SEVENTH FRAMEWORK PROGRAMME

ICT PPP

Future Internet

The Environmental Observation Web and its Service Applications within the Future Internet

FP7-284898

Collaborative project

D3.2.1 Use Case Requirements Report I

Marine Institute

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Creator	Marine Institute
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Glossary

The glossary of terms used in this deliverable can be found in the public document "ENVIROFI_Glossary.pdf" available at: http://www.envirofi.eu/

Abbreviations and Acronyms

Abbreviation / Acronym	Description
ADM	Data Administration & Storage
ATH	User Administration and Authentification
ERDAP	The Environmental Research Division's Data Access Program
FNF	Future Network Functionality
GEO	GeoSpatial datasets
INT	Integration of hetrogeneous datasets
ISDE	Irish Spatial Data Exchange
MOB	Mobile user interaction with Platform
NOT	Alert and Notification functionality
OGC	Open Geospatial Consortium
OWL	Web Ontology Language
PRE	Predictive modelling
RDF	Resource Description Framework
RTIMS	Real Time Integrated Monitoring systems
SOS	Sensor Observation Service
SWE	Sensor Web Enablement
UC	Use case
UGC	User Generated Content
VIS	Data Visualisation
WEB	Web Service Integration
WP	Work package
WPS	Web Processing Service

Executive Summary

The ENVIROFI [01] project has two main goals: (1) to 'Envirofy' the Future Internet, that is, to ensure that the FI applications can easily harvest existing and future sources of environmental data and services; and (2) to make the Core Platform functionality available in environmental applications.

The ultimate aim of this work package is the development of next generation intelligent internet enabled technology platforms to enable sustainable management and economic development of European marine resources and by definition the broader marine sector and associated coastal communities. Following extensive marine stakeholder consultation, work package 3 explores the opportunity to develop and deploy future internet technologies in a range of marine applications in the areas of Harmful Algal Blooms, Renewable Energy, Oil Spill and Marine Leisure and Safety. Building on the work of deliverable 3.1 this document focuses on the specific functional requirements of selected marine scenarios focusing on cross functionality of relevance as opposed to the definition of end-to-end solutions. The document further refines the common functionalities identified in deliverable 3.1 and includes a range of new use cases along with initial examples of UML diagrams for a selection of those use cases. Updated use cases have been included as an annex to this deliverable document.

1 Introduction

The development of intelligent data integration and management systems will act as a key enabler for the economic development of the European marine sector through the provision of next generation decision support tools. Scientific, legislative and socioeconomic requirements are key drivers for the development of new approaches to the integrated management of Europe's marine resource. Challenges that must be addressed include increased frequency and resolution of sensor platforms, increased frequency of sampling regimes and integrated management of resulting data to enable cost effective management solutions.

The focus of this document is on the elaboration of the cross cutting functionalities identified for the marine scenarios deliverable 3.1. New use cases derived from the original scenarios are outlined in more detail and include the areas of data administration, visualisation and integration of data streams. From an environmental perspective the spatial definition of data sources is of significant interest and the web enabled processing and predication capability. Relevant user groups and business cases are also identified. The individual use cases are outlined in further detail and included in the annex. In so far as possible the structure of this deliverable has been aligned to that of the other work packages focused on the delivery of personalised information systems for biodiversity and pollen monitoring.

IT innovation who are working on WP3 and WP5 have linked the section in WP6 on "Requirements to new knowledge (KNO)" to the Scenario A use cases in relation to Harmful Algal Blooms to help define a number of requirements within WP5.

The analysis and information presented in this deliverable should be seen as a snapshot of use cases at the end of project month 6 (September 2011), and will be further developed in partnership and consultation within the other packages in the ENVIROFI [01] project.

2 Overview of Extended Scenarios and Use Cases

2.1 Applied methodologies

ENVIROFI initially planned to follow the V-Model for all of its developments and deliverables. As result of the FI-Ware project decision to follow the AGILE development model, and due to strong relationship between projects in FI-PPP Programme, it was decided to adapt the initial planning in the following way:

The WP1, WP2 and WP3 shall continue developing the use cases (user stories in AGILE terminology) until the level where these can be used as specifications. Consequently, no formal "technical requirements" shall be developed within these WPs.

WP4 shall, as its first task analyse the pilot related use cases and formulate a set of abstract use cases common to various environmental applications. These abstract use cases shall serve as a basis for discussion on generic and specific enablers within FI-PPP.

Finally, the WP5 shall, as its first task, extract the functional and non-functional requirements, mainly based on WP1, WP2 and WP3 use cases, as well as on the architectural boundaries and stakeholders needs which were initially captured within D6.1.1 – in particular those inherited from GEOSS and INSPIRE. In order to simplify requirements tracking, WP5 requirements refer to abstract WP4 use cases where available, rather than directly referring the WP1, WP2 and WP3 use cases.

In this way, ENVIROFI team expects to be able to keep the overall V-Model structure of the software development process within WP2, while still profiting from the flexibility of the agile development approach. A full description of the software engineering methodology adopted by ENVIROFI is given in D4.1.1.

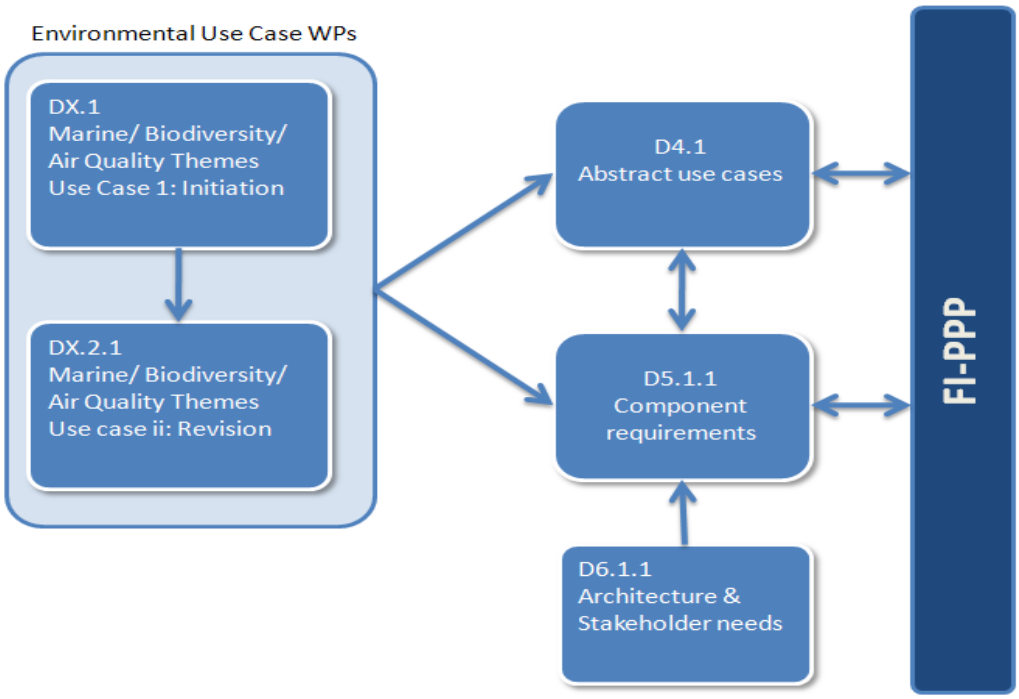

Figure 1 Schematic Overview of the Use Case Requirement deliverables in relation to the overall ENVIROFI project

2.2 Approach to D3.2

Deliverable 3.1 explored the key challenges facing respective marine sector communities outlined in four marine scenarios. The marine scenarios developed, included the areas of HAB (harmful algae bloom), WAV (renewable energy), OIL (oil spill prediction) and TRM (tourism) with nine possible stand alone pilots developed within these scenario areas, see D3.1 use cases for background on individual pilot areas. The initial exercise also illustrated at a high level the common functionalities required for a range of end-to-end solutions across the four scenarios.

Work for deliverable 3.2 has focused on the identification and elaboration of cross cutting functionality common across the marine scenarios towards the delivery of requirements for further implementation in conjunction with work package partners.

