NET4mPLASTIC PROJECT

WP3 – Act. 3.3 Study and Design of the Integrated Platform's structure associated with early warning system

D 3.3.2

EWS Hardware Architecture and network design

March, 2020 - Version 1.2

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INDEX

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 Act 3.3 deals with the study and design 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 expected deliverable are the following:

- D 3.3.1 – EWS Requirements definitions based on the stakeholders and users' needs, through questionnaires and specific meeting
- D 3.3.2 – EWS Hardware Architecture and network design (central Data Centre Hardware Architecture Client/Server, Data network architecture and related communication segments)
- 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
- 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).
- D 3.3.5 - Report and database provision with all the collected data

1.2 Purpose of the report

This document is the deliverable D.3.3.2 - EWS Hardware Architecture and network design, based on the EWS requirement definition report [R2], to describe the concept solution, feasibility and relevant design,

within the activity 3.3 of the **Net4mPlastic project - New Technologies for Macro and Microplastic Detection and Analysis in the Adriatic Basin.**

The purpose of this document is summarized as follows:

- The concept solution, based on requirements
- The feasibility of the solution
- The system design of the List, with descfriptino of the architecture and the network design.

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]	**EWS requirements definition**	HYD001-SPE-001.0	ACT3.3 – Net4Mplastic

2 Concept solution

2.1 Introduction

This chapter provides an overview of the concept solution expected for the EWS system, based mainly of stakeholder requirements collected through the questionnaires.

2.2 Description

Basically, the system to be designed and erected is depicted in the picture herebelow where the following elements can be identified:

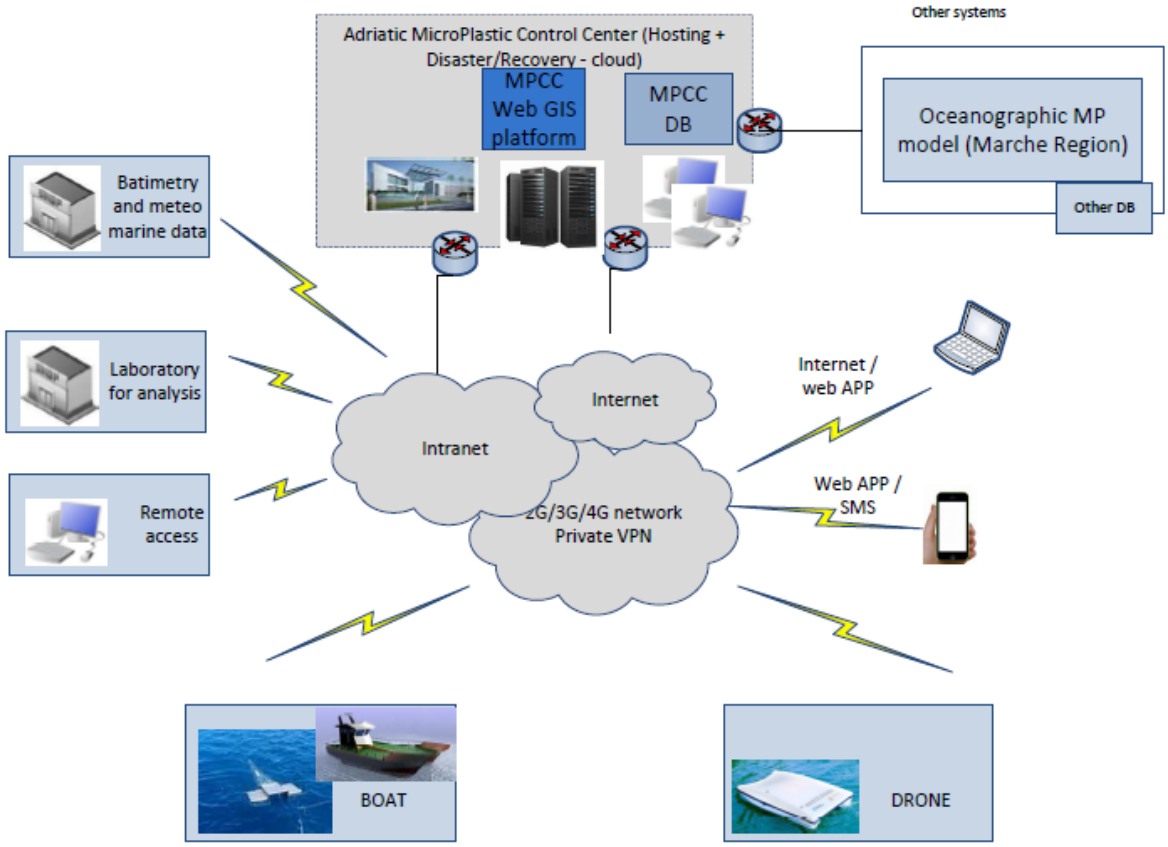


Fig. 2.1 - EWS Conceptual Design

- A Data Centre with all required hardware and software facilities to collect, process, store in organized way and show to the users all collected data.

