NET4mPLASTIC PROJECT

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

D 5.2.4

Marine OBU and Drone Test Procedure and Report

December, 2021 - Version 1.0

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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.5.2.4 – Marine Drone Test Procedure and Report**: it provides the procedures for testing the drone and the OBU, and the reporting of the tests done to assure the quality of the solution provided.

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:

- Description of the test cases with related procedure to verify the correct implmenetation of the functionalities of Drone and OBU;
- Report of test results carried out in laboratory and at sea.

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** 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 5.2.5 –Marine OBU / Drone Maintenance Manual	HYD525-MAN-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

[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

2 TEST CASES

The instrument used for detailing the test procedures and related results of the functionalities of Drone and Obu (test cases) is constituted by a table like the one attached in Table 1, in which are identifiable 5 macrosections:

1. header and general information,
2. procedure to execute the test case,
3. conditions of success of the test,
4. report of the obtained test results.

TEST CASE: *Code*	*Name of the test case*
Description:	*General description of the test case*
Related functionalities:	*Other features related to the one tested*
Test Environment:	*Description of the location and facilities required to execute the test*
Preconditions:	*Description of the initial conditions to start the test procedure*
Procedure	
1.	*<STEP 1>*
2.	*<STEP 2>*
Conditions of Success	
1.	
Test Report	
1.	

Table 1 - Table for the formalization of test procedure

The header and description shows a unique code, to be used to refer to the test case, and the name of the test case; the description field provides a summary of the functionality or performance to be tested.
Related functionalities indicates additional functionalities tested with the test case.
The test environment describes the location and the facilities required to execute correctly the test.
The pre-conditions are the conditions that must be met in order to execute the test case.
The procedure is a list of steps to be carried out to verify that the functionality or performance under test is satisfied.
The conditions of success are the results of the test with the correct execution of the same.
Finally, the test report describes the results of the test carried out by the user.
In the classification of the test cases, to ensure uniqueness and traceability, it is adopted the following methodology:

(type) – (system).(index) – (title)
where:

- (*type*) Can be:
  - Functional F
  - NF non-functional
- (*system*) can be:
  - OBU On Board Unit
  - DR Drone
  - LH LISST-HOLO2
  - MAN Mini Manta
- (*index*): is a progressive number
- (*title*): Identifying name of the use case

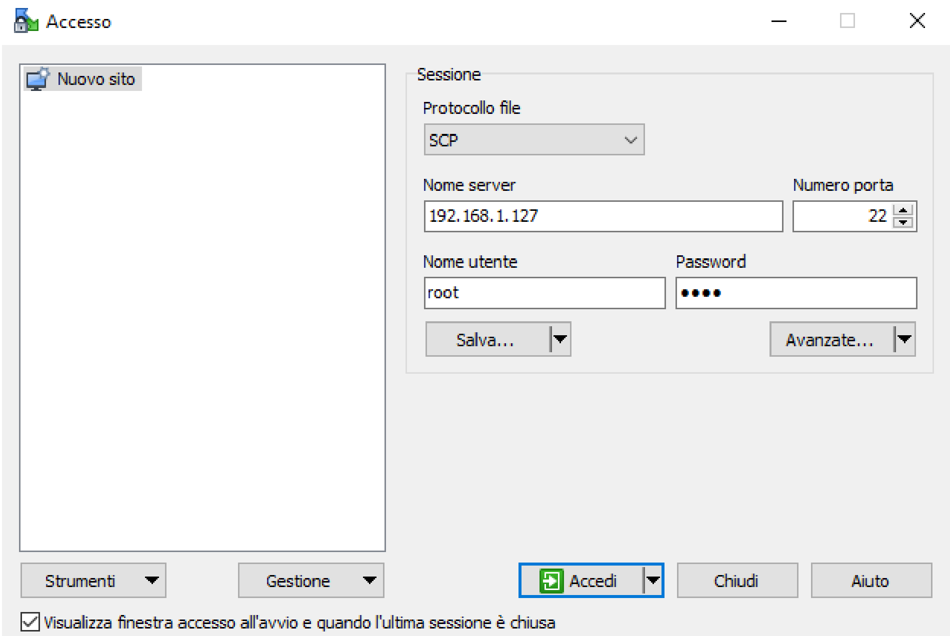
The chapters that follow are related to the test procedures and report of each system.

