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NET4mPLASTIC
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NET4mPLASTIC PROJECT

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

D 3.3.5

Report and database provision with all the collected data

March, 2020 - Version 1.2

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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 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.3.3.5 - EWS Report and Database description**, based on the EWS requirement definition report [R2], and the deliverable D.3.3.2 - EWS Hardware Architecture and network design, to describe the solution for reporting and archiving data, with database solution and architecture structure, 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:

- Description of the architecture and data flow;
- Specification of data reported;
- Database structure;
- Database specification and structure.

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
[R3]	**EWS hardware architecture and network design**	HYD002-SPE-001.0	ACT3.3 – Net4Mplastic

2 Description of the architecture and flow of data

2.1 Introduction

This chapter provides an overview of the data flow reported to the control center, and specification of datas.

2.2 Architecture and data flow

In the following diagram is illustrated the main data-flows architecture diagram.

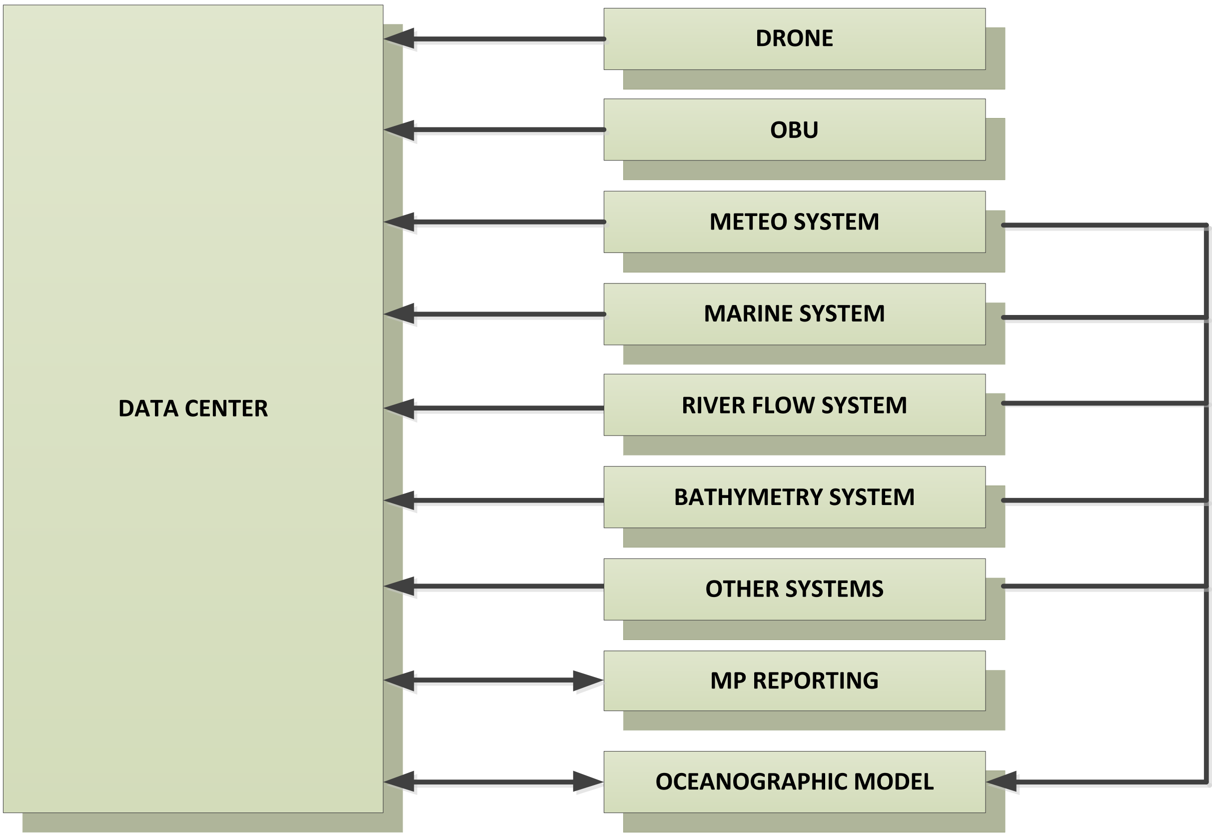

Fig. 2.2 – Main data flows.