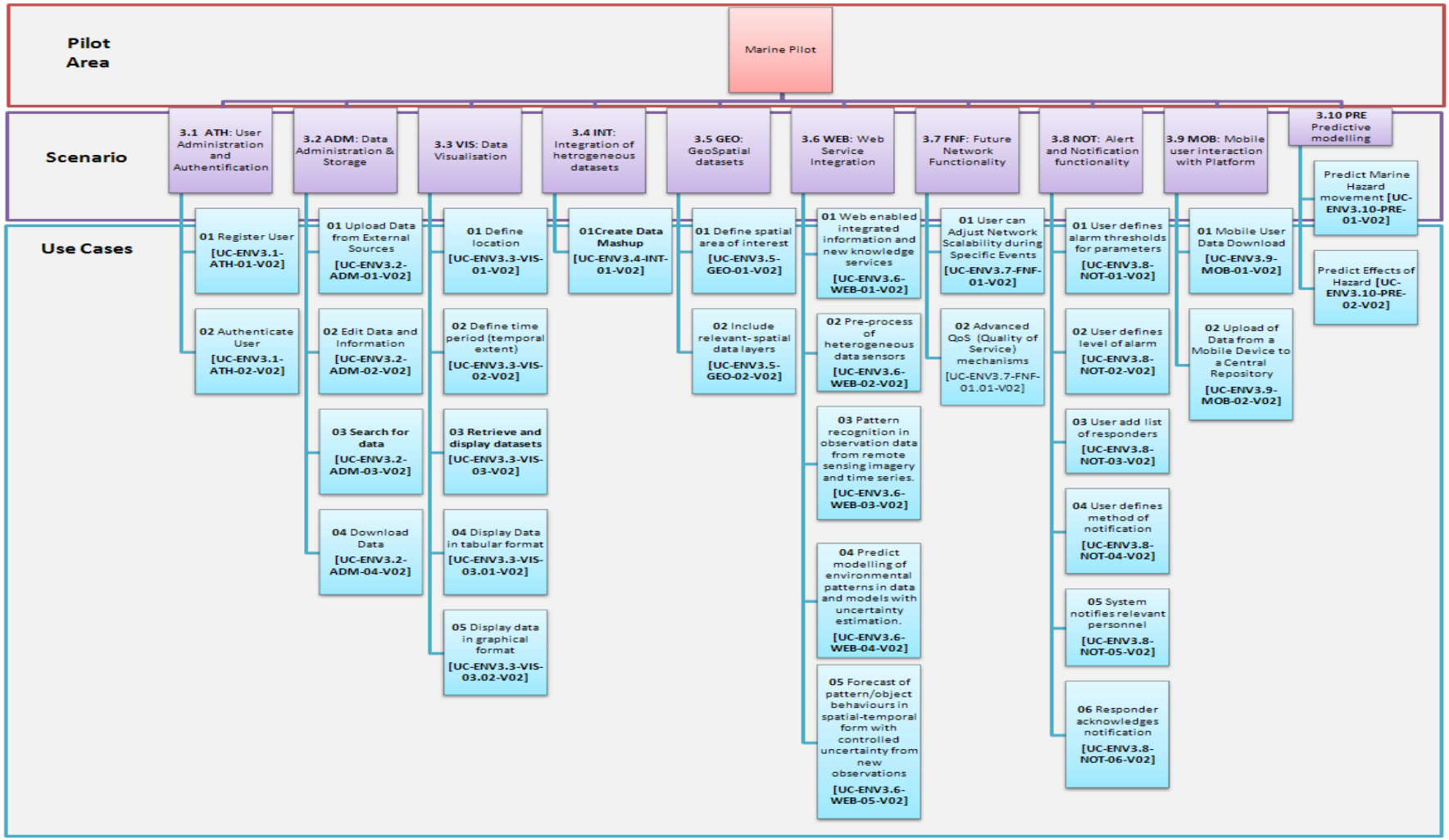

Figure 2 Naming Convention applied to the WP3 Use Cases

In order to align with the other scenario work packages and to alleviate communication with WP 4 and 5, the naming convention from deliverable D3.1 to D3.2 has been revised. By providing a consistent naming convention, we intend in particular to distinguish between Use Cases specific only to one scenario and cross-cutting Use Cases that are independent of the considered scenarios within work package 3. Use cases outlined in deliverable 3.1 have now been updated on the server to represent high level scenario areas:

UC: Use Case, REQ: Requirement, <workpackage>: eg marine environment (3). <scenario>: The LETTER of the scenario within the WP or the NUMBER of the cross-cutting UC Type <category>: Use Cases: no particular scheme has to be applied. The specification e.g. 'mob' (used for mobile application) etc. Use cases have also been linked to others of relevance on the use case server.

Example for work package 3 is: UC-ENV2.A-any-01.01-V01 where X is either a capital letter referring to the scenario or a number corresponding to a specified functionality.

2.3 Priority List of Use Cases

The cross cutting use cases throughout all of the original marine scenarios were identified, extracted and refined. The relationship of these newly developed use cases are linked back to the original pilots to provide further insights into the ability of the marine technology pilot to cater for a variety of data products and services. The tables below provide an overview for each functionality category, give an overview of their priority and show their link to the scenario-specific Use Cases.

Use Case	Use case ID	Priority
Create data mashup	UC-ENV3.4-INT-01-V01	Important
Web enabled integrated information and new knowledge services	UC-ENV3.6-WEB-01-V02	Important
Pre-process of heterogeneous data sensors	UC-ENV3.6-WEB-02-V02	Important
Pattern recognition in observation data from remote sensing imagery and time series	UC-ENV3.6-WEB-03-V02	Important
Predict modelling of environmental patterns in data with uncertainty estimation	UC-ENV3.6-WEB-04-V02	Important
Forecast of pattern behaviours in spatial-temporal form with controlled uncertainty from new observations	UC-ENV3.6-WEB-05-V02	Important
User can adjust network scalability during specific events	UC-ENV3.7-FNF-01-V02	Important
Advanced QoS mechanisms	UC-ENV3.7-FNF-01-V02	Important
Predict marine hazard movement	UC-ENV3.10-PRE-01-V02	Important
Predict effects of hazard	UC-ENV3.10-PRE-02-V02	Important
Define location	UC-ENV3.3-VIS-01-V02	High
Define time period	UC-ENV3.3-VIS-02-V02	High
Choose data format	UC-ENV3.3-VIS-03-V02	High
Display data in tabular format	UC-ENV3.3-VIS-03.01-V02	High
Display data in graphical format	UC-ENV3.3-VIS-03.02-V02	High
Define spatial area of interest	UC-ENV3.5-GEO-01-V02	High

Include relevant spatial data layers	UC-ENV3.5-GEO-02-V02	High
Register User	UC-ENV3.1-ATH-01-V02	Normal
Authenticate User	UC-ENV3.1-ATH-02-V02	Normal
Upload data	UC-ENV3.2-ADM-01-V02	Normal
Edit data and information	UC-ENV3.2-ADM-02-V02	Normal
Search for data	UC-ENV3.2-ADM-03-V02	Normal
Download data	UC-ENV3.2-ADM-04-V02	Normal
User defines alarm thresholds for parameters	UC-ENV3.8-NOT-01-V02	Normal
User defines level of alarm	UC-ENV3.8-NOT-02-V02	Normal
User adds list of responders	UC-ENV3.8-NOT-03-V02	Normal
User defines method of notification	UC-ENV3.8-NOT-04-V02	Normal
System notifies relevant personnel	UC-ENV3.8-NOT-05-V02	Normal
Responder acknowledges notification	UC-ENV3.8-NOT-06-V02	Normal
Mobile user data download	UC-ENV3.9-MOB-01-V02	Normal
Upload of data from a mobile device to a central repository	UC-ENV3.9-MOB-02-V02	Normal

