IOT

Indian Ocean sea Turtles

Newsletter 4

September 2020

Project carried out by

Ifremer
Délégation Océan Indien

In partnership with

LIRMM · cnrs · SIF seychelles islands foundation · TERRES AUSTRALES ET ANTARCTIQUES FRANÇAISES Liberté Égalité Fraternité · DÉPARTEMENT DE MAYOTTE · OFB OFFICE FRANÇAIS DE LA BIODIVERSITÉ · parc naturel marin Mayotte

TAG DEVELOPMENT

New tag design

A new design of the beacon has been developed following feedback from the tests and to improve the quality of reception of GPS signals and battery life. The new design of the tag integrates a slight increase (one centimetre per side) in the size of the ground plane on which the GPS antenna is fixed in order to improve the **acquisition time** and the **quality of the GPS positioning**, thus limiting and therefore **optimising the tag's consumption**. The second improvement this time concerns the **size of the battery**, which has been doubled in order to lengthen the tag lifespan.

In order to improve the detection of the surface when the turtle swims up to breathe and thus trigger the transfer of the collected data to the receiving stations, an **automatic pressure sensor calibration algorithm** has been added to the tag software to compensate for atmospheric pressure variations and correct any errors.

New tag design © Andréa GOHARZADEH/IFREMER

Embedded software development

In parallel with the mechanical improvements of the tag, the **software development** of the tag has continued.

Thus the acquisition of several **biological parameters** was added to the embedded software, namely the turtle diving profile (development of a first version of a compression algorithm to describe depth profiles), the minimum and maximum temperature, the diving time, the time at surface and the maximum depth.

Not to mention the software developments linked to the LoRa network and other terrestrial infrastructures of the project as well as the numerous tests wich have been carried out.

VALIDATION TESTS

Starting again tests at the Kelonia experimental platform:

A first series of tests was carried out at the beginning of the year, prior to the confinement. These tests had made it possible, in particular, to identify and make certain adjustments to the tags.

Back at the experimental platform after the confinement period due to COVID, Ifremer resumed the tests.

A **test bench** specially designed to reproduce the diving and "surfacing" phases of the sea turtles was installed. Thanks to this automated and repeatable mechanical system, the tags were successively immersed into a pool of seawater and then brought to the surface, thus mimicking the behaviour of the turtles. Thanks to software designed by Ifremer specifically for these tests, we were able to programme the exact number, duration and times of "surfacing" per day for ten days. These tests thus enabled the team to validate the correct operation of the **tag surface detection systems**.

Tag in surface position on the test bench deployed in Kelonia
© IFREMER

Another series of tests was carried out this time with the turtles in the basins of the Kelonia experimental platform. The very positive results of these tests allowed to validate the various "**software" aspects of the tag** directly on the turtles, in particular:

- the proper functioning of the surface detection,
- optimisation of GPS performance in order to limit consumption and increase the tag's lifespan,
- and optimisation of consumption.

Installation of the tag on one of the turtles of the experimental platform for validation of the proper functioning of the embedded software © Marie ROUMAGNAC/IFREMER

Test of a receiving station in Kelonia
© Marie ROUMAGNAC/IFREMER

A reception station was added to the experimental platform to test the equipment and network.

The installation made it possible to validate the correct operation and **autonomy of the system** (autonomous box and solar power supply) and to carry out **network adjustments** for the reception and transmission of the test signals.

Mechanical resistance tests of the tag:

In recent months, tests have been carried out to assess the **resistance of the tag external elements** (LoRa antenna, surface sensor electrodes) and **surface treatment** (gelcoat, resin) to the mechanical stresses likely to be produced by a turtle in its environment. The resistance of these elements is indeed essential to the proper functioning of the tag and the on-board algorithms.

The tests consisted in **manually reproducing in the laboratory** the impacts and mechanical stresses that the tags can undergo in an open environment. These efforts were repeated a certain number of times in order to test, on the one hand, the resistance to a major impact and, on the other hand, the resistance to many more regular efforts that could end up wearing out the components.

Of the four tags tested, a first series of tests focused on the resistance of the **LoRa antenna** to successive bending, tearing and abrasion at different points on the antenna on the first tag. The resistance of the surface sensor **electrodes** was analysed on a second tag and the abrasion of the **gelcoat** (external surface treatment of the tag) and the resistance of the **resin** to impacts were carried out on the third and fourth tag respectively.

The results of these tests were very satisfactory for all the elements tested and under the various conditions studied. No mechanical failures were observed, which means that the **final validation of the tag design** is now underway.