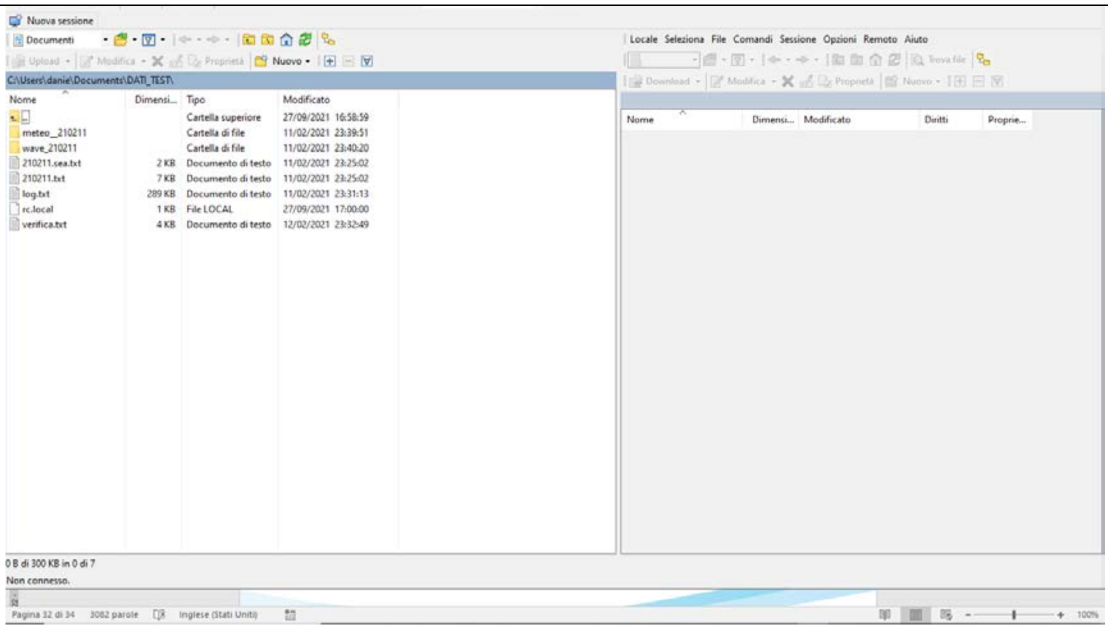
3 TEST OF OBU

The test cases of the OBU are the following:

- *F-OBU.001-Acquisition of CT and GNSS data*
- *F-OBU.002-Download of collected data*
- *NF-OBU.003-Autonomy of data acquisition*
- *NF-OBU.004-Ligth and easy to intall on board of a boat*

