# NET4mPLASTIC PROJECT

## WP5 – Act. 5.2 Development of the UAV/marine drone for data acquisition

## D 5.2.5

### Marine OBU and Drone Maintenance Manual

December, 2021 - Version 1.0

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| **Project Acronym** | NET4mPLASTIC |
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| **Partner in Charge** | PP3 |
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## Acronyms / Abbreviations

| ACRONYM | DEFINITION |
|---|---|
| EWS | Early Warning System |
| MP | Microplastic |
| OBU | On board Unit |
| PP | Project Plan |
| PT | Project team |
| TC | Technical task coordinator |
| TGS-ML | Technical Subgroup on Marine litter, European Union expert group On marine litter |
| TM | Task Manager |
| UML | Unified Modelling Language |
| WP | Workpackage |

# 1 Introduction

## 1.1 Background of the project

The main goal of the NET4mPLASTIC project is to achieve an efficient monitoring system for plastic and MP distribution along the Croatian and Italian coastal and marine areas in order to improve the environmental coastal and marine sea quality conditions.

According to doc R1, the WP5 deals with the design implementation of the EWS - Early Warning System including:

- a control centre, based on system hardware and network (Prosoft), and a EWS application (Hydra Solutions) integrated with the transport model and external systems (such as the oceanographic model - (Marche Region);
- Integrated Marine Drone, for collection of MP - microplastic, and geolocalized water indicators on the route (Hydra Solutions);
- Integrated Marine OBU, a unit to be installed on board of ships for improved MP collection with geolocalized water indicators on the route (Hydra Solutions).

The design shall be carried out with the modern system engineering approach based on UML - Unified Modelling Language (Hydra Solutions). UNITS and RERA SD will provide data for the first set up of the platform related to MP. Based on this WP, the transport model will be developed in WP4. The development of the EWS platform integrated with the transport model will be done in WP5.

The activities planned for WP5 are the following:

- development of the EWS - Early Warning System data center platform and integration with the transport model (WP4)
- development of the UAV/marine drone for real-time data acquisition
- testing and calibration
- business simulation for testing the solution with real users –
- final assessment of the solution, including a CBA–cost benefit analysis and the preparation of the business plan.

The main expected output will be:

- EWS integrated platform, implemented and tested

- Training for the required personnel and users - Assessment of the platform.

The required main software modules of the EWS platform will be:

- MP Transport model, providing data with distribution and concentration,
- MP WebGIS platform, for: a) Display MP data (historical, actual forecast, 24-72h forecast) b) Early warning provision, based on the transport model c) Data entry, recording & replay
- MP DB, the DB for collecting data
- A mobile APP, for starting/closing the field activities and for data reporting
- Firmware for marine remote units - Integration with external system, for meteo/other data

The coordinator will be Hydra Solutions. The EWS SW platform will be developed by Hydra Solutions, with the support of Marche Region for the transport model, and Prosoft for localization, the ICT

implementation, the integrated testing, training and support for maintenance activities. UNITS will coordinate the assessment of the platform. The other partners involved will give contribution for data entry, as target user, and for preparation of the required documentation. The user target group will be based on the main project partners, institution, regions and councils. They will be involved in the design stage for collecting the main needs, for testing and user training of the solution. The target group will be required to use the system during the business simulation, and provide feedback.

The expected reports within WP5 are the following:

- D 5.1.4 –Hardware and Network Integration Report (Report): this deliverable will provide a report with details on integration of the network and other hardware required for the system;
- D 5.1.5 –Test procedures and reporting (Report): this deliverable will provide the procedures for testing the data centre and the integrated solution in the test bed environment, and the reporting of the tests done to assure the quality of the solution provided;
- D 5.1.6 –Hardware & Network Maintenance Manual (Document); this deliverable will provide the manual for the maintenance of the hardware and the network of the system;
- D 5.1.7 –Software User and Maintenance Manual (Document); this deliverable will provide the manual for the maintenance of the software and the User manual for the operators
- D 5.2.4 – Marine OBU / Drone Test Procedure and Report (Document): this deliverable will provide the procedures for testing the drones and the OBU, and the reporting of the tests done to assure the quality of the solution provided;
- D 5.2.5 –Marine OBU / Drone Maintenance Manual (Document); this deliverable will provide the manual for the maintenance of the Drone and OBU;
- D 5.2.6 – Marine OBU / Drone User Manual (Document); this deliverable will provide the User manual for the operators;
- D 5.3.1 – Data Centre Hardware and Network Facility implemented (Hardware, report), in this deliverable is relevant to the implementation of the data centre for the integrated solution, hardware and the network facility, and the preparation of the AS BUILT document describing the data centre facility;
- D 5.3.2 – Remote Units and Data Centre Communication Test Procedure and Report (Document); this deliverable will provide the procedures for testing the communication integration between remote units and the data centre, and the relevant reporting of the tests done to assure the quality of the solution provided;
- D 5.3.3 – Data Centre Test Procedure and Report (Document): this deliverable will provide the procedures for testing the features of the solution provide in the data centre, and the relevant reporting of the tests done to assure the quality of the solution provided, that will be done in cooperation with the main stakeholders;
- D 5.3.4 – Integrated System Final Test Procedure and Report (Document): this deliverable will provide the procedures for the integrated test cases testing the integrated solution, and the relevant reporting of the tests done to assure the quality of the solution provided, that will be done in cooperation with the main stakeholders.
- D 5.4.1 – Training documentation (document): this deliverable is relevant to the implementation of the required documentation for performing training to the personnel involved in the business simulation (as defined in the WP3.3 and the design of the solution);

- D 5.4.2 – Training assessment (report): this deliverable is relevant to the implementation of the training to be done for the personnel involved in the business simulation, with a reporting on evaluation of the training;
- D 5.4.4 – Questionnaire for platform assessment (report) this deliverable is relevant to the preparation of a questionnaire for evaluation of the platform from the user point of view involved in the business simulation;
- D 5.4.5 –Cost Benefits Analysis – CBA of the platform (Document); this deliverable will provide a final document with lessons learnt during the real use of the platform, an evaluation of the benefits of the platform, and costs for full exploitation of the solution, including the future recommendations on potential improvement, and including a business plan for a full implementation of the platform.

## 1.2 Purpose of the report

This document is the **deliverable D.5.2.5 – Marine OBU-Drone Maintenance Manual**: it provides the manual in term of planned tasks and related procedures for the maintenance of the Drone and OBU to assure the correct functionalities and good performances of the system for long time.

This deliverable is within the activity 5.2 of the Net4mPlastic project – Development of the UAV/marine drone for data acquisition. This activity shall have as input the deliverables of WP3.3 relevant to the design of the solution to proceed with the execution of the following tasks:

- procurement and Integration of the autonomous electrical power supply system for the instruments payload;
- identification of the most suitable sensors for the detection of the MP;
- design, integration and test of a drone/OBU suitable for these innovative sensors;
- procurement and Integration of the electronic Data Acquisition and Communication System (DACS) relied on wireless technology;
- development and implementation of the firmware for DACS to get scientific instrumentation;
- data and system diagnostic sensors data (technical data);
- development and implementation of the deck control unit for navigation and data acquisition with related software interface (HMI);
- laboratory Integration Test;
- sea trials Test.

The coordinator will be Hydra Solutions, in cooperation with Prosoft, UNIFE, Marche Region. The purpose of this document is summarised as follows:

- Definition of a maintenance plan with related tasks.
- Defintion of ordinary and extraordinary maintenance task
- Description of the procedures associated to each maintenance task.