Table 1 Priority List of Use Cases**.**

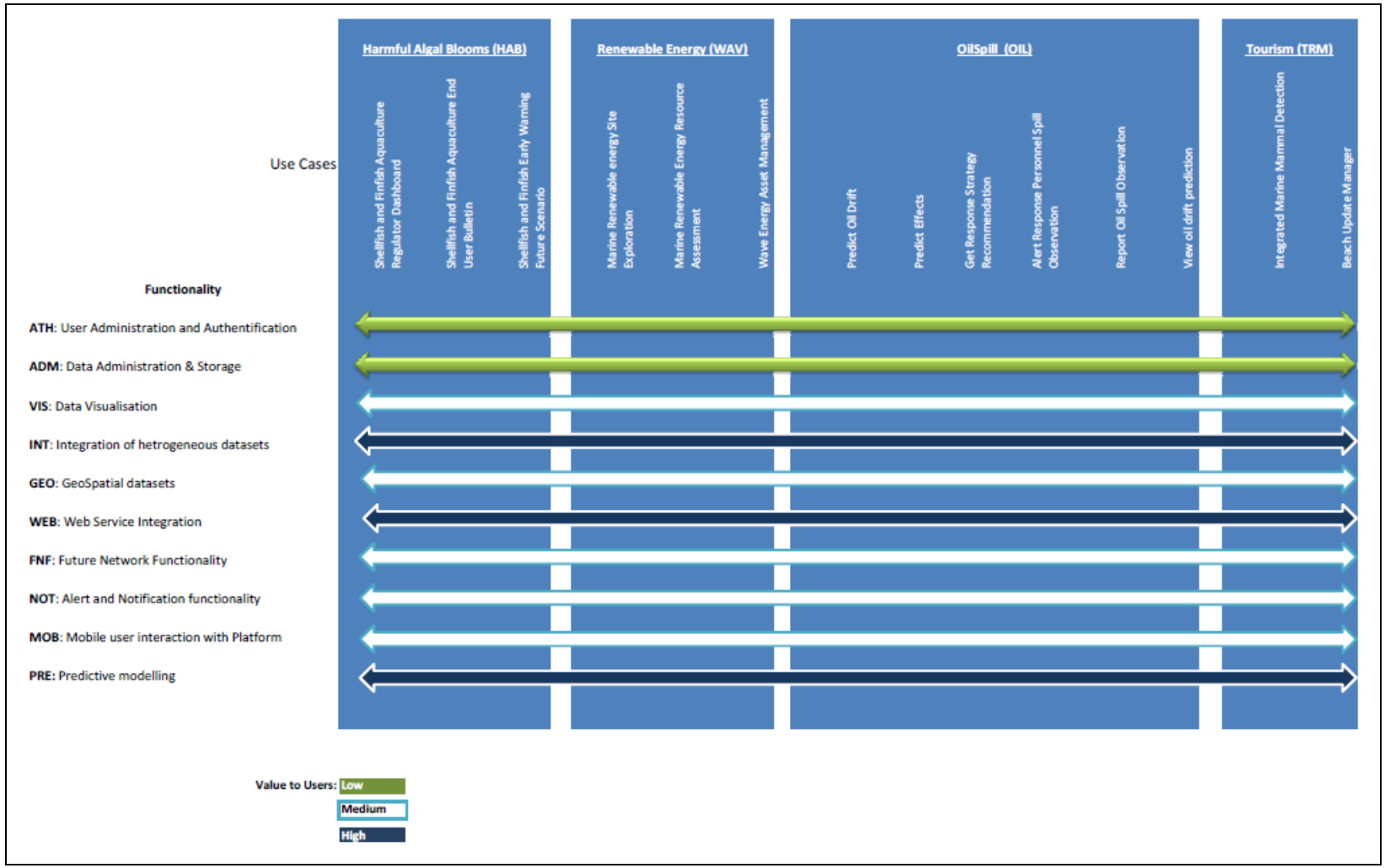

Figure 3 Relationship between Marine Scenarios and Use Cases defined in deliverable 3.1 and re-defined in deliverable 3.2.1

2.4 Use Case Scenarios

There were 4 original marine pilots, 3.1-HABS, 3.2-WAV, 3.3-OIL and 3.4-TRM. The use cases outlined in deliverable 3.1 explained how the marine pilots would function. This document outlines 9 Use Case Scenarios that further develop the features and functionality requirements relevant for all four original marine scenario areas. The features and functionalities are further described in section 6.

2.4.1 Scenario A: HAB – Harmful Algal Bloom

The first scenario related to the phenomena of harmful algal blooms (HABs) and the impacts that such events have on a variety of stakeholders. Consultations with the stakeholders prioritised 3 areas where the implementation of future internet technologies could deliver viable solutions to mitigate against the effects of HABs[1] on shellfish and finfish production bringing significant potential cost savings to the aquaculture industry.

Use case name	Original ID	New ID
Shellfish and Finfish Aquaculture Regulator Dashboard	UC-ENV3.1-HAB-01V02	UC-ENV3.A-HAB-01-V03
Shellfish and Finfish Aquaculture End User Bulletin	UC-ENV3.1-HAB-02V02	UC-ENV3.A-HAB-02-V03
Shellfish and Finfish Early Warning Future Scenario	UC-ENV3.1-HAB-03V02	UC-ENV3.A-HAB-03-V03

Table 2 Use Case identification mapping - Scenario A

2.4.2 Scenario B: WAV: Marine Renewable Energy

In European countries, which today are highly dependent on fossil fuel imports and has attractive wave climates like e.g. Ireland, UK, Spain or Portugal, wave energy is a high potential source for diversifying energy sources and increasing the share of domestic energy supply.

Consultations with the Ocean Energy Research community in Ireland as well as the MRIA (Marine Renewable Industry Association) identified 3 key areas where use cases involving future internet technologies will have an important role in the advancement of Marine Renewable Energy advancement over the coming years.

Use case name	Original ID	New ID
Marine Renewable Energy Site Exploration and Discovery	UC-ENV3.2-WAV-01V02	UC-ENV3.B-WAV-01-V03
Marine Renewable Energy Resource Assessment	UC-ENV3.2-WAV-02V02	UC-ENV3.B-WAV-02-V03
Wave Energy Asset Management	UC-ENV3.2-WAV-03V02	UC-ENV3.B-WAV-03-V03

Table 3 Use Case identification mapping - Scenario B

[1] Applied simulations and Integrated modeling for the understanding of toxic and harmful algal blooms (ASIMUTH) [http://cordis.europa.eu/fetch?CALLER=FP7_PROJ_EN&ACTION=D&DOC=7&CAT=PROJ&QUERY=013105abba0e:e803:5a3a5573&RCN=96871]

2.4.3 Scenario C: Oil Spill Response

The applications of future internet technologies in the areas of the reporting, alerting and information systems for a diverse range of stakeholders was explored through consultations with domain experts in the Marine Institute and its partners along with SINTEF as a partner in Work package 3 of ENVIROFI.

Use case name	Original ID	New ID
Predict oil drift	UC-ENV3.3-OIL-01V01	UC-ENV3.C-OIL-01-V02
Predict effects	UC-ENV3.3-OIL-02V01	UC-ENV3.C-OIL-02-V02
Get response strategy recommendation	UC-ENV3.3-OIL-03V01	UC-ENV3.C-OIL-03-V02
Alert response personnel	UC-ENV3.3-OIL-04V01	UC-ENV3.C-OIL-04-V02
Report oil spill observation	UC-ENV3.3-OIL-05V01	UC-ENV3.C-OIL-05-V02
View oil drift prediction	UC-ENV3.3-OIL-06V01	UC-ENV3.C-OIL-06-V02

Table 4 Use Case identification mapping - Scenario C

2.4.4 Scenario D: TRM: Marine Tourism

Marine Tourism and leisure is a very important generator of revenue particularly for coastal regions. Stakeholder consultations in this domain resulted in the identification of requirements for interactive Information systems for a range of marine leisure scenarios. Deliverable 3.1 focused on two scenarios relating to beach management and whale watching activities and based a use case on one of each

Use case name	Original ID	New ID
Integrated Marine Mammal Detection Systems	UC-ENV3.4-TRM-01V02	UC-ENV3.D-TRM-01-V03
Beach Update Manager	UC-ENV3.4-TRM-02V02	UC-ENV3.D-TRM-02-V03

Table 5 Use Case identification mapping - Scenario D

3 Features and Functionalities

As part of deliverable 3.2 we have restructured our use cases to focus on key elements of functionality that we would like to see included in the ENVIROFI platform. We have prioritised our use case based on cross cutting functionality across the four marine domains as well as common functionality identified in Work Packages 1 and 2.

In this chapter we list all the categories of cross cutting functionality - as well as a description of the newly constructed use cases related to each category of functionality

Note that since the cross-cutting UCs are new in this deliverable, we have no 'result of revision' part included into the description.

3.1 Administration and Authentication

It is anticipated that any application developed under all scenarios in each of the four domains will require security controls to protect System integrity, data integrity, Intellectual property rights and personal information etc. Such controls should address areas including:

- Identity Management offering tiered access control via a single sign-on via defined profiles
- Security Monitoring to detect and defend against unauthorised access
- Automated user registration
- Audit trial of user activities
- Communications security through the use of data encryption techniques
- Inherent risks associated with Cloud computing/hosting

It is likely that the security requirements will take the form of user registration and authentication with the System automatically assigning usernames and password for read only users. The System Administrator will subsequently grant additional permissions to users that require write/modify permissions.

Whilst the same underlying dashboard view will be available to all authenticated users the data and level of detail displayed will depend upon the users profiling with privileges and access rights.

Future Internet security systems, procedures and policies should be used where available; however it is vital that communication concerning sensitive data be secure (e.g. HABs, Oil Spill etc) and thus encryption techniques should be used.

The ongoing development of distributed, cross-domain application will require developers and content providers to address security concerns. The notion of identity and user security can prove to be a difficult concept, as the traditional Web is primarily built for anonymous access. Single-signon is a desirable feature, but there are a range of competing technologies that may need to be accommodated for authentication purposes in future web platforms.

In a future scenario providers of data are likely to employ authentication and authorisation schemes (which require the notion of secure identity or securely identifiable attributes) in their APIs to enforce business models that involve paid subscriptions or sensitive data.

Sensitive data also requires confidentiality (encryption), and care must be taken when it is integrated with other sources so not to put it at risk. Identity will also be crucial for auditing and regulatory compliance. Identity and credential delegation from the user to the mash-up service will likely become a requirement in the future to address security concerns.