<table>
<tr><td colspan="2">TEST CASE:
F-OBU.001</td><td>Acquisition of CT and GNSS data</td></tr>
<tr><td colspan="2">Description:</td><td>This test is amied at verify that the OBU is able to collect autonomously CT and GNSS data during a mission at sea</td></tr>
<tr><td colspan="2">Related functionalities:</td><td>Acquisition of the travel path of the mission to be shown in the WebGIS</td></tr>
<tr><td colspan="2">Test Environment:</td><td>OBU installed on board of a boat with related sensors.</td></tr>
<tr><td colspan="2">Preconditions:</td><td>OBU and related sensors available on board of a boat</td></tr>
<tr><td colspan="3">Procedure</td></tr>
<tr><td>1.</td><td colspan="2">Fix the sensors and the OBU-Box on board of a boat.</td></tr>
<tr><td>2.</td><td colspan="2">Connect the CT and GNSS sensors to the OBU-Box with related cables and connectors</td></tr>
<tr><td>3.</td><td colspan="2">Power ON che OBU-Box</td></tr>
<tr><td colspan="3">Conditions of Success</td></tr>
<tr><td>1.</td><td colspan="2">The files YYMMDDhhmmss.dat and YYMMDDhhmmss.gps are generated at the start of a mission at date time DD/MM/YYYY hh:mm:ss</td></tr>
<tr><td colspan="3">Test Report</td></tr>
<tr><td>1.</td><td colspan="2">The files are correctly saved in the folder /media/mmc/datames. They are small files easy to be transferred also via email. The name of the files is the GMT date and time of switch on of the OBU on board of the boat. No necessary to delete the files from the OBU datalogger as the storage autonomy is very big compared with the files sizes. .DAT and .GPS files can be open with EXCEL as they are CSV test files.</td></tr>
</table>

TEST CASE: *F-OBU.002*	*Download of collected data*
Description:	Scope of this test is to verify that the data collected by OBU during a missions can be easily transferred to a PC
Related functionalities:	Transfer of the data to the Web Server Platform
Test Environment:	OBU on board or in the Laboratory connected with ethernet cable to a PC.
Preconditions:	OBU has acquired data file as used in a mission at sea
Procedure	
1.	The OBU datalogger has IP address 192.168.1.127 thus it is necessary to set the notebook PC with the IP 192.168.1.100 (netmask 255.255.255.0) to get access to the data using WINSCP application (https://winscp.net/eng/download.php) in modality SCP. As indicated in the following picture set the server **IP 192.168.1.127** and insert the username and password **root, root** to get access to the OBU datalogger. 
2.	In the following window on the right side move from the root to the folder /media/mmc/datames to see the files ***YYMMDDhhmmss.dat*** and ***YYMMDDhhmmss.gps*** and drag and drop them on the left side in the PC hard drive. They are small files easy to be trasnsferred also via email. The name of the files is the GMT date and time of switch on of the OBU on board of boat B. No necessary to delete the files from the OBU datalogger as the storage autonomy is very big compared with the files sizes. .DAT and .GPS files can be open with EXCEL as they are CSV test files.

	
Conditions of Success	
1.	The data are trasferred in few seconds to the hard drive of the PC
Test Report	
1.	*This test was successfully executed after every mission at sea.*

TEST CASE: *NF-OBU.003*	*Autonomy of data acquisition*
Description:	Scope of the test is to verify that internal battery provides an autonomy for more the one mission at sea.
Related functionalities:	-
Test Environment:	On board of a boat of in the Laboratory
Preconditions:	OBU powered ON
Procedure	
1.	With the OBU powered ON measure the maximum time of data acquisition with the battery fully charged.
Conditions of Success	
1.	The battery can supply the OBU for at least 8 hours countinuosly
Test Report	
1.	*This test was successfully executed in the Laboraroty and the autonomy is more than 20 hours.*

TEST CASE: *NF-OBU.004*	*Ligth and easy to intall on board of a boat*	
Description:	Scope of the test is to demonstrate that the device has zero impact regarding the logistic aspects of the boat	
Related functionalities:	-	
Test Environment:	Boat at sea	
Preconditions:	OBU available on board of the boat.	
Procedure		
1.	Fix the OBU-Box on board of the boat with a plastic tie	
2.	Fix CT out board to a small pole and the GNSS on the top of the boat.	
Conditions of Success		
1.	The installation of OBU can be carried out in less than 10 minutes	
Test Report		
1.	*This test was successfully executed during the missions in diffrent type of boats and it was always possible to installe easily the OBU in less then 10mins.*	

4 TEST OF DRONE

The test cases of the Drone are the following:

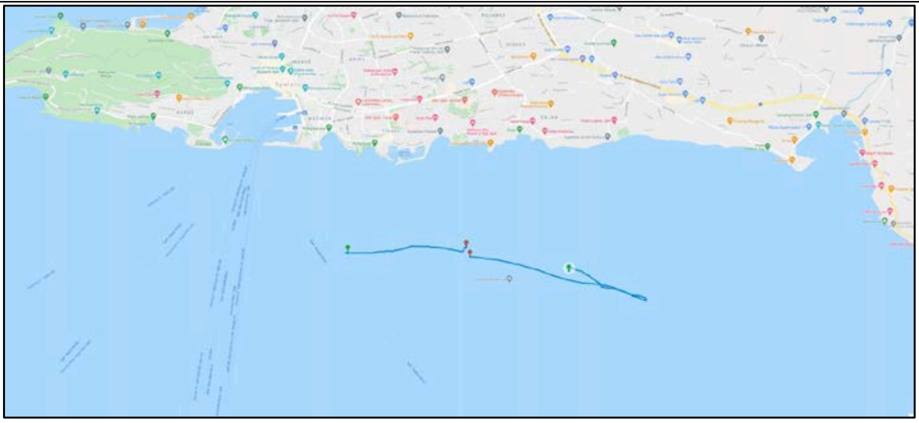
- *F-DR.001-Able to navigate with Manta and LISST-HOLO2*
- *F-DR.002-Remote Control of Drone Navigation*
- *NF-DR.003-Average speed*
- *NF-DR.004-Autonomy of Navigation*

TEST CASE: *F-DR.001*		*Able to navigate with Manta and LISST-HOLO2*
Description:		Scope of this test is to verify that the Drone can navigate in stable way with the LISST-HOLO2 fixed under the keel and towing the mini-manta
Related functionalities:		Integrated data collection during a mission at sea for MP measurement
Test Environment:		The mission at sea
Preconditions:		Drone prepared with LISST-HOLO2 under its keel and manta connected to the Drone stern to be towed. Drone powered on and paired with its remote control unit.
Procedure		
1.	From a boat to deploy the drone at sea paying attention to the LISST-HOLO2 fixed under its keel.	
2.	With the Drone at sea deploy the mini-mana in water and to fix it to the stern of the drone by means of dedicated wire rope.	
3.	With dedicated remote control unit start the navigation of the Drone.	
Conditions of Success		
1.	The Drone can navigate in stable way with no roll, no pitch and to reach a speed of at least 2knots	
Test Report		
1.	*This test was successfully executed during all missions carried out in Adriatic sea in Italy and Croatia as shown in these pictures. The pitch due to the weight of the LISST-HOLO2 is limited to less than 5 degrees and does not compromise the Drone navigation.*	



TEST CASE: *F-DR.002*	*Remote Control of Drone Navigation*
Description:	Scope of this test is to verify the possibility to maneuver the drone along a transept to collect data related to MP.
Related functionalities:	To get a Lagrangian monitoring node
Test Environment:	Mission at sea with maximum sea state Beaufort 2
Preconditions:	Drone equipped with LISST-HOLO2 and mini-manta

Procedure	
1.	To deploy the Drone in water connected to LISST-HOLO2 and mini-manta
2.	To start the navigation with the remote control unit from a boat followng the drone at a distance of maximum 50m with a speed in the range 1-2knots.
3.	To navigate along straingh lines route and turn left or right
Conditions of Success	
1.	The drone can follow the boat route for the whole mission
Test Report	
1.	*This test was successfully executed for each mission as indicated by the following test routes*  