## 1.3 Reference documentation

| No | Title | Rif/Report N. | Pubblished by |
|---|---|---|---|
| [R1] | **APPLICATION FORM - NET4mPLASTIC Project - New Technologies for macro and Microplastic Detection and Analysis in the Adriatic Basin**<br>2014 - 2020 Interreg V-A Italy - Croatia CBC Programme Call for proposal 2017 Standard - NET4mPLASTIC Priority Axis:Environment and cultural heritage | Application ID: 10046722, dated 30/06/2017 | Lead applicant: UNIVERSITY OF FERRARA |
| [R2] | D 5.1.4 –Hardware and Network Integration Report (Report) | HYD514-REP-001.0 | ACT5.1 – Net4Mplastic |
| [R3] | D 5.1.5 – Test Procedures & Reporting Report | HYD515-PRO-001.0 | ACT5.1 – Net4Mplastic |
| [R4] | D 5.1.6 –Hardware & Network Maintenance Manual | HYD516-MAN-001.0 | ACT5.1 – Net4Mplastic |
| [R5] | D 5.1.7 –Software User and Maintenance Manual | HYD517-MAN-001.0 | ACT5.1 – Net4Mplastic |
| [R6] | D.5.2.4 – Marine OBU-Drone Test Procedure and Report | HYD524-PRO-001.0 | ACT5.2 – Net4Mplastic |
| [R7] | D 5.2.6 – Marine OBU / Drone User Manual | HYD526-MAN-001.0 | ACT5.2 – Net4Mplastic |
| [R8] | D 3.3.1 – EWS Requirements definitions based on the stakeholders and users' needs, through questionnaires and specific meeting | HYD331-SPE-001.0 | ACT3.3 – Net4Mplastic |
| [R9] | D 3.3.2 – EWS Hardware Architecture and network design (central Data Centre Hardware Architecture Client/Server, Data network architecture and related communication segments) | HYD332-SPE-001.0 | ACT3.3 – Net4Mplastic |
| [R10] | D 3.3.3 – EWS Software Architecture design (data modelling software, GIS applications, early warning detection software, etc.), the Relational Database to manage all collected data with related meta data, the communication Front-End for web remote access, the Data Centre Software Interfaces for users | HYD333-SPE-001.0 | ACT3.3 – Net4Mplastic |

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|---|---|---|---|
| [R11] | D 3.3.4 – EWS Hardware and other software Components Specifications design (Integrated Marine Drone and Marine OBU, with details of required components (hardware and firmware), firmware and other software components (mobile apps for managing the drones and for remote mobile activities). | HYD334-SPE-001.0 | ACT3.3 – Net4Mplastic |
| [R12] | D 3.3.5 - Report and database provision with all the collected data | HYD335-SPE-001.0 | ACT3.3 – Net4Mplastic |
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# 2 MAINTENANCE PROGRAM

The following table provides the list of the ordinary maintenance tasks for the Drone and OBU with indication of related time interval. Each task is coded to be identified in the maintenance procedures detailed in the next section.

| ***MAINTENANCE TASK*** | ***TASK FREQUENCY*** | | | | | |
|---|---|---|---|---|---|---|
| | ***Every mission*** | ***3 Months*** | ***6 Months*** | ***1 Years*** | ***2 Years*** | ***4 Years*** |
| **O100 – OBU Maintenance** | | | | | | |
| O101 – CT instrumentation maintenance and calibration | ● | | | | | |
| O102 – OBU Battery Pack maintenance | | | | | | ● |
| O103 – Datalogger maintenance | | | | | | ● |
| O104 – Cables and connectors maintenance | ● | | | | | |
| **D200 – Drone Maintenance** | | | | | | |
| D201 – Clean the thrusters and the hull | ● | | | | | |
| D202 – Drone Battery Pack maintenance | | | | | | ● |
| D203 – Drone Deck Unit Maintenance | | ● | | | | |
| **H300 – Holo Sensor Maintenance** | | | | | | |
| H301 – Clean the probe | ● | | | | | |
| H302 - Internal batteries maintenance | | | | | | ● |
| **M400 – Mini-Manta maintenance** | | | | | | |
| M401 – Net maintenance | ● | | | | | |
| M402 – Flow sensor maintenance | ● | | | | | |