Abrasion tests of the LoRa antenna and resistance of the electrodes and resin to strong shocks
© Andréa GOHARZADEH/IFREMER

Autonomous USV board:

Over the last few months, Ifremer, alongside the company IDOCEAN (see newsletters n°2 and 3), has continued developments on the USV autonomous board, reinforcing the on-board electronics and making it fully operational in view of its forthcoming deployment on the Europa island, the first study site of the project to be equipped. To this end, several **validation tests** were carried out in the lagoon as well as on the Takamaka hydroelectric dam on Reunion Island. The Takamaka site presents particularities close to those that Ifremer will encounter on the Europa island, as an isolated environment, where no internet network is available and where the transport of equipment can be complex in terms of accessibility to the site.

Validation test of the USV autonomous board at Takamaka hydroelectric dam © IDEOCEAN

At the same time, a **new version** of the autonomous board (version 2) was developed. Among the new features, an **acoustic geolocation** system has been added allowing the tracking of sea turtles without disturbing them. Developments are still in progress and tests will be carried out in Reunion Island at the end of 2020.

PREPARATION OF THE EUROPA MISSION

From 16 September to 20 October 2020, three members of Ifremer's Indian Ocean delegation will visit the **Europa** Island in the Scattered Islands as part of the IOT project. The objectives of this mission are:

- to deploy the reception stations (an improved version of those set up for the "pIOT" project),
- install and test the LoRa network for proper operation,
- carry out bathymetry and photogrammetry measurements on predefined zones of interest for marine turtles using the USV autonomous board.

The island of Europa, like several other study sites of the IOT project, corresponds to a so-called **"remote"** site, i.e. without internet access or with a very limited and expensive satellite connection. In order to minimise the use of this satellite connection, Ifremer has worked on the development of a **hybrid network** based on LoRa.

Indeed, thanks to the LoRa network, the various receiving stations positioned all around the lagoon (where the juvenile sea turtles are present) will collect the data emitted by the turtle tags and will communicate this data between them in order to enable the geolocation of the tags and therefore of the turtles but also with the so-called "mother" station which will be located at the TAAF scientific base on the island. The role of this "mother" station will be to collect all the data re-transmitted by the lagoon's reception stations before transferring all the data to two separate servers, including a LoRaWan server.

Tests in La Reunion of the satellite antenna that will equip Europa's "mother" station © Pierre GOGENDEAU/IFREMER

For this 35-day mission, no less than **820 kilos of equipment** were sent to Europa thanks to the French Navy's multi-mission ship "*Champlain*" and the military light tactical transport aircraft "*Casa*", with the support of the Armed Forces in the Southern Zone of the Indian Ocean (FAZSOI) and the French Southern and Antarctic Territories (TAAF).

Preparation of material for the Europa mission © IFREMER

Departure for Europa Island:

On September 16 2020, three members of the Ifremer team boarded the Casa to Europa Island in the Scattered Islands district for the **first deployment of the project**.

The objectives of this 35-day mission are:

- removing the reception stations of the "pIOT" pilot project and the **deployment of four reception stations** that will make it possible, on the one hand, to receive the signals sent by the turtle tags and, on the other hand, to transfer the data collected in this way to a secure server,

- **installation of the LoRa network** and the satellite system for data reception and transmission,

- **characterisation of the LoRa radio channel** on the water surface and validation of the good transmission and reception of messages in the lagoon and particularly in the difficult to access areas of the mangrove,

- the **realization of bathymetric and photographic surveys** of the bottoms for the development of photogrammetry[1] of the areas of interest for the turtles,

- the **tagging** of 2 to 3 juvenile turtles in order to test and validate the robustness of the mechanical design and the on-board algorithms in an open environment and in real conditions. Once the system has been validated during this mission, a second tagging mission will take place in 2021 on a larger number of turtles (7 to 8 individuals), this time with the objective of using the dive data.

Departure of the team for Europa
© Sylvain BONHOMMEAU/IFREMER

[1] Technique for creating a three-dimensional virtual image of a real object from numerous photographs and algorithms

NEW IN THE TEAM

With the arrival of **Marie ROUMAGNAC** in May, the IOT team has grown even more. Marie participates in the implementation of various projects, including the IOT project within the Ifremer Indian Ocean delegation as VSC **Marine Biology Engineer**.

Her work within the project consists of designing and producing tags, participating in turtle tagging operations and she provides support in mediating the project. After a Master 2 in the development of molecular biology technologies at the University of Montpellier, Marie worked for 4 years at Ifremer's Laboratory of Microbiology of Extreme Environments (LMEE) in Brest, then 7 years at the Mediterranean Institute of Oceanography (MOI) in Marseille before joining Ifremer in Reunion Island.