- A network composed of communication segments relied on internet technology that allow the collection of data and related information from the different sources: monitoring campaigns data carried out with drones or onboard units, meteo-marine data, bathimetric and river flows

data. Also the hystorical data of the microplastic concentrations in the Adriatic region shall be stored in the data centre in order to have enough information for the forecasting model to be developed within the project scope.

- The Prediction Model developed by Marche Region composed by own hardware and software facilities able to run custom processing modules producing the microplatics concentration forecast. The data interface betweenthe Prediction Model and the Data Centre is mainly for the collection of new collected data and to transfer to the Data Centre of the forecast reports containing information related to the expected microplastics concentration in a specific area and time range.

- Other data sources or users to collect additional information (e.g. macroplastic information) or to get access to the data platform to find specific data.

The main functionalities to be implemented by the system are coded and described in the following table.

Id	Functionality description	Note
F001	Collection of bathymetric data of the monitored areas	
F002	Collection of Mateo-marine data of the monitorerd areas including the rivers flowrates as possobile sources of micro and macrolastics	
F003	Collection of Laboratory analysis data related to biota and microplastic concentrations	
F004	Collection of hystorical data related microplastics and macro-plastics	
F005	Collection of data measured along a transept by a Drone or Instrumented Onboard Units	
F006	Collection of data related to microplastics and macroplastics introduced by stakeholders with mobile devices (smart-phone or laptop)	
F007	Collection of metadata related to the diagnostic of the instrumentations, multimedia files, useful information correlated to the microplastics and macroplastics concentrations data	
F100	Processing of all data collected to get the forecast of microplastic distributions in the Adriatic sea	
F101	Tranfer of data to be processed to the Forecast Model and reception of the forecast report related to specific areas and time frames	
F200	Configuration of microplastics alarm thresholds in term of maximum allowed concentrations	

F201	Generation of Alarm messages in near real time	
F202	Generation and dispatching of alarm bullettins	
F300	Organization of all collected and processed data in a Database with defined set of queries to recover raw data and processed data	
F400	Presentation of the stored data in graphical and table formats	
F401	Presentation of the evolution of the microplastics concentrations on a GIS interface for a specific time range	

As for the Drone, it is composed of an off the shelf hull with related propulsion and navigation system, battery pack and remote configuration and control unit. It will be equipped with at least the following devices:

- A data acquisition and communication unit able to manage the following instrumentation:
- CTD probe with dissolved Oxygen sensor and Turbidity sensor;
- ADCP current profiler;
- Innovative sensor for microplastics detection.

The instrumented unit to be used on board of the boat will be the same hosted in the Drone but integrated in a light metal frame to be fixed to the boat.
Detail description of the Drone and Onborad units will be reported in a separated document.

3 Feasibility study

3.1 Introduction

This chapter provides an overview of the feasibility study relevant to the integration of the main components.

3.2 Description

Referring to the pictures in section 2 of the present document, the hardware infrastructure is composed of a Data Centre composed of PC Servers connected with Internet. Nowadays two solutions are available to implement the Data Centre:

- ✓ to purchase the hardware (PC Servers and network devices) and related commercial software (Operative Systems, DataBase Management System, Cybersecuirty software, Office Software Licences, etc) to be integrated and tested in dedicated premise of a project partner in Italy or Croatia.

- ✓ To adopt a Cloud solution.

On-premise servers have been primary before cloud services arose and still provide different pros and cons compared to cloud-based servers.

Pros	Cons
Physical control over server hardware	***Need for dedicated IT support***
Critical data is stored on-premise with no third party access	***Requires hardware and infrastructure capital investment***
Not reliant on internet access	No uptime guarantees
More cost-effective for companies not concerned about uptime	More prone to data loss in emergency situations

Cloud-based server hosting utilizes virtual technology to offer powerful and secure IT operations that are highly adaptable to business demands. Cloud-based operations are all the rage right now; however, there are pros and cons of the cloud to consider.