<u>Register User UC-ENV3.1-ATH-01-V02</u>

User visits Envirofi Platform and begins registration process. User creates a unique profile with login de-

tails, preferences and products. User receives confirmation of same through a separate communication channel (email) at the end of the registration process.

Authenticate User UC-ENV3.1-ATH-02-V02

User logs in to Envirofi Platform. User is recognised by the Envirofi Platform. Envirofi Platform applies User Preferences and Security measures. Security measures are based on the registration form, allowing the user to access Data Products and Services chosen by the User at Registration.

3.2 ADM: Data Administration & Storage

Upload data from external sources UC-ENV3.2-ADM-01-V02

Data sources from external sources may be critical in providing data for the decision based management functionality of the application. It is important that the system can facilitate the incorporation of external data sources from a variety of different sources and data formats and that the end user can control how the data is assimilated into the EnviroFi system.

Edit data and information UC-ENV3.2-ADM-02-V02

Data is edited by the Envirofi Platform to current standards so that it may update the Data Products and Services. Data is then archived.

Search for data UC-ENV3.2-ADM-03-V02

While huge volumes of marine, geological and other environmental and research data are held by public and academic organisations, these data can often be difficult to find and access, Many organisations have developed online catalogues of their data holdings . The EnviroFi system should include an online resource to facilitate the searching and access to all marine, geological, environmental and other spatial data. The data search architecture should be based around OGC and ISO standards, which allows it to be independent of any catalogue implementation technologies.

Download data: UC-ENV3.2-ADM-04-V02

The user can access relevant information via the EnviroFI platform and download the data or subsets of data in a user specified format for further analysis or other use.

3.3 VIS: Data Visualisation

Define location UC-ENV3.3-VIS-01-V02

User defines spatial area of interest via user interface.

Define time period UC-ENV3.3-VIS-02-V02

To facilitate comparisons of data from different datasets, the ENVIROFI data requests and results should use standardized space/time axis units:

- longitude is always in degrees_east.
- latitude is always in degrees_north.
- altitude is always in meters with positive=up.

time when formatted as a number is always in "seconds since 1970-01-01T00:00:00Z" (which is UDUNITS-compatible) and, when formatted as a string, is formatted according to the ISO 8601:2004 extended format standard (YYYY-MM-DDThh:mm:ssZ, for example, "1985-01-02T00:00:00Z"). Also, to avoid time zone and daylight savings time confusion, time values are always converted to the UTC (Zulu) time zone.

This makes it easy to specify constraints in requests without having to worry about the altitude data format (are positive values up or down? in meters or fathoms?) or the time data. This makes the results from different data sources easy to compare. A Requirement for system for dealing with time is to have a single system that allows any time data to be compared to any other time data

Retrieve and Display Data Sets UC-ENV3.3-VIS-03-V02

The system users require a mechanism to respond very quickly to data searches, requests for lists of datasets, and requests for information about a dataset.

- Request the data in various ways (standard formats like DAP, WMS etc).
- Get the data response in various file formats.
- Make graphs and maps.
- When a user requests data from the system :
- reformats the data request into the format required by the remote server,
- sends the request to the remote server,
- gets the data,
- reformats the data as per user defined criteria
- system sends the data to the user so they don't have to go to different data servers to get data from different datasets.

Display data in tabular format UC-ENV3.3-VIS-03.01-V02

User can use the system to take a user defined data sets and create a new visualisation of the dataset to allow a better understanding of the data which can be uploaded to the system of distributed to stakeholders.

Display data in graphical format UC-ENV3.3-VIS-03.02-V02

User can use the system to take a user defined data sets and created a new visualisation of the dataset to allow a better understanding of the data which can be uploaded to the system of distributed to stakeholders.

3.4 INT: Integration of heterogeneous datasets

In relation to integration of heterogeneous datasets there are in existence middleware systems like ERDDAP (the Environmental Research Division's Data Access Program) [02] - which is a data server that gives users a simple, consistent way to download subsets of scientific datasets in common file formats and make graphs and maps. Systems like ERDAAP can be used for any datasets including oceanographic data (for example, data from satellites and buoys and marine sensors). The system unifies the different types of data servers so there is a consistent way to get the data in the format required.

Standard features and functionalities of these systems include:

- System acts as a middleman between you and various remote data servers. When you request

data from ERDDAP, ERDDAP reformats the request into the format required by the remote server, sends the request to the remote server, gets the data, reformats the data, and sends the data to you.

- An easy-to-use, consistent way to request data: via the OPeNDAP standard. Many datasets can also be accessed via the Web Map Service (WMS).
- System returns data in the common file format of your choice. For example, .html table, ESRI .asc and .csv, Google Earth .kml, OPeNDAP binary, .mat, .nc, ODV .txt, .csv, .tsv, .json, and .xhtml.
- System can also return a .png or .pdf image with a customized graph or map.
- Standardizes the dates+times in the results.
- Web pages (for humans with browsers) and web services (for computer programs) via RESTful web services let anyone build other web applications (with web pages) and web services on top of the system.

The development and refinement of middleware systems like ERDAP will facilitate easier integration of datasets giving users more control and flexibility on how data is presented to simplify the decision - making process.

Create data Mashup UC-ENV3.4-INT-01-V02

A 'mashup' is an innovative composition of content (often from unrelated data sources), made for human (rather than computerized) consumption. This combination of data modeling technologies stemming from the Semantic Web domain and the maturation of loosely-coupled, service-oriented, platform-agnostic communication protocols is providing the web infrastructure needed in developing applications that can leverage and integrate the massive amount of information that is available on the Web.

The power of the mashup approach is the intelligence built into it by using semantic Web techniques, specifically the Web Ontology Language (OWL) and its base languages , the Resource Description Framework (RDF) and RDF Schema Language (RDFs)[03 - Chase].

The user can combine similar types of media and information from multiple sources into a single representation. The combination of all these resources creates a new and distinct web service that was not originally provided by either source. Semantic technology is applied to enable users to create their own mash-ups by swapping services, or by picking and choosing data from different sources delivering a visually rich Web application that exposes information from diverse internal and external information sources to aid in decision support management.

3.5 GEO: GeoSpatial datasets

Access to Geospatial data and infrastructure is a key pillar of the data requirements for Marine stakeholders. Many users of ocean data operate at sea, from a moving platform, in an environment which is for the most part very remote by terrestrial standards. As such, the technologies,methodologies, policies and the processes required to validate, process, store, retrieve, manipulate, disseminate, archive, maintain and use ocean data sets all need to be carefully considered when establishing a marine geospatial data infrastructure.

Geospatial data infrastructure and functionality should be a key component within ENVIROFI and a system of data and enabling technologies that support timely access to data and information which are critical to the sustainable development, management and control of marine and coastal offshore areas.

Define spatial area of interest UC-ENV3.5-GEO-01-V02

User uses the system to identify a spatial area of interest to retrieve datasets from or add new informa-

tion to the system.

Include relevant spatial data layers UC-ENV3.5-GEO-02-V02

In order to successfully integrate mapping services from different data source the platform will convert the data from the internal format into the file format requested by the client (e.g., .csv, Google Earth .kml, .htmlTable, .dods, .mat, .nc, ODV .txt, .png). Users don't have to worry about, or know about, the type of the source data server. They just get the data they want, in the file format they want.

3.6 WEB: Web Service Integration

Web enabled integrated information and new knowledge services UC-ENV3.6-WEB-01-V02

There is a common need to translate observation data from individual sensors and social networking to advance high-level fusion, context and situation awareness requirements of domain specialists. Sensor data fusion and modelling services can be used individually or in combination with semantic enrichment services as new knowledge management enablers.

Pre-process of heterogenous data sensors UC-ENV3.6-WEB-02-V02

Sensor data processing involves association and state estimations of streams tailored to specific application requirements. The aim of a sensor fusion implementation will be to integrate heterogeneous data sources of multiple formats (in situ, remote sensing images, reporting...etc.) to give access to richer knowledge about environmental observations and implicated risks. The approach makes also use of the SWE (Sensor Web Enablement) standards. The use of data fusion and SWE services offers a powerful knowledge and communication service infrastructure for end-users who are interested in a geo-spatial and temporal data management. Data fusion services support the processes which enrich sensor observation and measurement with human knowledge in environmental processes management. They enable the aggregation of data and phenomenological based models, and lead to the identification of new knowledge and situation awareness about multiple environmental domains of interest. SWE services have proven to be an effective implementation with OGC compliant data fusion services when using sensor service architecture The implementation of OGC (Open Geospatial Consortium) standards provides a set of services that are capable of configuring independently from data sources.

The key research challenges behind the implementation of data fusion services are to do with sharing, processing and representing sensor capabilities and the accuracy associated with each of the measurements; metadata provided as part of the SWE standards supports representation of uncertainty and precision associated with particular sensing data sets or devices.