TEST CASE: *NF-DR.003*	*Average speed*
Description:	Scope of this test is to verify the average speed that can reach the drone to carried out a mission of about 1NM in less than one hour
Related functionalities:	Data acquisition mission at sea
Test Environment:	Mission at sea with maximum sea state Beaufort 2
Preconditions:	Drone equipped with LISST-HOLO2 and mini-manta
Procedure	
1.	To deploy the Drone in water connected to LISST-HOLO2 and mini-manta
2.	To start the navigation with the remote control from a boat followng the drone at a distance of maximum 50m with a speed in the range 1-2knots.
3.	To measure the time to cover a transept of maximum 2NM and to get the average speed.
Conditions of Success	
1.	The drone can follow the boat at a speed of 1-2knots
Test Report	
1.	*This test was successfully executed with the following missions* *Mission of 27th Oct 2021 12.18 CEST* *Average Speed: 2,0 km/h* *Misson of 27th Oct 2021 17.30 CEST* *Average Speed: 4,2 km/h* *Mission of 29th Oct 2021 9.52 CEST* *Average speed: 2,2 km/h*

	Misson of 29th Oct 2021 10.48 CEST *Average Speed: 4,2 km/h*

TEST CASE: *NF-DR.004*	*Autonomy of navigation*
Description:	This test is aimed at verify that the drone can navigate autonomously with its internal battery initially fully charged for at least 45-60mins
Related functionalities:	Countinuous data collection along a transept
Test Environment:	Mission at sea with maximum sea state Beaufort 2
Preconditions:	Drone equipped with LISST-HOLO2 and mini-manta
Procedure	
1.	To deploy the Drone in water connected to LISST-HOLO2 and mini-manta
2.	To start the navigation with the remote control from a boat followng the drone at a distance of maximum 50m with a speed in the range 1-2knots.
3.	To measure the time to cover a transept of maximum 2NM
Conditions of Success	
1.	The Drone can navigate along the transept from the begnning to the end without interrupting the navigation for about 45-60mins
Test Report	
1.	*This test was successfully executed with the following missions* *Mission of 27th Oct 2021 12.18 CEST* *Length: 2,1 km* *Duration: 1h, 3min, 26sec* *Misson of 27th Oct 2021 17.30 CEST* *Length: 1,8 km* *Duration: 25min and 29sec* *Mission of 29th Oct 2021 9.52 CEST* *Lenght: 1,7 km* *Duration: 47min and 7sec* *Misson of 29th Oct 2021 10.48 CEST* *Length: 3,6 km* *Duration: 52min and 16sec*

5 TEST OF LISST-HOLO2

The test cases of LISST-HOLO2 sensor are the following:

- *F-LH.001-Mechanical connection of the sensor under the drone hull*
- *F-LH.002-Start and Stop of data acquisition*
- *F-LH.003-Download of collected holograms*

TEST CASE: *F-LH.001*	*Mechanical connection of the sensor under the drone hull*
Description:	This test is aimed at verify that the LISSST-HOLO2 can be connected under the hull of the drone and stay in stable position during the navigation
Related functionalities:	Drone is able to support the LISST-HOLO2
Test Environment:	The connection can be verified onshore and at sea
Preconditions:	Availability of the drone and of the LISST-HOLO2
Procedure	
1.	The drone is placed onshore or on board of a boat.
2.	With a special stainless steel clamp it is possible to fix the LISST-HOLO2 under the keel of the drone.
Conditions of Success	
1.	The LISST-HOLO2 is fixed in a stable way under the keel of the drone.
Test Report	
1.	*This test was successfully executed as indicated in this picture* 