Pros	Cons
No capital expenses	Internet speed and connection controls user experience
Data can be backed up regularly, minimizing risk of losses	Third party cloud servers might have access to your data
Only pay for options you need	***Access to data is solely dependent on internet connection***

Great for expanding companies outgrowing their infrastructure, connecting employees globally	Cost outweighs benefits for companies not reliant on uptime

It is evident that the Cloud Solution allows saving the investment for the hardware faciliites and related installation. Moreover, in case of implementation it is possible to define also two different virtual servers, e.g. one for the Italian sites and one for the Croatian sites, sharing the same virtual resources with no need of local premises in Italy and Croatia.

Fig. 3.1 – Server Cloud Solution

As depicted in picture 3.1, the Cloud solutions allows the full access everywhere to all partners: in phase of implementation, it will be necessary to identify the different type of users with related credentials to get access to subset of functionalities. At this stage the following classes of users can be defined:

- ***Administrators***: able to manage the whole system for maintenance purposes and for the installation of new software modules.

- ***Internal Users***: personell of project partners and stakeholders authorized to import data.

- ***Generic Users***: generic user registered with account to be authorized to export data.

In the procurement phase the final choice between On-premise servers and Cloud-servers will be decided. As for the network communication segments, due to the typical sizes of the data files to be exchanged between the client applications and the servers facilities, data rate of 20MBps in download and 10MBps in download are sufficient to allows the execution of the main functionalities of the Data Centre. Only the multimedia data (classified as metadata) composed of movie and pictures (e.g. movie and picutres of

macroplastics) are saved in files that can have a significant sizes: anyway they will be uploaded/downladed and displayed in the local device only at the end of the file transfer process.
For the coding and exchange of data, files in textual format will be used with all data coded in readable formats with standard software (text editor, Excel, etc.).
All functionalities described in section 2 will be implemented with custom software modules wherease for data visualization in plots and table format, some commercial applications can be used and configured.

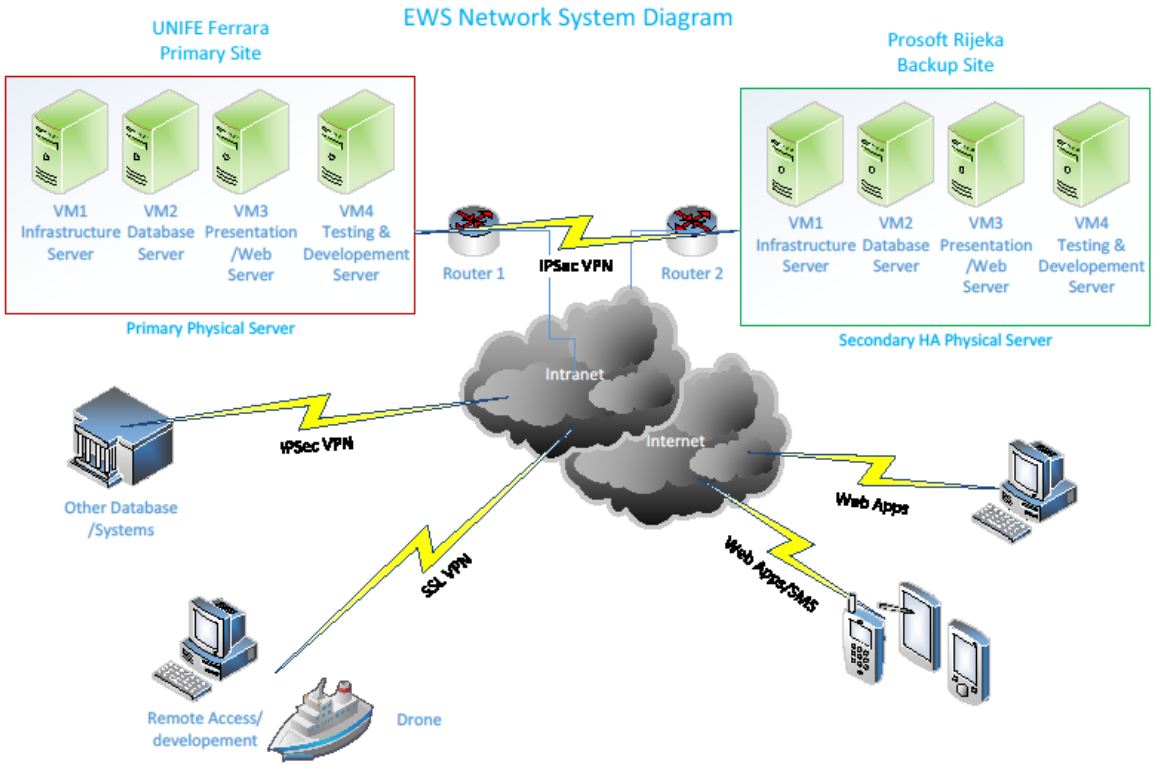
4 EWS System architecture and network design