The data fusion process consists of estimating and predicting states of observed and modelled entities into the system. It also includes the association, correlation and combination of the system data in a multi-process service based architecture The Joint Directors of Laboratories (JDL) model is the de facto model for generic fusion and modelling It defines a set of generic fusion ‘levels’ in a structured manner. It is composed of four processing levels as a systematic view of information fusion together with the propagation of uncertainty. The JDL fusion levels based services can also be associated with exemplar data management and control numerical techniques (See Figure 2). They are defined as follows:

- Level 0: Data pre-processing: This fusion level specialises for example in the aggregation of fragmented and asynchronous data of different formats and spatial-temporal resolutions. It may also specialise in filling gaps in data and also the analyses and removal of outliers in data if required.
- Level 1: Object (Trends) Identification: This fusion level specialised in the analyses of data for the discovery/detection of patterns/trends, and their interpretation/recognition by domain knowledge experts (image pattern recognition, time series trends and interpretations of dominant processes for modelling..etc.);
- Level 2: Data estimation and refinement: This level of fusion specialises in modelling trends,

their relationships and modelling error estimations;

- Level 3: Prediction-Correction: This high level of fusion specialises in predicting observed parameters with uncertainty control through new feeds of observations, for adaptive learning and calibration of modelling algorithms.

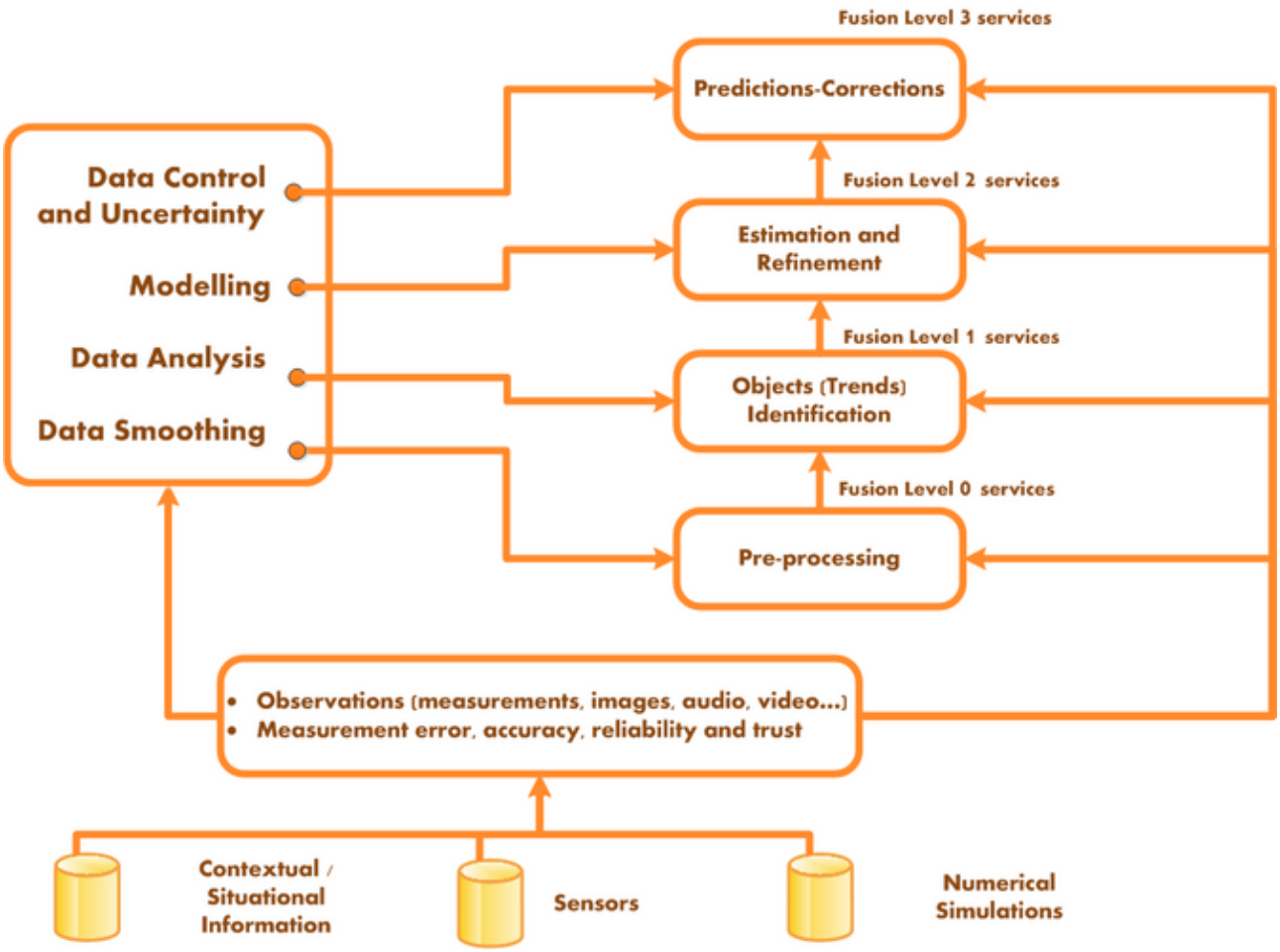

Figure 4 Exemplar associated JDL fusion levels

3.6.1 SWE Fusion Infrastructure

The deployment of fusion services as one of the environmental enablers would allow the users to access to coherent sensors information, aggregated data and new geospatial knowledge with advanced context and situation awareness.

For example, to access sensor or synthetic (fused) datasets from a SWE service, the information is assigned to a SOS (Sensor Observations Service) client. Then, the processing services are assigned to a SPS (Sensor Planning Service) for steering measurement policies as part of a continuously executing process. Additionally, the data processing task is assigned to a WPS (Web Processing Service) whenever it involves an on-demand request for information processing and forecasting. Finally, notifications of progress and results could also be supported by a Web Notification Service (WNS) according to user specific demands.

As part of a generic data fusion methodology, the SWE is integrated in four stages:

- Pre-processing: the raw data is obtained and converted into a SOS. Once data is formatted, it is also syntactically checked and prepared to the Observations and Measurements (O&M) conceptual model.

- Processing: the SOS source data set is executed reiteratively through algorithms in SPS and WPS to obtain a result set.
- Post-processing: the result set is formatted by adding meta-data that contains the necessary information to be able to reproduce the process. The information is granted but not limited to the algorithm inputs, parameters, outputs and a description of fusion process.
- Storage: the result set is assigned according to the client requirements for accessing the information.

The above mentioned formalised data fusion methodology and generic fusion service framework represents a robust way for intelligent data and environmental situation awareness management. This will be applied to multiple environmental scenarios and potentially in some of those within the FI-PPP usage areas.

3.6.2 Semantic Enrichment:

Semantic enrichment is a technique through which the gap between raw sensor data and the high level domain requirements can be bridged. A particular benefit of this technique is that it provides means to access to non-conventional data sources such as social network messages, making them available as inputs to the kind of sensor fusion service described above. In the information fusion context, these may be considered as “social sensors”. The three stage process is a semantic enrichment of raw sensor feeds by adding XML tags. The main steps involved are structural transformation, contextual enrichment for sensed data and finally domain knowledge enrichment. This methodology can be applied in our application domain taking raw environmental sensed data as input. A Semantic Framework Semantic enrichment itself forms part of a conceptual semantic framework which, together with semantic mapping and metadata extraction and a suitable knowledge base, can be used to provide rich semantic information streams from a wide range of discrete data sources, including non-traditional data sources such as social networks and user-generated content (UGC) repositories. In this approach, the Semantic Framework has responsibility for the following tasks:

- Semantic enrichment of raw sensor data
- Metadata extraction from Web 2.0 based systems / collective intelligence
- Semantic mapping to domain ontologies
- Knowledge base support

3.6.3 Metadata extraction from Web 2.0 systems

With the advent of Web 2.0 systems, a significant amount of user-generated content is being created that in some way describes environmental conditions. Photographs taken on mobile phones during emergency situations such as an earthquake or flood are posted to photo-sharing websites like Flickr, often annotated with time and geolocation metadata; messages describing the weather conditions and other environmental events are posted onto popular social networking sites such as Twitter, Facebook etc. A metadata extractor is able to make sense of this so-called ‘citizen data’ by employing natural language processing and information extraction techniques to data from a range of different media. Once the metadata from user-generated content is extracted, it can be mapped to a common schema using a semantic mapping function.

3.6.4 Semantic Mapping:

Metadata in ENVIROFI can be generated using a range of different schemas. For example dedicated environmental sensor feed data may be accessible using SWE services, whereas metadata extracted from Web 2.0 feeds maybe formatted using a proprietary schema; historic content from archives maybe

formatted differently again. A semantic mapping module can be used to semi-automatically map the concepts present in these various schemas/ontologies into a common ENVIROFI knowledge model or ontology.

