**System requirements**

The Master Thesis by Rundhovde [33] is especially useful as it is recent and thus contains up-to-date problems.

**3.1 Buoy prototype requirements**

The buoy consists of an acoustic telemetry receiver (ATR) and a buoy controller. The ATR should

be able to detect acoustic signals from tags with high reliability, range and timing precision, process

the signals and forward the detections to the buoy controller. To synchronize the time with other

buoys, the communication with the buoy controller must be duplex, enabling data to be sent to

and received by the acoustic telemetry receiver. As the distance between the controller module

and ATR can be several meters, it is preferable with a robust communication interface for such

distances. In addition, the ATR must also be able to detect, process and transmit sensor data

like sea temperature. For the IoF project, two prominent use cases apply: Standalone use and

bio-telemetry use. Some requirements are valid for both use cases, while others are unique for the

two. At first all-use-case requirements are presented before presenting special requirements.

**3.1.1 All-use-case requirements**

* Communicate with the ATR and forward tag and sensor data to mainland. Furthermore, the controller must obtain a precise local time and make sure the acoustic receiver is synchronized.
* Buoy controller must obtain its position based on GNSS. The system should keep operating without a position fix to facilitate periods without GNSS signal coverage and to reduce battery usage by powering GNSS module off or sleep mode.
* Buoy controller must transmit its status to mainland (battery status, position, metadata (position loss, dilution of precision, number of tracked satellites), timing accuracy and other relevant parameters). The controller must set peripherals on standby or sleep when not in use to save energy. Keep operating without waking the peripherals more frequently than necessary.
* The buoy controller should use LPWAN technology to transfer data (energy and cost-efficiently) must work at longer distances from shore.
* Follow ITU and local radio regulations to avoid overloading the frequency bands.
* Both LoRa and NB-IoT should be used to compare the performance.
* In addition to transmitting the observations and status of the system to the mainland, the data should be logged locally to support periods of no LPWAN connectivity, as well as enabling extra logging of events. Furthermore, logging system status and errors locally are preferable for debugging and further improvements while keeping a low wireless link budget. The systems should convey its state and relevant information to the user without debugging or serial communication equipment and should be observable from a distance.
* To reduce maintenance costs, it is preferable that the system can be deployed at prolonged periods, ideally up to 7 moths, to keep up with the lifetime of the acoustic telemetry receivers. However, during moths of deployment, errors will most likely occur at some point in time. Therefore, the system need to detect these errors, recover and forward the status to the user.

For a single buoy, drift of maximum 500ms is acceptable, whilst 500us for multiple buoys.

**3.2 Standalone buoy module requirements**

* The standalone module is expected to consist of a single PCB with all necessary components from the nRF9160-DK as well as the cSLIM shield, as described I in section 3.1. The extra components needed is:
  + nRD9160 with required circuitry as capacitors and resistors, a voltage regulator reset button, antenna matching networks for the nRF9160 cellular antenna, and preferably matching networks for the nRF9160 GNSS antenna, if this is to be used.
  + A SIM or eSIM is also required to register the device on an NB-IoT network.
* Include connectors for the external antennas, power supply and an SWD connector for programming the nRF9160.
* PROBABLY some power consumption criteria and timing drift.

**3.3 LPWAN requirements**

* Should allow the data to be transmitted cost-effectively, both regarding low-power consumption and economic costs.
* All required infrastructure for the LPWAN should be easy to deploy if not already provided by the network operators.
* Regarding data usage, the LPWAN should support data-transfers of an appropriate number of buoy controllers and fish-tag detections.
* To support deployment in the remote environments and away from the mainland, the LPWAN should uphold a link with several kilometers between the buoy and other infrastructure.
* Communication must follow ITU and local radio regulations.

**3.4** **DUNE bridge requirements**

* The DUNE bridge should receive the fish-tag and sensor data from the bouy controllers and forward this information to the DUNE framework.
* N. Lauvås already define a IMC::FishTag and IMC::TBRSensor message format. Preferable to use these formats.
* The DUNE bridge should be easy to set up in an already defined DUNE framework and require minimal configuration. (statement or requirement?)