4.1 Introduction

This chapter provides an overview of the system architecture design and communication.

4.2 Description

Whichever the solution adopted (On-premise Server or Cloud Server) the EWS network solution is depicted in the following diagram.



It is planned to have two Servers infrastructures in hot backup: the Primary one located in UNIFE (Italy) and the Backup one located in PROSOFT (Croatia). In case of Cloud Servers solutions both infrastrucutres are virtual.

Interconnection of the remote units with the Data Centre is implemented with internet connections through wired or wirelss links.

In order to assure flexibility for the implementation of the functionalities, the server facility is composed by 4 different servers:

- *Infrastructure Server*
- *Database Server*
- *Presentation WEB/Server*
- *Testing and Development Server*

The *Infrastructure Server* hosts the software modules for the following functionalities:

- Communication Front-End with the remote units;
- Data Verification and Conversion in formats suitable for the presentation;
- Cybersecurity software modules.

The *Database Server* integrates the DBMS (Database Management System) to store in organized way all data collected. This server will integrate the mass memory composed of Hard Drives in raid configuration to store all collected and processed data.
The *Presentation WEB/Server* hosts the software modules to present on WEB based interfaces the data in table and plot format with a cartographic base (GIS).
Testing and Development Server hosts all software development tools required to develop all custom software modules that before to be installed in the other Servers, will be tested with temporary releases in this server.
The Drone will be composed of an off the shelf autonomous veichle with related navigation system and remote control, equipped with custom instrumentation and data acquisition system composed of

- A rechargeable battery pack
- A low power fanless PC with 4G Modem and WiFi interface
- A CTD probe with Dissolved Oxygen sensor and Turbidity sensor
- An ADCP Current Profiler
- Innovative instrumentation for the monitoring of microplastics

The onboard unit will be composed of the same instrumentation of the Drone with the same data acquisition system integrated in a light metal frame to be fixed to the boat.
In this case the electrical power supply will be provided by a boat socket with an custom adapter to get the suitable voltage for the instrumentation and related data acquisition unit.

4.3 Data Flow

At this stage a diagram to show the data flows in the EWS is shown in the following picture.