3.6.5 Knowledge Base support:

A knowledge base is required to hold metadata as it is extracted and enriched. An ideal technology is a triple store capable of robust storage and querying capabilities; 4Store and Sesame are examples of existing software that could be considered for this role. The knowledge base will contain metadata structured according to the ENVIROFI domain ontology. The fusion services will be able to query this knowledge base and extract relevant data, geospatial and contextual information for multi-level data fusion and modelling.

Pattern recognition in observation data from remote sensing imagery and time series UC-ENV3.6-WEB-03-V02

The user will require to identify trends and/or detect pattern as part of web client request by using a Web Processing Service (WPS) or a as part of a chain of automated processes in a Sensor Planning Service (SPS).

Predict modelling of environmental patterns in data and models with uncertainty estimation UC-ENV3.6-WEB-04-V02

The user requires of a prediction-correction process by modelling prediction of environmental patterns and presenting results with uncertainty estimations. The results are presented in an available web service according to clients requirements.

Forecast of pattern/object behaviours in spatial temporal form with controlled uncertainty from new observations UC-ENV3.6-WEB-05-V02

The user would like to correct existing predictions from environmental modelled patterns with new observations. The process would become part of a web client request by using a Web Processing Service (WPS) or a as part of a chain of automated processes in a Sensor Planning Service (SPS).

3.7 FNF: Quality of Service and scalability

In order to create a picture of the health of the environment, the environment is instrumented with sensors in various locations across Europe and the world. In order to create a detailed picture of a global environment, it is expected that the environment will require large scale instrumentation across an entire county / continent. It is also important to note additional sensor sources from smart grid applications which will require integration to form a wider global picture. The backhaul, aggregation and grooming of all these sensors sources and the expected super-large-scale deployment over the next 50 years presents a significant challenge for telecoms networks.

Environmental data is inherently dynamic where interest is normally peaked with respect to specific events e.g. mammal detection, pollution detection and oil spill detection. Therefore it is important for environmental stakeholders to have the capability dynamically increase the resolution into specific events and the associated data sets. ENVIROFI will study these requirements in the context of super-large-scale sensor network deployments. However the dynamic nature of environmental sensing will require telecoms services which can dynamically scale from low bandwidths to very high bandwidths in fractions of a second. Additionally, in some cases the quality of the data will be critical and QoS will be an important factor where the large data-sets are required in real time for real time computing and

processing applications. It has become apparent throughout consultation periods that Intune's Exemplar[2] Smart Communications Networks meets these requirements and its use will be explored in the context of the EnviroFI project.

User can adjust network scalability during specific events UC-ENV3.7-FNF-01-V02

One of the fundamental challenges in enabling a super large scale environmental sensing Future Internet is resource utilisation. It is not economically feasible to deploy advanced high bandwidth sensor technologies and also the associated backhaul network services. Networks are currently engineered for static services, where as sensing networks will require sporadic network services based upon continuously varying environmental conditions. The Future Internet will need to delivery liquid bandwidth or bandwidth on demand services where the sensing stakeholders can make best economic use of available resources but reserve the capability to ramp services is response to emergency environmental events.

Advanced QoS (Quality of Service Mechanisms UC-ENV3.7-FNF-02-V02

Various environmental sensors capture data of various priorities. For example HD video sensors require more advanced QoS mechanisms than temperature sensors. In this scenario a future internet must be able to differentiate between the priority level of the various sensor requirements. Next generation environmental sensing networks will require various levels of CoS (class of service) levels varying from guaranteed CoS to regular best effort services. There must be a minimum requirement of at least 8 CoS levels with reducing priority for different sensors and applications where e.g. CoS 7 services will always take priority over CoS 6 etc and will have the lowest possible delay, jitter and packet loss. Additionally, various sensing systems must also have the ability to dynamically change CoS level based on dynamic environmental events.

3.8 NOT: Alert and Notification functionality

The automated alert generation involves responding to individuals when pre-designated thresholds for conditions have been exceeding that exist within either a temporal or spatial boundary of interest to the given stakeholder. The identification of these thresholds and the individuals/agencies/organizations who receive the information is performed through a subscription-based model whereby the consumer of the information must take the lead effort in registering for the alert notification and providing the appropriate threshold settings and methods of desired notification.

The automated notification method follows the preferred communication method whether this is electronic notification via such methods as cellular text messages or Internet email or perhaps through a voice message to a designated telephone number [7]. These use case highlight some of the common functionality requirements in designing such a system

User defines alarm thresholds for parameters UC-ENV3.8-NOT-01-V02

The system administrator can access the data feeds into the system and identify values or thresholds which if exceeded will trigger an alarm. The administrator will identify the thresholds

User defines level of alarm UC-ENV3.8-NOT-02-V02

Different marine conditions and events may require a different level of response depending on the po-

[2] Exemplar Smart Communications Network, next generation network based on a dynamic optical infrastructure [http://www.dcenr.gov.ie/Communications/Communications+Policy/Exemplar+Network/]

tential impact of the event on operations. The system will allow an administrator to define the level of alarm to be raised based on incoming data feeds and define the responders to the alarm and how they should react under the different conditions

User add list of responders UC-ENV3.8-NOT-03-V02

Responders to a particular event need to be alerted when an event has occurred to which they have a duty to respond to. The system should be able to alert the necessary marine responders and notify them of the level of the response required by setting up alarm thresholds on a range of relevant parameters and triggering alerts when these are exceeded. The system should also be configurable to categorise the status or level of the alarm so that a measured response is initiated.

User defines method of notification UC-ENV3.8-NOT-04-V02

The system should have the capability to alert marine responders via a variety of tools and technologies to ensure a timely response. The purpose of the system is to improve communication during times of emergency and ensure that the appropriate responders can act in a timely manner for critical situations.

System notifies relevant personnel UC-ENV3.8-NOT-05-V02

The system will send out the alert to a responder or relevant stakeholder. This use case generates an action leading to a distribution of an automated alert when processing of the trigger mechanisms in the alert notification profile matches the criteria as determined after a scan of the desired thresholds exceeded in the system's database. The system will distribute alert notifications using pre-defined telecommunications methods

- Identify the type and severity of the event
- Communicate the event
- Notify other stakeholders if appropriate.

Responder acknowledges notification UC-ENV3.8-NOT-06-V02

The user responds to the alert issued by the system which updates the system regarding what action the responder is undertaking.

3.9 MOB: Mobile user interaction with Platform

All of the scenarios essentially offer a distributed decision support system for marine users that will be used in both an office and field environment. As a result it is essential that the various portals can be accessed and updated from a range of devices including Notebook computers, tablets, and Smart phones irrespective of operating system. Such functionality will enable operators to make informed decisions and update data whilst on the move.

As it is anticipated that some users may require access in remote areas where low bandwidth exists, thus a scaled down version which only offers critical information is key.

User downloads data from their mobile phones UC-ENV3.9-MOB-01-V02

This use case describes how a Widget or a mobile phone Application can provide a user with weather , sea state conditions, Water quality information dependant on its real location.

User uploads data via mobile phone UC-ENV3.9-MOB-02-V02

This use case describes how a mobile web application can upload data to the EnviroFI platform, other data repositories and relevant social networks.

3.10 PRE: Predictive modeling

Predict marine hazard movement UC-ENV3.10-PRE-01-V02

Based on data about the nature of the marine hazard, geography, and environmental conditions, the system will simulate transport processes and movement of the marine hazard

Predict effects of hazard UC-ENV3.10-PRE-02-V02

Predict the most likely effects (environmental, ecological, economical) of the Marine Hazard - The user will predict the effects by running an extended simulation of the marine hazard.

4 Comparison with State of the art

With the identification of 4 marine use case scenarios in deliverable 3.1 we have performed an assessment of the current state of the art in terms of internet application technology within each of the identified scenarios. This exercise has contributed to identifying and developing the key areas of functionality of highest importance with the marine domain in respect to the development of the EnviroFI platform.

4.1 Scenario A: Harmful algal bloom monitoring

The future solution required will be at the cutting edge of integrating data from models, satellite and real time monitoring programmes for the purpose of providing synoptic advice from the participant countries to key stakeholders in the aquaculture industry. A key driver for this approach has been from the outset that better access to information means better decisions.

Integrated decision support systems and alerting system for Habs monitoring are in existence with some exciting development work currently taking place - ASIMUTH is a EU funded initiative to develop short term HAB alert systems for Atlantic Europe. This will be achieved using information on the most current marine condition (weather, water characteristics, toxicity, harmful algal presence etc.) combined with local numerical predictions. Geospatial products will be used by ASIMUTH to initiate the HAB models developed during the project. Biological HAB experts from each country will evaluate data from the HAB monitoring programmes, satellite images and model output to produce bulletins to inform the public and aquaculture industry. The bulletins produced will present the current state of HABs in each area and the likelihood of a toxic or harmful event of target species for the following week.