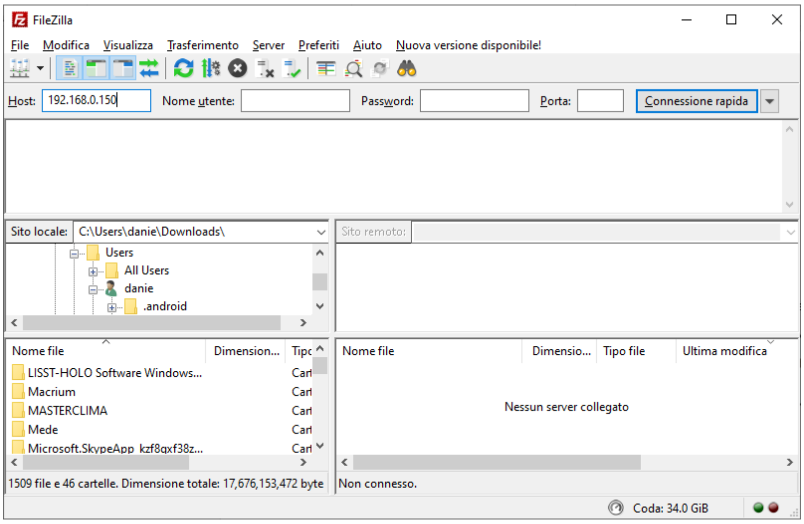
TEST CASE: *F-LH.002*	*Start and Stop of Data Acquisition*

Description:	This test is aimed at verify that the LISSST-HOLO2 can start and stop the data acquisition only with the movement of an external magnetic switch
Related functionalities:	Data acquisition of holograms
Test Environment:	The LISST-HOLO2 is prepared with internal battery charged
Preconditions:	Availability of the LISST-HOLO2
Procedure	
1.	Move the magnetic switch from 0 to 1 and after 1 second back to 0. Connect a PC to the instrument with an ethernet cable as described in [R6], delete the old holograms and eventually change the configuration as described in [R6]. Disconnect the PC and move the switch to 1 to start new holograms acquisition at the start of the boat navigation.
2.	At the end of the navigation stop the data acquisition moving the magnetic switch from 1 to 0.
Conditions of Success	
1.	The LISST-HOLO2 is able to start and stop holograms data acquistion
Test Report	
1.	*This test was successfully executed several times moving the magnetic switch from 0 to 1 position and viceversa. It is important to remember that to get the ethernet connection with the esxternal PC it is always necessary to move the switch as follow: from 0 to 1 and after 1 sec back to 0. With the magnetic switch in position 1 the sensor cannot be connected to the external PC because it is collecting holograms.* 

TEST CASE: *F-LH.003*	*Download of collected holograms*
Description:	This test is aimed at verify that holograms collected by the LISST-HOLO2 can be downloaded from the internal mass memory of the sensor with an ethernet cable connected to a PC.

Related functionalities:	Data acquisition of holograms
Test Environment:	The LISST-HOLO2 is connected to a PC with an ethernet cable
Preconditions:	Availability of the LISST-HOLO2 and of a PC with installed the FTP client FileZilla.
Procedure	
1.	To connect the ethernet cable from the sensor to a notebook PC with ethenet interface (IP address 192.168.0.1/24) and with installed an FTP client (e.g. Filezilla).
2.	Move the magnetic switch of HOLO2 from 0 to 1 for 1 second and immediately back to 0. After about 1 minute it is possible from the PC to get access to the web server interface of the sensor using a web borwser with URL 192.168.0.150.
3.	Go to the ***Tools*** page and disable the automatic sleep to keep the sensor awaken during the data transfer.
4.	Open Filezilla ftp client, insert the IP 192.168.0.150 and no need to specify a host thus you can push directly the button “Quick Connection”.

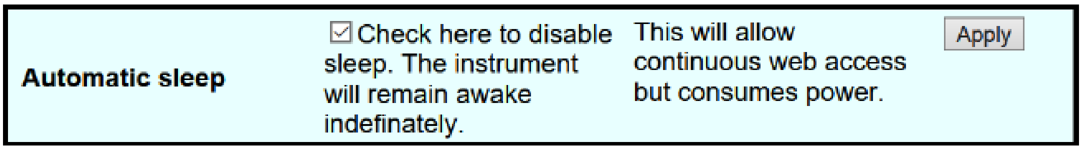
5.