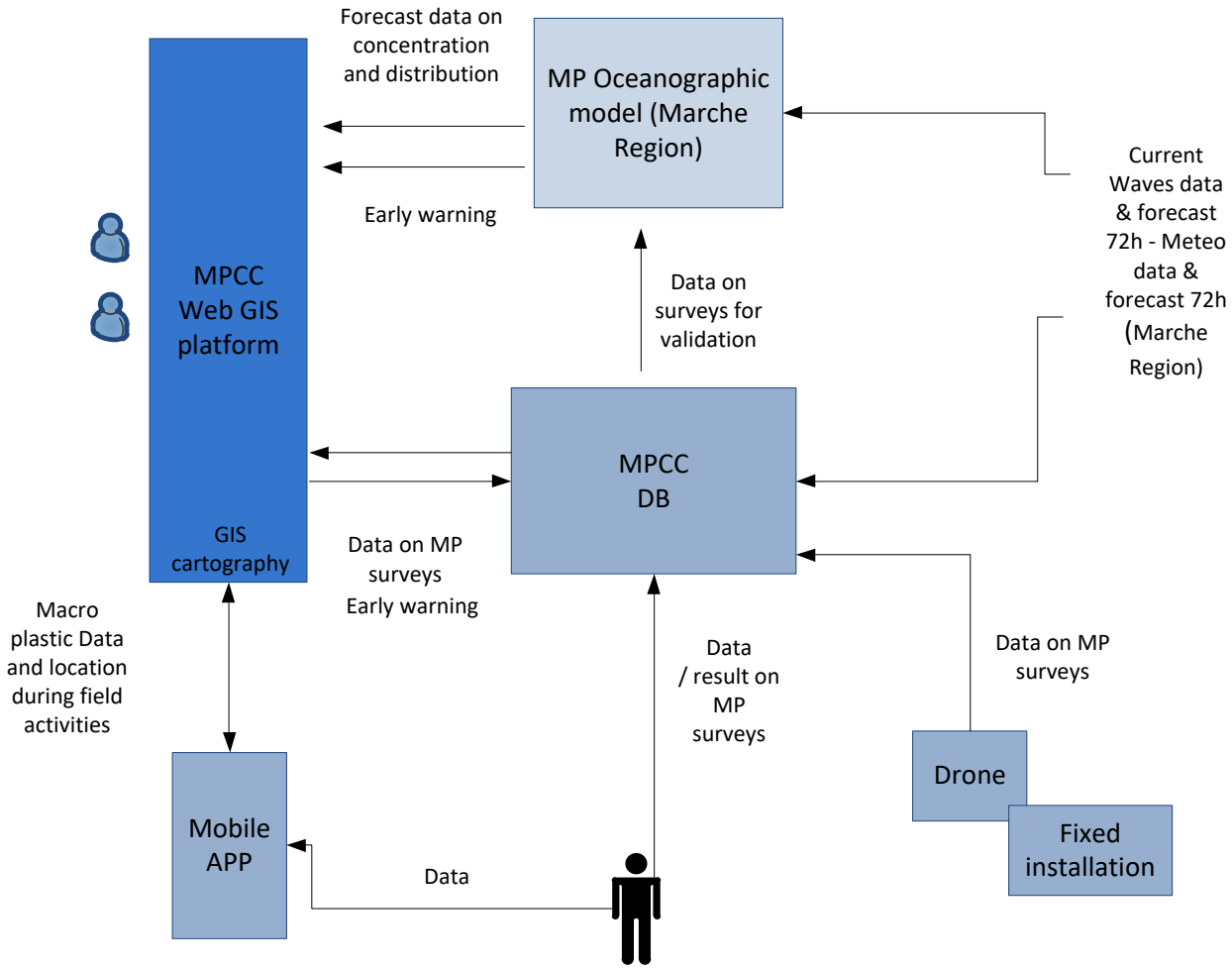


Fig. 4.1 – EWS Data Flow

Data collected by Drone or Onboard Units or Fixed monitoring installations, are stored in the MPCC DB: data can be transferred automatically via FTP or similar protocols or manually by a user.

Also the others data collected in other ways (e.g. hystorical data, stakholders data) can be sotred in the MPCC DB.

Meteomarine data, bathymetric data and rivers flow data are stored in the MPCC DB and also in the Regione Marche hardware facilities that host the MP Oceanographic Model.

The Forecast results of the MP Oceanograpic Model are transferred to the Data Centre to be displayed on a GIS interface and shared via WEB interface. Surveys data collected are transferred to MP Oceanographic Model for verification and validation of the forecast model.

In case of microplastic concentraions in some areas above some maximum thresholds, alarm messages with related summary bulletin are generated and dispatched to the users.

4.4 Functional Diagram

The functionalities already described in section 2 of the present document, are illustrated also in the following block diagrams.