The current system under development include model output, satellite data, in situ data and biological samples including biotoxin chemistry, phytoplankton counts and mouse assay. The system uses a single point of entry portal to facilitate ease of access to data. The portal can link to a distributed network of stakeholders to deliver data in a standard easy to understand format. The portal permits the application of statistical tools and the integration of GIS systems.

The current state of the art lacks the capability to integrate the web interface to mobile internet services supported by "push text" alert services. Integration of a secure and reliable alert and notification system is currently lacking. Future functionality that will improve the current systems available include easier to manage and use security access to the system, scalability, increased integration of third part web services in supporting the decision making process.

4.2 Scenario B: Marine Renewable Energy Applications

Wave energy may represent the greatest need for application of future internet developments, as it is a relatively new alternative energy technology, approximately at the same stage of development that solar and wind energy system were some 15 years ago. Not only will sensors be needed to support wave energy convertor assets, they will also be needed to scout out the best locations for installing these plants. That is, wave level, strength, and profile must be measured over time and compared to installation costs to determine those locations that will provide the optimal oceanic or tidal energy that can be harvested by wave energy systems.

Market Research carried out by Frost & Sullivan [04] on behalf of the Marine Institute in 2009 showed that the uptake of Real Time Integrated Monitoring systems (RTIMS) in the Marine Energy sector to date has been confined to a limited number of commercial opportunities.

Marine energy device developers consider weather and wave monitoring a critical tool in their operations as it enables them to improve operational efficiency. They perceive the link between short- and long term change in wave regime, and its potential impact on machine performance to be critical in order to build a better understanding on how to enhance efficiency of operations.

The incentive for investment in RTIMS is also driven by the need to correctly predict and meet prede-

termined targets for power output as failure to do so may be penalised; which highlights the importance of accurate real-time wave buoy data and forecasts. The importance of real-time data, together with significant long-term growth expectations for the Marine Energy sector is expected to provide a significant scope of opportunity for the uptake of RTIMS in the next 5 years. The heightened need for effective data management together with pressure to reduce operational costs is expected to drive the uptake of multi-sensor instruments and platforms.

1. The development and deployment of microsystems, including aquatic sensors that measure various parameters, and microfluidic devices, including chemical samplers and analyzers, which are easily integrated with electronic signal processing components and wireless communications components have potential to be widely deployable at relatively low cost in the future, significantly increasing the number and dispersion of measurement points. The potential for mass production of Micro-electromechanical systems - MEMS devices and the potential to develop them with wireless capabilities make them obvious choices for use in marine environments.

2. More sophisticated modelling will mean that ecological and environmental conditions can be forecast more accurately so that marine and estuarine operations, such as those conducted in wave energy systems can be managed more efficiently.

3. Launching an initiative like the Future Internet PPP that facilitates standardization of devices and particularly data output for sensor, communications, and data management systems will prove expensive and time consuming, and it will require cooperation from multiple, diverse stakeholders. Nonetheless, standardization Technologies will be needed, as sensor vendors and integrators, communications device and system developers, and data management system developers and suppliers work together, increasing the number of investors and reducing each stakeholder's share of investment.

4. Wireless technology offers a potentially cost-effective means of marine monitoring and is considered a key area for future research. Future Technology developments will enable the networking of different and distant sensing instruments to communication networks that transmit the processed data to land-based control stations and to data management systems.

4.3 Scenario C: Oil Spill Reporting, Alerting and Information Systems

A good example of the state of the art in oil spill modelling and visualisation technologies was deployed in Ireland in April of 2011. The OILMAPWeb [05] system contains the following functionality:

- An interactive mapping system using adobe flex technology which includes an interactive oil spill model and visualization of GIS resources. The system connects to web sevice map data served by the ordnance survey of Ireland. The land side data is integrated with nautical chart data from the british admiralty and other relevant web map services.
- The oil spill modelling system (OIL MAP) is a database system that allows remote clients secure access to run and retrieve oil spill simulations. The OILMAP system uses high resolution wind forecasts and data from a hydrodynamic model from third part sources.
- The system is also integrated into a multimedia reference section with information pertaining to oil spill response activities for the region in question.

Beyond the State of the art for oil spill decision response tools will allow multiple remote users to model interpret and respond to emergencies using the latest web technologies to facilitate the rapid assimilation, interpretation and response to an oil spill event.

(IT Innovation\AJC, BAZ, RS and ZAS): Specifically, multi-level fusion based algorithms can be deployed to pre-process remote imagery and in situ sensing information to recognise oil spills and assimilate their conditions into oil spill modelling scenarios. Furthermore, collective intelligence can be harnessed from social networks to determine the validity of the assimilated oil spill model and remote sensing information prediction during oil spill beaching at coastal zone [1].

There has been a number approaches to automatic oil spill detection from SAR (Synthetic Aperture Radar) images. Topouzelis [06] has provided an overview of these works. Statistical approaches and neural networks have been used as well as feature- and object-based methodologies in recognition of

oil spills. Automatic detection of oil spills is a challenging task due to: i) the presence of look-alike phenomena; ii) varied surface shapes and dispersion; iii) the lack of verified common examples and data.

4.4 Scenario D: Marine Tourism and Leisure applications

E-Tourism is about using Internet technologies to transform the way key tourism approaches can be enhanced and developed. E-Tourism is a modern business methodology in the tourism sector that addresses the needs of investors, organizations, and consumers to cut cost while improving the quality of products and services to the consumer. The term also applies to the use of computer networks to search and retrieve tourism information in support of human and corporate decision-making. With e-Tourism, companies reach more and different customers and gain exposure in new markets not covered by existing physical channels, thus increasing the profits. "Tourism Technology" is a term that encompasses all social, cultural, managerial, and value-adding activities of the tourism industry. Tourism Technology also incorporates and encourages technological advancements and economic development in the tourism industry.

"Tourism Technology" is a paradigm covering knowledge used to add to the value of tourism products and services. New tourism products are also the end result of tourism technology combining with other industries. These include marine tourism and the application of information technology to the marine tourism industry.

5 Mapping of Users to Common Roles

The 4 marine domains related to the Marine Environment on which deliverable 3.1 was based presented a diverse range of marine related use cases and Users. Analysis of the 4 domains and the use case scenarios within identified the need for applications where there are numerous users each with different roles within the use case. However in the majority of use cases there is a Primary Actor who is responsible for accessing the application and make a management decision based on the integration of a range of different datasets.

Users Category	Harmful algal blooms monitoring	Marine Renewable Energy	Oil spill reporting alerting and information systems	Interactive Information systems for marine Leisure and safety	Business Model Category*
System administrators	National Regulatory Authority Manager	Marine Renewables exploration manager	Oil spill response team Manager	Marine Mammal Tour operator Local Authorities	3
Decision makers with Domain Expertise	National Regulatory Authority Manager Food safety Authority Manager	Marine Renewables exploration manager, Electric Grid operator	Oil spill response Manager, Shipping Company Manger, Oil Company Marine Experts	Local Authorities Marine Mammal Tour operator	3
Responders and Field personnel	Aquaculture farm operators Scientists	Marine Renewable Field technicians Coast Guard	Coast Guard Civil authorities Military Authorities	Life Guard Beach Goers Fisherman Sailors	2
Non-critical marine stakeholders	Food Consumer Groups Fishermen	Electrical Grid Manager Coast Guard Harbour Authorities	Harbour Authorities Whale Dolphin Interest Groups Wildlife protection groups	Water Safety Authority Coast Guard	2
General Interest users	General Public	General Public	General Public	General Public	1

Table 6 Mapping of Marine Scenario actors to User Category

The marine scenarios articulated in deliverable 3.1 identified a broad range of users who will engage with the ENVIROFI functionality at a variety of different levels from mission critical rapid response decision based management to casual interest. There are many potential business models which could be exploited relating to these different levels of requirements and interaction.

We have categorized the list of potential marine users of the ENVIROFI system in terms of the 4 marine scenarios and ranked these users on a scale of 1 to 3 their likelihood to pay for the services and functionality provided by the system.

3 represents users who will pay for key aspects of the functionality to support critical environmental and business decisions. This will mainly be the commercial sector as well as regulatory and civil authorities.

2 represents users who will use the functionality to derive savings by optimizing operations and having better access to information services which may impact on their business

1 indicates user who will use services primarily as an information and networking service and who would be willing to pay on a subscription basis for the services. The volume of users in this category would greatly exceed categories 1 and 2 but the amounts they would be willing to pay would be relatively small.

Key aspects of functionality by user category

What elements of the functionality are giving the Marine users the most value?

