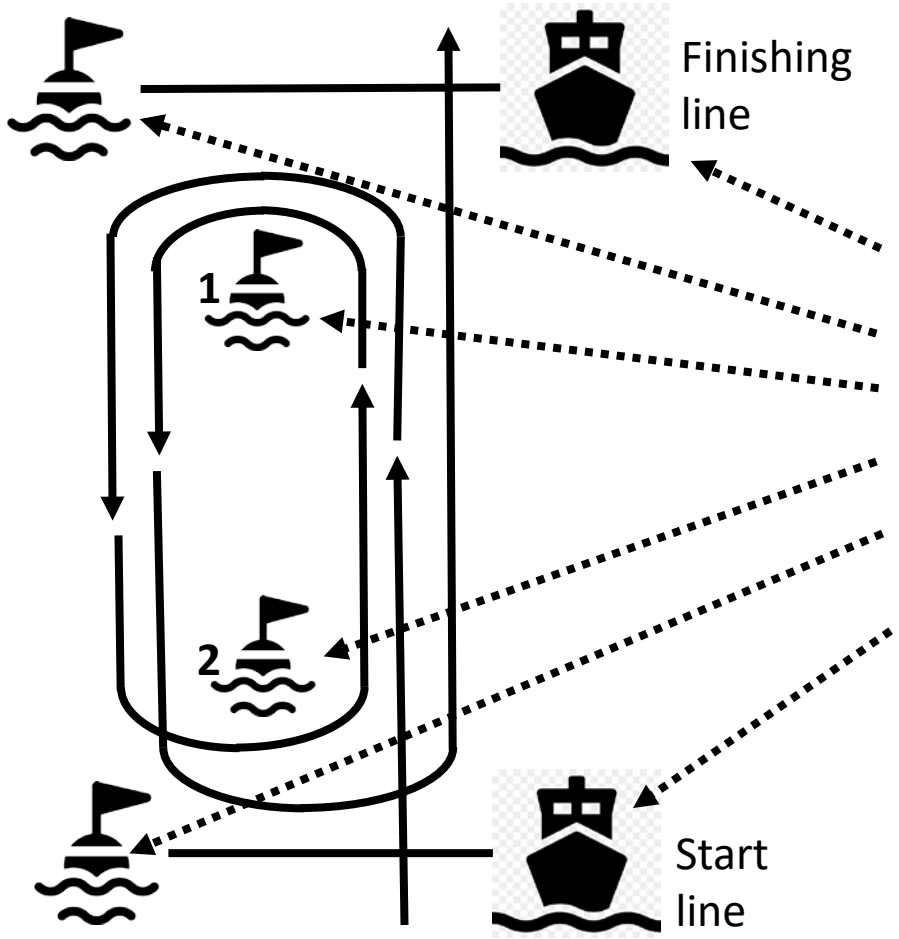


Monitoring a sailing race: smart buoys

- Sailing Lab is experimenting the **same sw/hw infrastructure** with prototypes of **smart buoys**, in order to
  - improve the procedures for the **deployment of buoys in the race field**,
  - automatically monitoring their position and the **detection of the force and direction of the wind** (for the automatic attribution of points in a regatta).
- Smart buoys are equipped with an **ultrasonic wind sensor** and a **GPS receiver**.
- They are able to communicate the data detected by these sensors in **real time** to the committee boat thanks to the use of a **LoRa transmitter**.

Automation of a regatta field





Wind sensor

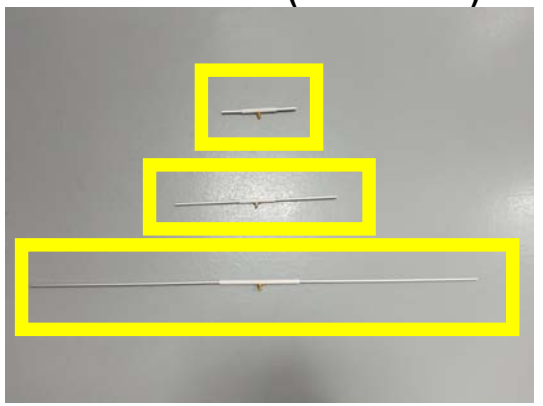
IMU/Compass

Antennas (in-house)

868 MHz

433 MHz

169 MHz



Need for Standards

- At low level (edge) sensors management is quite easy (and standard):
  - almost all the marine devices (talkers) expose data in NMEA format (either v. 0183 or v. 2000) to listeners:
    - **$PREFIX,data1,data2 ... dataN-1,dataN*CHECKSUM**
  - Argos parses and processes data in NMEA format, providing higher level information in JSON format via LAN or WAN connections.
- At application level, everything in the market is more or less ad-hoc:
  - **power supply** is an issue, setting limits to hardware resources;
  - Internet connections are **not always available**;
  - ready-to-use applications are **closed** and **not customizable**;
  - a **standard architecture** (e.g., via microservices) would help to ease the communications and data handling between software modules of different vendors.