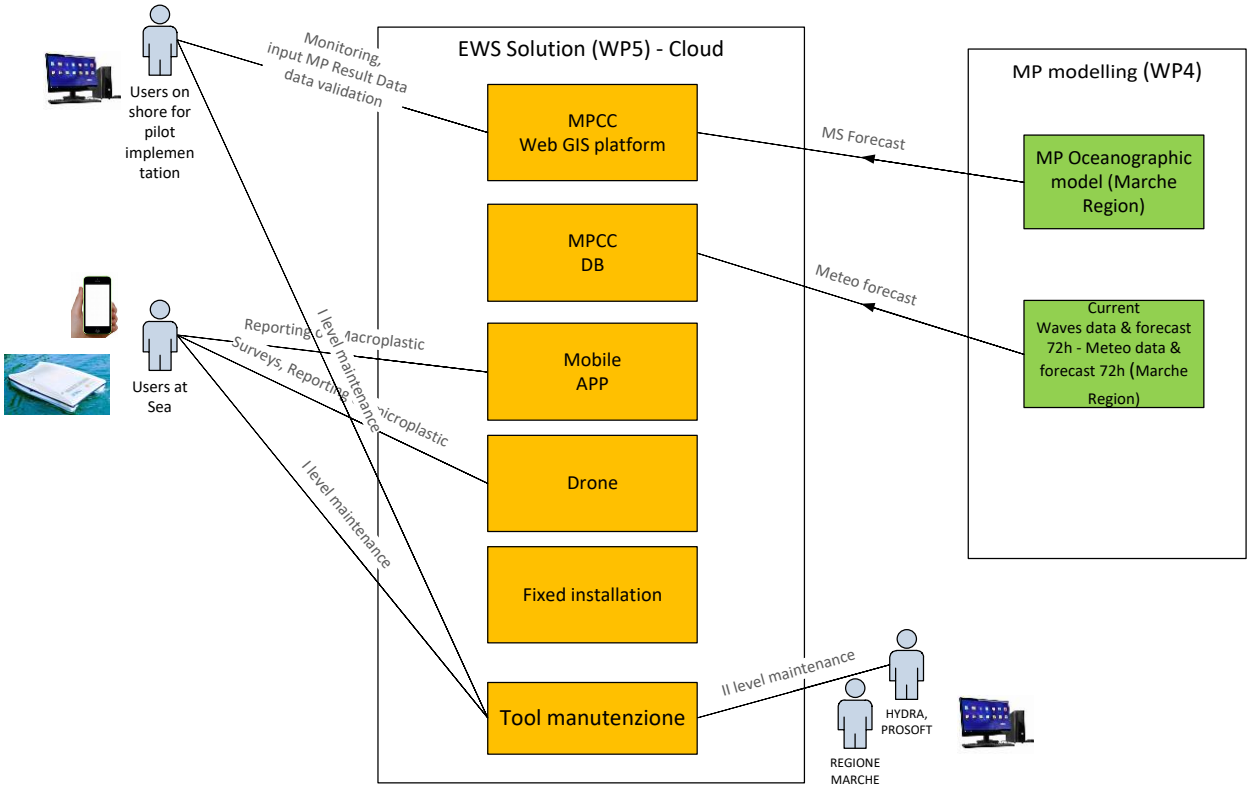


Fig. 4.2 – EWS Functional Diagram

As evidenced in the block diagram, one of the main functionality of the system EWS is realised by the Model provided by Regione Marche. In the initial implementation phase it shall be validated with historical data of microplastics cocentrations. After this tuning phase the Model will be "supplied" with the current meteo-marine data and microplastics concentration data collected from the Net4Mplastic involved partners in monitoring campaigns carried out with drones or onboard units.

The output of the Model shall be a forecast up to 72h with resolution up to 200m of the microplastics concentration in the Adriatic areas.

Thus focus of EWS platform shall be on microplastic and relevant forecast of concentration and location. The processing of the forecast will be daily, based on input of wind, current, and meteorological conditions.

The macroplastic can be provided by an application on smartphone/tablet able to do reporting geolocalized to detect plastic on the surface and add any specific information including a picture. There is olready an application developed in the project ML REPAIR that could be used for the same purpose.

The EWS will present information and forecast of the microplastics concentration with focus on some specific selected sites on a GIS interface with the possibility to show also meteo-marine data including wind speed and direction, air pressure, air temperature and humidity, sea current profile and directional waves parmeters.

Main data collected by the drones or onboard units during a monitoring campaigns will be related to a transept of about 5Nm will be the following:

- temperature, salinity (surface), current, location (differtial GPS), O2, Turbidity, RAMAN Spectra. Some data possibily not only on surface, but along the column.
- Capability to collect microplastic sample (through a manta), usually for at least 500mt having a surface of 1sqm for collecting samples on bottles (more than 1 usually).
- Data collected by additional innovative instrumentation.

5 System Breakdown

5.1 Introduction

This chapter provides an overview of the system configuration in terms of components to be procured and witch partners within the Net4Mplastic project is required to do the procurement.

5.2 System Breakdown

A system breakdown including EWS components and also drone and onboard units components is reported in the following table where for eache device it is indicated the subsystem and the quantity; a code allows to identify the component along the project live.