VALORISATION

Over the last few months, the IOT team has taken the opportunity to work on the creation of objects to enhance the value of the project. Stickers, caps and anti-UV t-shirts will thus contribute to increasing the visibility of the project.

IOT project stickers, caps and anti-UV t-shirts of © Anne-Laure CLEMENT/IFREMER

PARTNER PRESENTATION

SIF and IFREMER team up to unravel the mysteries of juvenile turtle movements

Following previous successful collaborations together, Ifremer approached the Seychelles Islands Foundation to partner in the development of the first marine turtle movement observation network throughout the southwest Indian Ocean basin.

The **Seychelles Islands Foundation** (SIF) is a non-profit charitable organisation that was established as a public trust by the government of Seychelles in 1979. SIF has been responsible for the management and protection of the **Aldabra Atoll UNESCO World Heritage Site** since 1979.

As such, SIF is the longest established local organisation working in nature conservation in Seychelles. It has been instrumental in various conservation and management successes because the foundation is dedicated to ensuring that the World Heritage Sites of Seychelles are well-managed protected areas where conservation, research, education and tourism are sustainably balanced.

Within the IOT project framework, the synergy between the two partners is to facilitate research activities at Aldabra. SIF, which **manages**, **implements** and **coordinates all research and monitoring on the atoll**, will be participating in the **deployment** of new technological bio-logging solutions for the study of marine turtles; in particular green turtles (*Chelonia mydas*), but with relevance for other species such as hawksbill turtles (*Eretmochelys imbricata*).

Aldabra, despite being 1200 km south-west of the Seychelles' main island of Mahé, is an ideal site for this work.

Aldabra Atoll © Foto Natura

As well as its UNESCO status, Aldabra is designated as a **Special Nature Reserve** and is part of the **IOSEA Marine Turtle Site Network** in recognition of its importance to marine turtles (2014). Aldabra currently hosts the second highest nesting population of endangered green turtles in the Western Indian Ocean and a smaller population of critically endangered hawksbill turtles. The extensive coral reefs, sea grass beds and sandy beaches are ideal feeding and nesting habitats.

Aldabra green turtle © Richard Baxter

Prior to its protection Aldabra's green turtles were intensely exploited. The Aldabra population was the first to be protected in the Indian Ocean and although the original, pre-exploitation population size is unknown, population surveys were conducted just before, during and after its protection, providing baseline data to assess the population recovery. SIF has run a **long-term monitoring** programme on nesting turtles since 1980, using a standardized track count protocol. Analysis concluded a 500–800% increase in the green turtle population from 1968 to 2008 (Mortimer et al. 2011) and the population has continued to increase. Mortimer et al. (2011) estimated that 3100–5225 females were nesting annually on Aldabra in 2008. The population has increased since then and a new estimate will soon be published.

Ten turtles will be tagged and **five receiving stations** will be deployed at key locations on the atoll, and an extra one as a back-up. Training will be provided by Ifremer to SIF staff on Aldabra in tag attachment and deployment and maintenance of receiving stations. Tags will be attached to juvenile green turtles, which are the chosen target group of turtles because they usually remain at a site for several years (unlike the migratory adults), which will increase the length of the follow-up period. Optimal positioning of receiving stations will be done to maximise both the chances of sea turtle encounters and the accuracy of geo-location. The five stations will also be deployed according to the site's geography and topography, aiming to ensure safety of access for staff while avoiding damage by animals e.g. coconut crabs.

Monitoring of marine turtles by SIF teams on Aldabra atoll © SIF
(left: measuring the width of a juvenile turtle shell, right: placing an identification tag on the flipper)

Knowledge on movement patterns is crucial in sea turtle conservation, and often, juvenile movement patterns are barely known, despite representing the bulk of the population. Even on Aldabra, where turtles have been monitored for nearly 40 years, almost nothing is known about movement and habitat use of juveniles or males. This exciting project will help fill the information gap on juvenile turtle foraging grounds, movement patterns and habitat connectivity within Aldabra. It's possible that juveniles utilise neritic zones as developmental habitats. As such, long-term data will gather information on fidelity of neritic feeding grounds and juvenile residence time in these and other zones, helping us determine length and seasons of functional habitat use.

Ultimately, this great project will reveal **answers** to a wealth of **conservation** questions, which will vastly improve our **understanding of the turtles on the atoll and their management**. SIF is very excited to be participating in this regional project and delighted to have the opportunity to help advance turtle knowledge and monitoring technology.