Substantially, the following main entities with related data-flow (that can be articulated by other sub-dataflows envolving other subsystems/sub-actors) are involved in the architecture:

- Data Center, that concentrate all the EWS data to be stored, analyzed and elaborated to then produce the designed outputs via Web GIS platform to the final users;
- Drone, that produces the data acquired by the designed sensors upon mission completed;
- OBU, that produces the data acquired by the designed sensors upon mission completed;

- Meteo system, consisting of a set of weather information that can be directly acquired from sensors as same as it can come by websites or other sources of data;
- Marine system, consisting of a set of sea parameters that can be directly acquired on field as same as it can come by websites or other sources of data;
- River flow system, consisting of a set of river parameters that can be directly acquired on field as same as it can come by websites or other sources of data;
- Bathymetry system, consisting of the bathymetry of the analyzed sea portion;
- MP Reporting App, consisting of a set of data, mainly pictures and geolocations that are transmitted to the data centre;
- Oceanographic model, that both can feed the data centre with the simulated data and be feeded with required data, as same as it can be directly feeded by external sources of data.
- Others;

However, as the Oceanographic model will anyway handle all the data subsets coming from Marine, Meteo and Bathymetry systems, it could be used as the main feeder of external data for the Data Centre so, another possibility of data-flows (as depicted in the following diagram) shall be evaluated and defined during the constructive design.

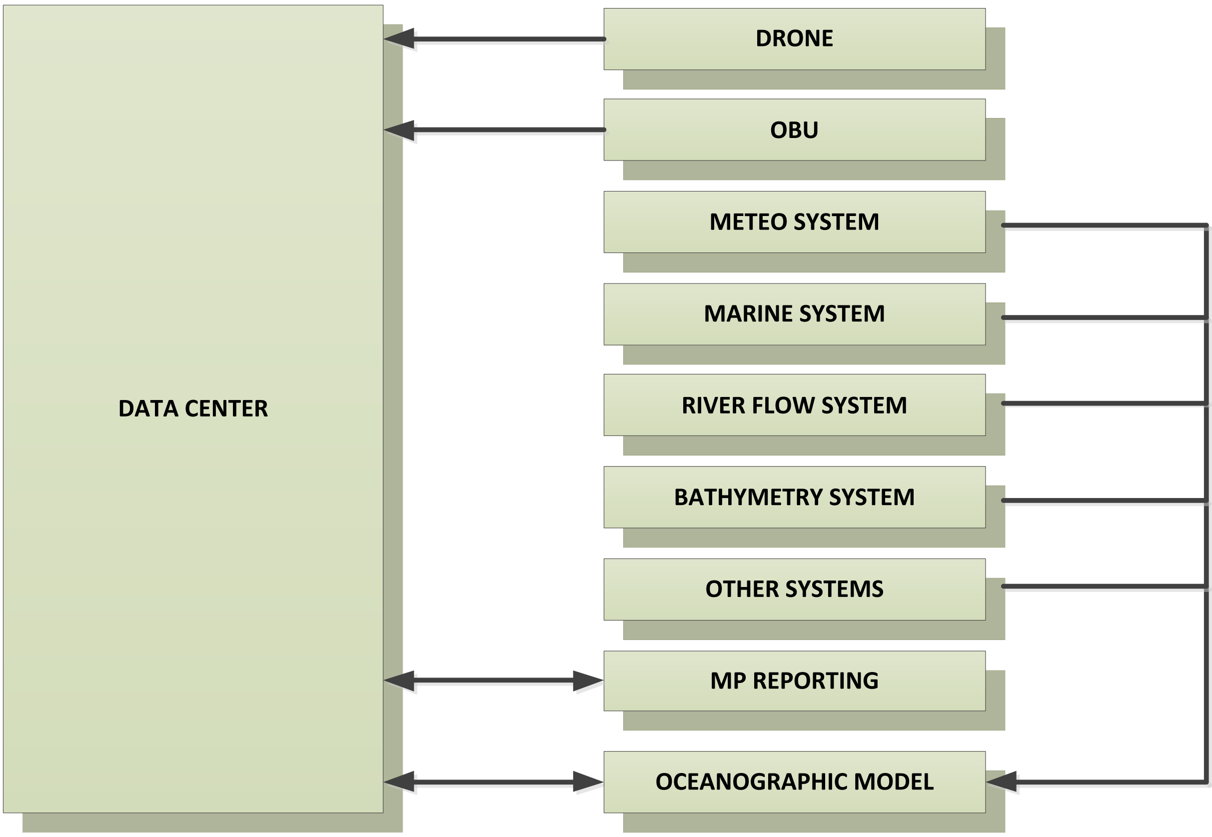

Fig. 2.3 – Main data flows alternative.