- *Infrastructure Server*
- *Database Server*
- *Presentation WEB/Server*
- *Testing and Development Server*

SUBSYSTEMS	ID	EQUIPMENT	Qty
Control center (HW)	CCHW01	Infrastructure Server	2
Control center (HW)	CCHW02	Database Server	2
Control center (HW)	CCHW03	Presentation WEB/Server	2
Control center (HW)	CCHW04	Testing and Development Server	2
Control center (HW)	CCHW05	Workstation	2
Control center (HW)	CCHW06	Smartphone	2
Control center (HW)	CCHW07	Tablet	2
Control center Commercial Software (SW)	CCSW01	Operative Systems	8
Control center Commercial Software (SW)	CCSW02	GIS Software development tool	1
Control center Commercial Software (SW)	CCSW03	WEB Based Software development tool	1
Control center Commercial Software (SW)	CCSW04	DBMS	1
Control Centre Custom Software modules (SW)	CCSW05	WEB Based Data Presentation module	1
Control Centre Custom Software modules (SW)	CCSW06	WEB GIS Data Visualization module	1
Control Centre Custom Software modules (SW)	CCSW07	WEB GIS platform report module	1
Control Centre Custom Software modules (SW)	CCSW08	Database Definition	1
Control Centre Custom Software modules (SW)	CCSW09	Front-end module	1
Control Centre Custom Software modules (SW)	CCSW10	Smartphone software application for Macroplastic data reporting	1

Control Centre Custom Software modules (SW)	CCSW11	Data fromats conversion software	1
Control Centre Custom Software modules (SW)	CCSW12	Data processing software	1
Integrated Marine Drone (HW)	DRHW01	Drone autonomous vehicle with related navigation and remote control unit	1
Integrated Marine Drone (HW)	DRHW02	ADCP – current profiler	1
Integrated Marine Drone (HW)	DRHW03	CTD probe with Dissolved Oxygen and Turbidity	1
Integrated Marine Drone (HW)	DRHW04	Winch for CTD profile	1
Integrated Marine Drone (HW)	DRHW05	On board unit for data acquisition	1
Integrated Marine Drone (HW)	DRHW06	Communication system	1
Integrated Marine Drone (SW)	DRWW06	Software for Drone data collection	1
Onboard Unit (HW)	OBHW01	Light Custom Metal Frame	1

6 Cost estimation and Analysis

6.1 Introduction

This chapter provides an overview of the estimated costs of the needed components.

6.2 Priced BOQ of Centre

SUBSYSTEMS	ID	EQUIPMENT	Unitary Price	Qty	SubTotal Price	NOTE
Control center (HW)	CCHW01	Infrastructure Server	3500 €	2	7000€	
Control center (HW)	CCHW02	Database Server	3500 €	2	7000€	
Control center (HW)	CCHW03	Presentation WEB/Server	3500 €	2	7000€	
Control center (HW)	CCHW04	Testing and Development Server	3500 €	2	7000€	
Control center (HW)	CCHW05	Workstation	750 €	2	1500€	
Control center (HW)	CCHW06	Smartphone	200 €	2	400€	
Control center (HW)	CCHW07	Tablet	250 €	2	500€	
Control center Commercial Software (SW)	CCSW01	Operative Systems	-	8	-	Included with the PC servers
Control center Commercial Software (SW)	CCSW02	GIS Software development tool	5000€	1	5000€	
Control center Commercial Software (SW)	CCSW03	WEB Based Software development tool	5000€	1	5000€	
Control center Commercial Software (SW)	CCSW04	DBMS	2000€	1	2000€	
Control Centre Custom Software modules (SW)	CCSW05	WEB Based Data Presentation module	-	1	-	
Control Centre Custom Software modules (SW)	CCSW06	WEB GIS Data Visualization module	-	1	-	
Control Centre Custom Software modules (SW)	CCSW07	WEB GIS platform report module	-	1	-	
Control Centre Custom Software modules (SW)	CCSW08	Database Definition	-	1	-	
Control Centre Custom Software modules (SW)	CCSW09	Front-end module	-	1	-	

Control Centre Custom Software modules (SW)	CCSW10	Smartphone software application for Macroplastic data reporting	-	1	-	
Control Centre Custom Software modules (SW)	CCSW11	Data fromats conversion software	-	1	-	
Control Centre Custom Software modules (SW)	CCSW12	Data processing software	-	1	-	