Green turtle equipped with a tracking device © SIF

IOT
Indian Ocean sea Turtles

Test and deployment sites and periods:

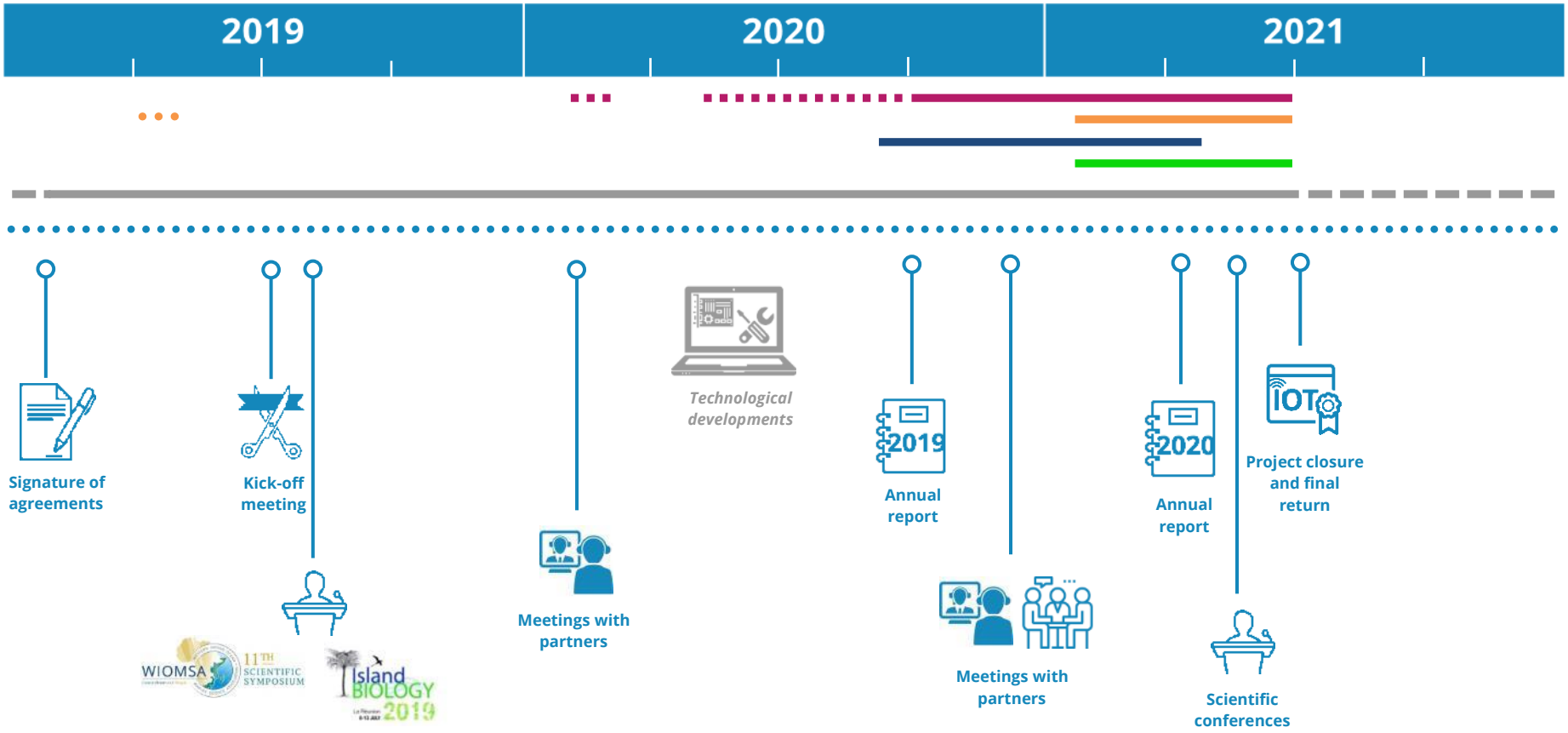
Reunion Island:
tests
deployment

Mayotte Island:
prospecting
deployment

Scattered Islands (TAAF) :
deployment

Aldabra Island (Seychelles) :
deployment

PROGRAMMING AND PROGESS



To know more about it, visit the web site :

https://wwz.ifremer.fr/lareunion_eng/Projects/Technological-innovations/pIOT-2018-2020-IOT-2018-2021

CONTACTS OF PROJECT LEADERS		SCIENTIFIC AND TECHNOLOGICAL CONTACTS	
IFREMER		**LIRMM**	
S.BONHOMMEAU	sylvain.bonhommeau@ifremer.fr	S. BERNARD	serge.bernard@lirmm.fr
A.L. CLEMENT	anne.laure.clement@ifremer.fr	V. KERZERHO	vincent.kerzerho@lirmm.fr
P. GOGENDEAU	pierre.gogendeau@ifremer.fr		

FUNDS

PARTNERS

TECHNICAL AND TECHNOLOGICAL SUPPORT