2.3 Data from users reporting

Data collected from users shall be introduced in the Database through some specific forms on web pages, where the users can introduce the following parameters:

Meta Value	Description
USER DATA	Name
	Surname
	Others information to be defined
TIMESTAMP	Current date of detection
	Current time of detection
CLASSIFICATION	Microplastic
	Macroplastic
AREA (For Microplastic)	Parameters to define a specific area
	Short description of the place or google map link
POSITION (For Macroplastic)	Latitude & Longitude
	Short description of the place or google map link
PLASTIC PARAMETERS (For Microplastic)	Concentration in the monitored area (table of data)
	Statistics of particles size (table of data)
	Type of material and related percentage (table of data)
	Others parameters to be defined
PLASTIC PARAMETERS (For Macroplastic)	Image of the macroplastic
	Weight (also estimation)
	Sizes (also estimation)
	Others parameters to be defined

2.4 Data from drone

The Drone Software Module shall produce the acquired data in the following meta-data string format:

{SoM[TIMESTAMP<Date,Time>,POSITION<Latitude,Longitude>,DIAGNOSTIC<V,A,T>,CTDPROBE<C,T,D,DO,Tu>,ADCP<Speed_01,Direction_01:Speed_50,Direction_50>,MPSENSORBINARY<ProprietaryData>,CRC]EoM}

Where:

Meta Value	Sub Value	Description
SoM	Start Of Message (including an identifier – Drone)	
TIMESTAMP	Date	Current date of sampling
	Time	Current time of sampling
POSITION	Latitude	Aquired GPS Latitude
	Longitude	Acquired GPS Longitude
DIAGNOSTIC	V	Internal battery voltage
	A	Current sink
	T	Internal electronic housing temperature
CTDPROBE	C	Acquired Conductivity from CTD Probe
	T	Acquired Temperature from CTD Probe
	D	Acquired Pressure from CTD Probe
	DO	Acquired Dissolved Oxygen from CTD Probe
	To	Acquired Turbidity from CTD Probe
ADCP	Speed_01 : 50	Acquired Sea Current Speed, 50 values, one each cell of depth
	Direction_01 : 50	Acquired Sea Current Direction, 50 values, one each cell of depth
MPSENSORBINARY	ProprietaryData	Binary File acquired from the innovative microplastic sensor, to be post-processed in the Data Centre
CRC	Cyclic Redundancy Check	
EoM	End of Message	

Currently it is possible to define the following meta-data type:

Sub Value	Description	Data type
Start Of Message (including an identifier – Drone)	Header	VarChar(32)
Date	Current date of sampling	DateTime
Time	Current time of sampling	

Latitude	Aquired GPS Latitude	VarChar(16)
Longitude	Acquired GPS Longitude	VarChar(16)
V	Internal battery voltage	Real
A	Current sink	Real
T	Internal electronic housing temperature	Real
C	Acquired Conductivity from CTD Probe	Float
T	Acquired Temperature from CTD Probe	Float
D	Acquired Pressure from CTD Probe	Float
DO	Acquired Dissolved Oxygen from CTD Probe	Float
To	Acquired Turbidity from CTD Probe	Float
Speed_01 : 50	Acquired Sea Current Speed, 50 values, one each cell of depth	Float
Direction_01 : 50	Acquired Sea Current Direction, 50 values, one each cell of depth	Float
ProprietaryData	Binary File acquired from the innovative microplastic sensor, to be post-processed in the Data Centre	VarBinary
Cyclic Redundancy Check	CRC Code	Integer
End of Message	Footer	Varchar(32)

2.5 Data from OBU

The OBU Software Module shall produce the acquired data in the following meta-data string format:

{SoM[TIMESTAMP<Date,Time>,POSITION<Latitude,Longitude>,DIAGNOSTIC<V,A,T>,CTDPROBE<C,T,D,DO,Tu>,ADCP<Speed_01,Direction_01:Speed_50,Direction_50>,MPSENSORBINARY<ProprietaryData>,CRC]EoM}

Where:

Meta Value	Sub Value	Description
SoM	Start Of Message (Including an identifier - OBU)	
TIMESTAMP	Date	Current date of sampling
	Time	Current time of sampling
POSITION	Latitude	Aquired GPS Latitude
	Longitude	Acquired GPS Longitude
DIAGNOSTIC	V	Internal battery voltage
	A	Current sink
	T	Internal electronic housing temperature
CTDPROBE	C	Acquired Conductivity from CTD Probe
	T	Acquired Temperature from CTD Probe
	D	Acquired Pressure from CTD Probe
	DO	Acquired Dissolved Oxygen from CTD Probe
	To	Acquired Turbidity from CTD Probe
ADCP	Speed_01 : 50	Acquired Sea Current Speed, 50 values, one each cell of depth
	Direction_01 : 50	Acquired Sea Current Direction, 50 values, one each cell of depth
MPSENSORBINARY	ProprietaryData	Binary File acquired from the innovative microplastic sensor, to be post-processed in the Data Centre
CRC	Cyclic Redundancy Check	
EoM	End of Message	

Currently it is possible to define the following meta-data type:

Sub Value	Description	Data type
Start Of Message (including an identifier – OBU)	Header	VarChar(32)
Date	Current date of sampling	DateTime

Time	Current time of sampling	
Latitude	Aquired GPS Latitude	VarChar(16)
Longitude	Acquired GPS Longitude	VarChar(16)
V	Internal battery voltage	Real
A	Current sink	Real
T	Internal electronic housing temperature	Real
C	Acquired Conductivity from CTD Probe	Float
T	Acquired Temperature from CTD Probe	Float
D	Acquired Pressure from CTD Probe	Float
DO	Acquired Dissolved Oxygen from CTD Probe	Float
To	Acquired Turbidity from CTD Probe	Float
Speed_01 : 50	Acquired Sea Current Speed, 50 values, one each cell of depth	Float
Direction_01 : 50	Acquired Sea Current Direction, 50 values, one each cell of depth	Float
ProprietaryData	Binary File acquired from the innovative microplastic sensor, to be post-processed in the Data Centre	VarBinary
Cyclic Redundancy Check	CRC Code	Integer
End of Message	Footer	VarChar(32)

2.6 Data from meteo sources

The Meteo System Software Module shall produce the acquired data in the following meta-data string format:

{SoM[TIMESTAMP<Date,Time>,POSITION<Latitude,Longitude>,METEO<Ws ,Wd,P,H,T,Sr>,CRC]EoM}

Where:

Meta Value	Sub Value	Description
SoM	Start Of Message (Including an identifier – Meteo System)	
TIMESTAMP	Date	Current date of sampling
	Time	Current time of sampling
POSITION	Latitude	Aquired GPS Latitude
	Longitude	Acquired GPS Longitude
METEO	Ws	Acquired Wind Speed
	Wd	Acquired Wind Direction
	P	Acquired Pressure
	H	Acquired Humidity
	T	Acquired Temperature
	Sr	Acquired Solar Radiation
CRC	Cyclic Redundancy Check	
EoM	End of Message	

Currently it is possible to define the following meta-data type:

Sub Value	Description	Data Type
Start Of Message (Including an identifier – Meteo System)	Header	VarChar(32)
Date	Current date of sampling	DateTime
Time	Current time of sampling	
Latitude	Aquired GPS Latitude	VarChar(16)
Longitude	Acquired GPS Longitude	VarChar(16)
Ws	Acquired Wind Speed	Float
Wd	Acquired Wind Direction	Float
P	Acquired Pressure	Float
H	Acquired Humidity	Float

T	Acquired Temperature	Float
Sr	Acquired Solar Radiation	Float
Cyclic Redundancy Check	CRC Code	Integer
End of Message	Footer	VarChar(32)

2.7 Data from marine sources

The Marine System Software Module shall produce the acquired data in the following meta-data string format:

{SoM[TIMESTAMP<Date,Time>,POSITION<Latitude,Longitude>,WAVE<Wsh,Wd,Wp>,CTDPROBE<C,T,D,DO,Tu>,ADCP<Speed,Direction>, CRC]EoM}

Where:

Meta Value	Sub Value	Description
SoM	Start Of Message (Including an identifier – Marine System)	
TIMESTAMP	Date	Current date of sampling
	Time	Current time of sampling
POSITION (if available, eventually one for each instrument)	Latitude	Aquired GPS Latitude
	Longitude	Acquired GPS Longitude
WAVE (if available)	Wsh	Acquired Significant Wave Height
	Wd	Acquired Wave Direction
	Wp	Acquired Wave Period
CTDPROBE (if available)	C	Acquired Conductivity from CTD Probe
	T	Acquired Temperature from CTD Probe
	D	Acquired Pressure from CTD Probe
	DO	Acquired Dissolved Oxygen from CTD Probe
	To	Acquired Turbidity from CTD Probe
ADCP (if available, number of cells can vary)	Speed	Acquired Sea Current Cell Speed
	Direction	Acquired Sea Current Cell Direction
CRC	Cyclic Redundancy Check	