On the right side of the window above there will be the folder ***images***: drag and drop it to the left side. It is suggested to select as destination folder on the left side an external SSD in order to allow an easy data transfer among the project partners.

With an acquisition rate of 20fps the time to transfer the holograms collected in 15mins is about 30-40mins. At the end of the transfer rename the folder images on the left side with a name associated to the transept: e.g. Rijeka_Transept_1 and inside the folder create a ***readme.txt*** file where to write date and time of begin and end of the transept:

```
BEGIN 25/10/21 09:23:12
END   25/10/21 09:52:24
```

6.	At the end of the data transfer you can delete all the HOLO2 internal images with the following command 
7.	Before disconnecting PC from HOLO2 you can put the HOLO2 to sleep after 10min as indicated in this picture 
Conditions of Success	
1.	After a time that depends on the number of holograms to download, all the holograms are transferred to the PC
Test Report	
1.	*This test was successfully executed several times for each mission at sea. Due to the setting of 20 holograms per second, for a mission of 15 minutes the time tor download all holograms is aboout 45-60mins.*

6 TEST OF MINI-MANTA

The test cases of mini-manta are the following:

- *F-MAN.001-Mechanical connection of the manta to the stern of the drone;*
- *NF-MAN.002-The manta is towed correctly by the drone;*
- *F-MAN.003-The manta is able to measure the volume of water filtered during a transept;*

TEST CASE: *F-MAN.001*	*Mechanical connection of the manta to the stern of the drone*
Description:	This test is aimed at verify that the manta can be easly connected and disconnected to the stern of the drone during a mission at sea.
Related functionalities:	Drone is able to tow the manta
Test Environment:	The connection can be verified onshore and at sea
Preconditions:	Availability of the drone and of the manta with related wire rope.
Procedure	
1.	The drone is placed onshore or at sea close to the boat that shall follow the drone during the mission.
2.	Put the manta close to the drone (onshore or at sea) and fix the hook of the wire rope to the stern hook of the drone.
Conditions of Success	
1.	The manta is mechanically connected to the drone that can tow it at sea.
Test Report	
1.	*This test was successfully executed as indicated in this picture* 

TEST CASE: *NF-MAN.002*	*The manta is towed correctly by the drone*
Description:	This test is aimed at verify that the manta is stable at sea during the towing of the drone
Related functionalities:	Drone is able to tow the manta
Test Environment:	The connection can be verified at sea
Preconditions:	Availability of the drone connected to the manta at sea. Drone switched on and alreaiy paired with related remote control unit.
Procedure	
1.	With the remote control unit of the drone start moving the drone along a straight line with a speed up to 2knots.
2.	With the remote control turn the drone right and left.
Conditions of Success	
1.	The manta stays in horizontal position during the drone navigation in stright line and during the turning maneuvers.
Test Report	
1.	*This test was successfully executed as indicated in this picture*  

TEST CASE: *F-MAN.003*	*The manta is able to measure the volume of water filtered during a transept*
Description:	This test is aimed at verify that the manta can measure the volume of water passing through its mouth.
Related functionalities:	Calculation of the concentration of microliter per cubic meter of water processed.
Test Environment:	Manta towed by the drone at sea.
Preconditions:	Availability of the drone with the manta at sea.

Procedure	
1.	Take note of the counter indicated by the flow sensor before to start the navigation
2.	Start the navigation along a path of 100m
3.	Stop the navigation and take note of the counter indicated by the flow sensor
Conditions of Success	
1.	The flow sensor of the manta is able to measure the water volume passing through the manta mouth during the navigation along a transept.
Test Report	
1.	*The initial counter is 243. The final counter is 580. The difference is 337. The coefficinet of the sensor is 0.3 thus the lenght of the navigation path is 0.3 X 334 = 101.1m as expected with an acceptable error of 1%. The mouth of the manta is 0.3 x 0.15 = 0.045m^2 thus the processed water volume is 101.1 x 0.045 = 4.55m^3.*