6.3 Priced BOQ of Drone and Onboard Unit

SUBSYSTEMS	ID	EQUIPMENT	Unitary Price	Qty	SubTotal Price	NOTE
Integrated Marine Drone (HW)	DRHW01	Drone autonomous vehicle with related navigation and remote control unit	45000€	1	45000€	
Integrated Marine Drone (HW)	DRHW02	ADCP – current profiler	18000€	1	18000€	
Integrated Marine Drone (HW)	DRHW03	CTD probe with Dissolved Oxygen and Turbidity	15000€	1	15000€	
Integrated Marine Drone (HW)	DRHW04	Winch for CTD profile	5000€	1	5000€	
Integrated Marine Drone (HW)	DRHW05	On board unit for data acquisition	1200€	1	1200€	
Integrated Marine Drone (HW)	DRHW06	Communication system	500€	1	500€	
Integrated Marine Drone (SW)	DRWW06	Software for Drone data collection	-	1	-	
Onboard Unit (HW)	OBHW01	Light Custom Metal Frame	1500€	1	1500€	

7 Procurement Plan

7.1 Introduction

Provide indicative time of procurement and related partner having in charge the procurement.

7.2 Procurement Delivery Timetable

For the hardware and commercial software of the Control Centre, the delivery time is about 3 weeks.
For the Drone with related instrumentation and data acquisition unit the delivery time is 5 weeks.

7.3 Procurement Breakdown for the partners

SUBSYSTEMS	ID	EQUIPMENT	Unitary Price	Qty	SubTotal Price	PARTNER
Control center (HW)	CCHW01	Infrastructure Server	3500 €	2	7000€	Marche Region
Control center (HW)	CCHW02	Database Server	3500 €	2	7000€	Marche Region
Control center (HW)	CCHW03	Presentation WEB/Server	3500 €	2	7000€	Marche Region
Control center (HW)	CCHW04	Testing and Development Server	3500 €	2	7000€	Marche Region
Control center (HW)	CCHW05	Workstation	750 €	2	1500€	Hydra Solutions
Control center (HW)	CCHW06	Smartphone	200 €	2	400€	Hydra Solutions
Control center (HW)	CCHW07	Tablet	250 €	2	500€	Hydra Solutions
Control center Commercial Software (SW)	CCSW01	Operative Systems	-	8	-	Included with the PC servers
Control center Commercial Software (SW)	CCSW02	GIS Software development tool	5000€	1	5000€	Marche Region
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Control center Commercial Software (SW)	CCSW04	DBMS	2000€	1	2000€	Marche Region
Control Centre Custom Software modules (SW)	CCSW05	WEB Based Data Presentation module	-	1	-	Hydra Solutions internal man power
Control Centre Custom Software modules (SW)	CCSW06	WEB GIS Data Visualization module	-	1	-	Hydra Solutions internal man power
Control Centre Custom Software modules (SW)	CCSW07	WEB GIS platform report module	-	1	-	Hydra Solutions internal man power

Control Centre Custom Software modules (SW)	CCSW08	Database Definition	-	1	-	Prosoft internal man power
Control Centre Custom Software modules (SW)	CCSW09	Front-end module	-	1	-	Hydra Solutions internal man power
Control Centre Custom Software modules (SW)	CCSW10	Smartphone software application for Macroplastic data reporting	-	1	-	Hydra Solutions internal man power
Control Centre Custom Software modules (SW)	CCSW11	Data fromats conversion software	-	1	-	Hydra Solutions internal man power
Control Centre Custom Software modules (SW)	CCSW12	Data processing software	-	1	-	Hydra Solutions internal man power

SUBSYSTEMS	ID	EQUIPMENT	Unitary Price	Qty	SubTotal Price	NOTE
Integrated Marine Drone (HW)	DRHW01	Drone autonomous vehicle with related navigation and remote control unit	45000€	1	45000€	UNIFE
Integrated Marine Drone (HW)	DRHW02	ADCP – current profiler	18000€	1	18000€	UNIFE
Integrated Marine Drone (HW)	DRHW03	CTD probe with Dissolved Oxygen and Turbidity	15000€	1	15000€	UNIFE
Integrated Marine Drone (HW)	DRHW04	Winch for CTD profile	5000€	1	5000€	UNIFE
Integrated Marine Drone (HW)	DRHW05	On board unit for data acquisition	1200€	1	1200€	Hydra Solutions
Integrated Marine Drone (HW)	DRHW06	Communication system	500€	1	500€	Hydra Solutions
Integrated Marine Drone (SW)	DRWW06	Software for Drone data collection	-	1	-	Hydra Solutions internal man power
Onboard Unit (HW)	OBHW01	Light Custom Metal Frame	1500€	1	1500€	Hydra Solutions