# 3 MAINTENANCE PROCEDURE

This section deals with the maintenance procedures related to the different subsystems constituting the OBU and the Drone. For each subsystem the instructions for a correct maintenance are provided in order to keep the system operative with the expected performances.
For each maintenance task the following details are provided:

a) Placing of the part or sub system to be serviced;
b) Related drawings or equivalent graphical representation;
c) Required resources for the service;
d) Expected minimal perfomances;
e) Possible Failures;
f) End User Maintenance Interventions;
g) Specialist User Interventions.

| ***O100 – OBU Maintenance***<br><br>O101 – CT instrumentation maintenance and calibration | |
|---|---|
| *Placing* | - |
| *Drawings* | - |
| *Minimal Performance* | - |
| *Possible Failures or Anomalous Conditions* | CT cables and connectors damaged.<br>CT sensors provide not reliable data.<br>No link CT-Datalogger |
| *Required Resources* | Calibration solutions and drink water. |
| *End User Interventions* | The calibration of the conductivity sensor is a 2-step process:<br>- Step 1 (offset): Expose the sensor to the air to perform the first stage of the Calibration process. The value for this first calibration standard is set to 0 0 µS/cm.<br>- step 2 (gain): the sensor is placed in a buffer solution of known conductivity which depends of the range using.<br>Example of standard solutions |

| | |
|---|---|
| | <table><tr><th>Measurement range</th><th>Concentration of standard solution</th></tr><tr><td>0.0-200.0 µS/cm</td><td>84 µS/cm</td></tr><tr><td>0 -2,000 µS/cm</td><td>1,413 µS/cm</td></tr><tr><td>0.00 - 20.00 mS/cm</td><td>12,880 µS/cm</td></tr><tr><td>0.0 – 200.0 mS/cm</td><td>111.8 mS/cm</td></tr></table><br>The C4E sensor uses a 4–electrode conductivity measuring principle, and care must be taken to maintain these 4 electrodes in optimal working condition. After each use, rinse the sensor before storing it.<br>To clean the electrodes (made from graphite and platinum), insert and retract an abrasive strip through the slot in the sensor, under a stream of running water. |
| *Specialist Intervention* | Repair in a workshop the eventual cables and connectors damaged. |

| ***O100 – OBU Maintenance***<br>O102 – OBU Battery Pack Maintenance | |
|---|---|
| *Placing* | - |
| *Drawings* | - |
| *Minimal Performance* | - |
| *Possible Failures or Anomalous Conditions* | Battery pack not able to be recharged<br>Battery pack autonomy very short |
| *Required Resources* | Volt meter |
| *End User Interventions* | The OBU battery pack shall be recharged with related battery charger the day before a planned mission at sea.<br>Anyway after 4 years the battery pack performances decrease significantly thus it shall be replaced with a new one. |
| *Specialist Intervention* | - |

| ***O100 – OBU Maintenance***<br>O103 – Datalogger Maintenance | |
|---|---|
| *Placing* | - |
| *Drawings* | - |
| *Minimal Performance* | - |
| *Possible Failures or Anomalous Conditions* | SD card does not log the GNSS and CT data<br>Datalogger clock is lost when power supply |
| *Required Resources* | Notebook with Ethernet cable connected to the OBU Datalogger |
| *End User Interventions* | - |
| *Specialist Intervention* | The internal Lithium battery of the datalogger shall be replaced in the laboratory and with a console command it is possible to set data time of the internal clock and to verify that is it maintained.<br>The SD card shall be replaced or formated in laboratory.<br>For both tasks it is necessary to open the case of the datalogger and to provide dedicated Linux console commands. |

| ***O100 – OBU Maintenance***<br>O104 – Cables and connectors maintenance | |
|---|---|
| *Placing* | - |
| *Drawings* | - |
| *Minimal Performance* | - |
| *Possible Failures or Anomalous Conditions* | Cables or connectors visibly damaged.<br>Both electrical contacts between bulkhead and inline connectors of CT and GNSS receiver |
| *Required Resources* | Notebook with Ethernet cable connected to the OBU Datalogger |
| *End User Interventions* | To dry the bulkhead and inline connectors with tissue and to put a small quantity of silicon grease on the o-ring of the connectors. This operation has to be carried out before and after each mission at sea to keep all connectors in good status.<br>After the connections of inline connectors with bulkhead connectors, verify the correct acquisizion of GNSS and CT sensors with Putty console application. |