EoM	End of Message

Currently it is possible to define the following meta-data type:

Sub Value	Description	Data Type
Start Of Message (Including an identifier – Marine System)	Header	VarChar(32)
Date	Current date of sampling	DateTime
Time	Current time of sampling	
Latitude	Aquired GPS Latitude	VarChar(16)
Longitude	Acquired GPS Longitude	VarChar(16)
Wsh	Acquired Significant Wave Height	Real
Wd	Acquired Wave Direction	Real
Wp	Acquired Wave Period	Real
C	Acquired Conductivity from CTD Probe	Float
T	Acquired Temperature from CTD Probe	Float
D	Acquired Pressure from CTD Probe	Float
DO	Acquired Dissolved Oxygen from CTD Probe	Float
To	Acquired Turbidity from CTD Probe	Float
Speed	Acquired Sea Current Cell Speed	Float
Direction	Acquired Sea Current Cell Direction	Float
Cyclic Redundancy Check	CRC Code	Integer
End of Message	Footer	VarChar(32)

2.8 Data from river flow sources

The River Flow System Software Module shall produce the acquired data in the following meta-data string format:

{SoM[TIMESTAMP<Date,Time>,POSITION<Latitude,Longitude>,FLOW<f>, CRC]EoM}

Where:

Meta Value	Sub Value	Description
SoM	Start Of Message (Including an identifier – Marine System)	
TIMESTAMP	Date	Current date of sampling
	Time	Current time of sampling
POSITION (if available, eventually one for each instrument)	Latitude	Aquired GPS Latitude
	Longitude	Acquired GPS Longitude
FLOW	F	Acquired River Flow
CRC	Cyclic Redundancy Check	
EoM	End of Message	

Currently it is possible to define the following meta-data type:

Sub Value	Description	Data Type
Start Of Message (Including an identifier – River Flow System)	Header	VarChar(32)
Date	Current date of sampling	DateTime
Time	Current time of sampling	
Latitude	Aquired GPS Latitude	VarChar(16)
Longitude	Acquired GPS Longitude	VarChar(16)
F	Acquired River Flow	Float
Cyclic Redundancy Check	CRC Code	Integer
End of Message	Footer	VarChar(32)

2.9 Data from other sources

The following meta-data string format represent a possible encapsulation of bathymetry data:

{SoM[TIMESTAMP<Date,Time>,BATHYMETRY<XYZ>, CRC]EoM}

Where:

Meta Value	Sub Value	Description
SoM	Start Of Message (Including an identifier – Marine System)	
TIMESTAMP	Date	Current date of sampling
	Time	Current time of sampling
BATHYMETRY	XYZ	Encapsulated typical XYZ ASCII bathymetry format
CRC	Cyclic Redundancy Check	
EoM	End of Message	

Currently it is possible to define the following meta-data type:

Sub Value	Description	Data Type
Start Of Message (Including an identifier – Marine System)		VarChar(32)
Date	Current date of sampling	DateTime
Time	Current time of sampling	
XYZ	Encapsulated typical XYZ ASCII bathymetry format	Float
Cyclic Redundancy Check	CRC Code	Integer
End of Message	Footer	VarChar(32)

2.10 Data from smartphones for Macroplastic reporting

In case of identification of Macroplastic at sea, it is possible to use the ML Repair APP for smartphone to insert the following parameters detected at sea with a boat:

Meta Value	Description
BOAT DATA	Name of the boat
	Type of the boat
	Others information related to the boat (type and port)
TIMESTAMP	Current date of detection
	Current time of detection
POSITION	Latitude & Longitude with GNSS of the smartphone.
	google map link

PLASTIC PARAMETERS	Image of the macroplastic
	Weight (also estimation)
	Sizes (also estimation)
	Notes

3 Database specification

3.1 Introduction

This chapter provides an overview of the structure and the specification of the needed solution.

3.2 Overall structure of database

A database is defined as a related collection of data that are stored on a mass memory support, that can be manipulated by one or more software applications. Following this premise, a DataBase Management System is introduced as the collection of tools that it shall be used within EWS and defined as following: a DBMS is a software system for the management of the database. It supplies at the main functions as:

- Keeping the database updated;
- Maintaining an efficient and effective database;
- Giving easy access to data retrieving operations.