Functionality	Value to users
3.1 ATH: User Administration and Authentication	Low
3.2 ADM: Data Administration & Storage	Low
3.3 VIS: Data Visualisation	Medium
3.4 INT: Integration of heterogeneous datasets	High
3.5 GEO: GeoSpatial datasets	Medium
3.6 WEB: Web Service Integration	High
3.7 FNF: Future Network Functionality	Medium
3.8 NOT: Alert and Notification functionality	Medium
3.9 MOB: Mobile user interaction with Platform	Medium
3.10 PRE Predictive modelling	High

Table 7 Summary of the functionalities of highest value to marine stakeholders

6 Conclusions and Future Work

This deliverable has summarized the work done with regards to the use case revision within ENVIROFI WP3. We have taken the original use cases and the cross cutting functionalities from deliverable 3.1

To construct a new series of use cases based on generic functionalities across the marine scenarios as well as WP1 and WP2. These new use cases are outlined in more detail and include the areas of data administration, visualisation and integration of data streams. In so far as possible the structure of this deliverable has been aligned to that of the other work packages focused on the delivery of personalised information systems for biodiversity and pollen monitoring.

On further analysis of the user requirements presented in deliverable 3.1 it is clear that there is common functionality required by the stakeholders. It is also clear that there is a requirement to make better informed decisions to inform a business/industrial/recreational decision based on a web interface which consists of an innovative composition of content (often from unrelated data sources), made for human (rather than computerized) consumption.

We have monitored the approach outlined by WP4 in deliverable 4.1 where an analysis methodology for the defined use cases which will initially follow the model of a Design Methodology for Information Systems based upon Geospatial Service-oriented Architectures and the Modelling of Use Cases and Capabilities as Resources.

The aim is to use this model to capture and analyze the requirements of the three usage examples (WP1-3) of ENVIROFI. These requirements are elaborated in a first step as use cases (UC) by the experts of the application pilots (i.e., in the work packages WP1-WP3) and documented in the deliverables Dx.1, respectively. Applying an iterative approach, the use cases are matched in a second step with the capabilities of the emerging Future Internet platform, encompassing generic enablers (to be provided by the FI-WARE project as part of the core platform) and environmental enablers (to be provided by ENVIROFI).

As a result of this iterative process, future use case and requirement descriptions might be provided with extended, more restrictive and formal guidelines for the next deliverable.

Future Work:

- Development of UML diagrams in association with the other work packages
- Alignment of use cases with capabilities of the FI platform.
- Use further marine stakeholder input into the functionalities being developed
- Definition of the Environmental enablers required to interact with the generic enablers defined in FI-Ware.

7 References

	References
01	The Environmental Observation Web and its Service Applications within the Future Internet (ENVIROFI) project home page, *http://www.ENVIROFI.eu/*, - available online
02	ERDAP Easier access to scientific data http://coastwatch.pfeg.noaa.gov/erddap/index.html - available online
03	Chase N. (The ultimate mashup - Web services and the semantic Web (2006) https://www.ibm.com/developerworks/xml/tutorials/x-ultimashup1/x-ultimashup1-pdf.pdf - available online
04	Frost And Sullivan - Real Time Integrated Marine Water Management and monitoring systems - A Market Opportunity Analysis. Frost & Sullivan Report for The Marine Institute.(2009) – Unpublished
05	OilMap System - http://www.asascience.com/software/oilmap/index.shtml , available online
06	K. TOPOUZELIS - Contribution to the Research on the Capability of SAR Images in Recognizing and Detecting Oil Spills on Sea Surface(2007) - National Technical University of Athens, Athens (Greece) - JRC40315
07	North West Passage Clarus initiative – Use Case scenarios http://clarus.meridian-enviro.com/nwpassage/files/NWPassage_ClarusUseCaseScenarios.pdf available online

Table 8. References

8 Annexes

List of Use Cases and link to their location on the ENVIROFI Use Case Server

3.1 ATH: User Administration and Authentification

- **01** Register User **[UC-ENV3.1-ATH-01-V02]**
  http://envirofi.server.de/servlet/is/6180/
- **02** Authenticate User **[UC-ENV3.1-ATH-02-V02]**
  http://envirofi.server.de/servlet/is/6203/

3.2 ADM: Data Administration & Storage

- **01** Upload Data from External Sources **[UC-ENV3.2-ADM-01-V02]**
  http://envirofi.server.de/servlet/is/6213/
- **02** Edit Data and Information **[UC-ENV3.2-ADM-02-V02]**
  http://envirofi.server.de/servlet/is/6216/
- **03** Search for data **[UC-ENV3.2-ADM-03-V02]**
  http://envirofi.server.de/servlet/is/6436/
- **04** Download Data **[UC-ENV3.2-ADM-04-V02]**
  http://envirofi.server.de/servlet/is/6437/

3.3 VIS: Data Visualisation

- **01** Define location **[UC-ENV3.3-VIS-01-V02]**
  http://envirofi.server.de/servlet/is/6220/
- **02** Define time period (temporal extent) **[UC-ENV3.3-VIS-02-V02]**
  http://envirofi.server.de/servlet/is/6222/
- **03** Retrieve and display Datasets **[UC-ENV3.3-VIS-03-V02]**
  http://envirofi.server.de/servlet/is/6224/
- **04** Display Data in tabular format **[UC-ENV3.3-VIS-03.01-V02]**
  http://envirofi.server.de/servlet/is/6226/
- **05** Display data in graphical format **[UC-ENV3.3-VIS-03.02-V02]**
  http://envirofi.server.de/servlet/is/6228/

3.4 INT: Integration of hetrogeneous datasets

- **01** Create Data Mashup **[UC-ENV3.4-INT-01-V02]**
  http://envirofi.server.de/servlet/is/6232/

3.5 GEO: GeoSpatial datasets

- **01** Define spatial area of interest **[UC-ENV3.5-GEO-01-V02]**

  http://envirofi.server.de/servlet/is/6236/

- **02** Include relevant- spatial data layers **[UC-ENV3.5-GEO-02-V02]**

  http://envirofi.server.de/servlet/is/6238/

3.6 WEB: Web Service Integration

- **01** Web enabled integrated information and new knowledge services **[UC-ENV3.6-WEB-01-V02]**

  http://envirofi.server.de/servlet/is/6479/

- **02** Pre-process of heterogeneous data sensors **[UC-ENV3.6-WEB-02-V02]**

  http://envirofi.server.de/servlet/is/6240/

- **03** Pattern recognition in observation data from remote sensing imagery and time series.**[UC-ENV3.6-WEB-03-V02]**

  http://envirofi.server.de/servlet/is/6248/

- **04** Predict modelling of environmental patterns in data and models with uncertainty estimation. **[UC-ENV3.6-WEB-04-V02]**

  http://envirofi.server.de/servlet/is/6431/

- **05** Forecast of pattern/object behaviours in spatial-temporal form with controlled uncertainty from new observations **[UC-ENV3.6-WEB-05-V02]**

  http://envirofi.server.de/servlet/is/6432/

3.7 FNF: Future Network Functionality

- **01** User can Adjust Network Scalability during Specific Events **[UC-ENV3.7-FNF-01-V02]**

  http://envirofi.server.de/servlet/is/6250/

- **02** Advanced QoS (Quality of Service) mechanisms **[UC-ENV3.7-FNF-01.01-V02]**

  http://envirofi.server.de/servlet/is/6253/

3.8 NOT: Alert and Notification functionality

- **01** User defines alarm thresholds for parameters **[UC-ENV3.8-NOT-01-V02]**

  http://envirofi.server.de/servlet/is/6255/

- **02** User defines level of alarm**[UC-ENV3.8-NOT-02-V02]**

  http://envirofi.server.de/servlet/is/6257/

- **03** User add list of responders **[UC-ENV3.8-NOT-03-V02]**

  http://envirofi.server.de/servlet/is/6259/

- **04** User defines method of notification**[UC-ENV3.8-NOT-04-V02]**

  http://envirofi.server.de/servlet/is/6261/

- **05** System notifies relevant personnel**[UC-ENV3.8-NOT-05-V02]**

  http://envirofi.server.de/servlet/is/6263/

- **06** Responder acknowledges notification**[UC-ENV3.8-NOT-06-V02]**
  http://envirofi.server.de/servlet/is/6265/

3.9 MOB: Mobile user interaction with Platform

- **01** Mobile User Data Download **[UC-ENV3.9-MOB-01-V02]**
  http://envirofi.server.de/servlet/is/6336/
- **02** Upload of Data from a Mobile Device to a Central Repository **[UC-ENV3.9-MOB-02-V02]**
  http://envirofi.server.de/servlet/is/6422/

3.10 PRE Predictive modelling

- **01** Predict Marine Hazard movement **[UC-ENV3.10-PRE-01-V01]**
  http://envirofi.server.de/servlet/is/6846/
- **02 Predict Effects of Hazard [UC-ENV3.10-PRE-01-V01]**
  http://envirofi.server.de/servlet/is/6849/