| | |
|---|---|
| *Specialist Intervention* | In laboratory tha cables and connectros visibly damaged shall be repaired or replaced. |

| **D200 – Drone Maintenance**<br>D201 – Clean the thrusters and the hull<br>D202 – Drone Battery Pack maintenance<br>D203 – Drone Deck Unit Maintenance | |
|---|---|
| *Placing* | - |
| *Drawings* | - |
| *Minimal Performance* | - |
| *Possible Failures or Anomalous Conditions* | No correct manoeuvring of the Drone.<br>The battery pack of the Drone are not able to assure sufficient autonomy for a mission at sea.<br>No radio link Deck-Unit / Drone |
| *Required Resources* | Fresh water |
| *End User Interventions* | **D201 – Clean the thrusters and the hull**<br>To clean with fresh water the thruster of the drone after a mission at sea.<br>To clean with fresh water the whole hull.<br>To dry the electrical connector with tissue.<br>The main control module and the driving module are all installed in the control cabin. Because of the influence of remote-controlled ship in water work and air humidity, it is inevitable to generate humid and hot air in the control cabin. Therefore, in order to prevent damage of damp heat air to control circuit, regular maintenance is needed: after each use, the hull and module can be dried by a water absorbent towel.<br>**D202 – Drone Battery Pack maintenance**<br>The battery has to be charged with related charging device before a mission. After 4 years of life the battery shall be replaced.<br>**D203 – Drone Deck Unit Maintenance**<br>The Deck Unit of the Drone has and internal rechargeable battery that has to be fully charged before each mission at sea. |

| | |
|---|---|
| | The internal accumulator shall be replace after4 years. |
| *Specialist Intervention* | - |

| **H300 – Holo Sensor Maintenance**<br>H301 – Clean the probe<br>H302 - Internal batteries maintenance | |
|---|---|
| *Placing* | - |
| *Drawings* | - |
| *Minimal Performance* | - |
| *Possible Failures or Anomalous Conditions* | |
| *Required Resources* | Fresh water, towels, soapy solutions, Laptop PC and Ethernet cable. |
| *End User Interventions* | **H301 – Clean the probe**<br>Make sure that the windows are as clean as possible. The windows can be cleaned with Windex, but often a mild, lukewarm, soap solution is the best for cleaning optical windows. Dip a finger in the soapy solution and gently rub the windows. Rinse several times with clean, particle-free water.<br>Lubricate the connectors regularly with silicone spray or a light coating of silicone grease. Avoid contaminating the windows with lubricant. Do not use any petroleum-based lubricant.<br>Clean the LISST-Holo2 with fresh water and dry it before storage.<br>Store in a clean dry place or inside the provided ship case.<br>Make sure the caps for the connectors are in place before storage.<br>The instrument should be disconnected from power when not in use. The internal batteries should be fully charged and the switch lever should be in the '0' position.<br>**H302 - Internal battery maintenance**<br>The Holo sensor has two internal battery: real time clock battery and main battery. Both battery shall be replaced evey 4-5 years to maintain the correct functionalities and performances. |

| | |
|---|---|
| *Specialist Intervention* | To replace these batteries the instrument has to be opened and the o-ring has to be replaced. |

| **M400 – Mini-Manta maintenance**<br>M401 – Net maintenance<br>M402 – Flow sensor maintenance | |
|---|---|
| *Placing* | - |
| *Drawings* | - |
| *Minimal Performance* | - |
| *Possible Failures or Anomalous Conditions* | The net of the manta is visibly damaged (holes or cut or disconnected from its mouth).<br>The flow sensors does not work properly. |
| *Required Resources* | Fresh water |
| *End User Interventions* | To clean with fresh water the manta net, the bottle and the flow sensor before and after a mission at sea |
| *Specialist Intervention* | If the net or the flow sensor are damaged they shall be sent to the supplier to be repaired or replaced. |