A DBMS can easily execute command from the following sources:

- Thru direct user command by using accepted queries languages;
- Thru user-defined dedicated software applications;
- Thru traditional user-defined software applications (i.e. C, C#, .NET, etc) that integrates suitable queries language as per the first point.

Every action that happens within a DBMS is called transaction and it consist of a series of operation such as reading, writing and updating that are executed like a single atomic operation, to guarantee its related success. To achieve at this result, a DBMS has to:

- Manage the transactions, to ensure a correct and concurrent access to the database by multi-users;
- Control the access, to preserve the data from unauthorized sources of access;
- Recover the data, to self-recovery after a loss of data and prevent it as much as possible.

Finally, for a GIS system, the best way to implement and model a DBMS is the Entity-Relationship (ER) one, that consist of:

- Entities, defined as tables that hold specific information (data)
- Relationship, defined as the associations of interactions between entities.

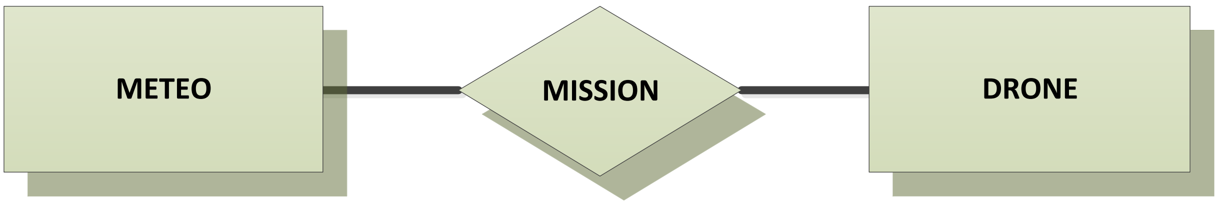

Fig. 3.1 – ER Example

For example, given the entity “Drone”, consisting in a table containing all the data acquired by the Drone during a mission and given the entity “Meteo”, consisting in a table containing all the data acquired by external Meteo sensors, we can define the relationship “Mission”, that associates both the data included in the table “Drone” and “Meteo”, that are sharing some common information; in this case, for example, the period of the mission as same as the retrival of a particular information coming from the “Drone” during a specific event stored in “Meteo”.

3.3 Database specification

The implemented database shall guarantee the following specifications:

- Store received data following Relational Data Base Management System Standards
- Provide Easy and Fast data retrieval
- Ensure data atomicity
- Ensure data consistency
- Ensure data isolation
- Ensure data durability
- Easy commit and roll-back operations
- Periodic backup and restore capability
- User login/logout

3.4 Database main entities

The Database main entities (summarized and described herebelow) involved shall be transformed into tables during the constructive design phase and integrated with its related fields and internal/external references keys, including the creation of other utility tables and/or interchange ones.

Entity	**Description**
DRONE_DATA	Consist of the set of data acquired from the drone unit
OBU_DATA	Consist of the set of data acquired from the on-board unit
METEO_DATA	Consist of the set of meteo data
MARINE_DATA	Consist of the set of marine data
RIVER_DATA	Consist of the set of river flow data
BATHYMETRY_DATA	Consist of the set of bathymetric data
SPARE_1	Consist of an empty entity to be populated in case of other kind of system to be acquired
SPARE_2	Consist of an empty entity to be populated in case of other kind of system to be acquired

SPARE_3	Consist of an empty entity to be populated in case of other kind of system to be acquired
SPARE_4	Consist of an empty entity to be populated in case of other kind of system to be acquired
MACROP_DATA	Consist of the set of MP data/pictures
OCEANOGRAPHIC_MODEL_DATA	Consist of the set of data coming from the simulations of the Oceanographic Model
OCEANOGRAPHIC_MODEL_INTERCHANGE	Consist of a utility entity to be used to interchange information with the oceanographic model. During the constructive design phase it could be possible to split the main entity in the following related sub-entities, based on the amount of data to be exchanged:
	OM_INTER_MAIN
	OM_INTER_METEO
	OM_INTER_MARINE
	OM_INTER_RIVER
	OM_INTER_BATH
USER	Consist of the user configuration set of data
UTILITY_1 to N	Consist of a set of utility entities for internal use of the data centre software.