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D3.3.2 Functional and Organisational Specification for FI Marine Scenario Pilot II

Intune Networks Limited

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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 Authentication
DOW	Description of Work
ERDDAP	Environmental Research Division's Data Access
FI	Future Internet
FIA	Future Internet Assembly
FI-PPP	Future Internet Public-Private Partnership Programme (FI-PPP)
GEOSS	Global Earth Observation System of Systems.
GMES	Global Monitoring for Environment and Security.
GPS	The Global Positioning System
MI	The Marine Institute of Ireland is the national agency responsible for Marine Research, Technology Development and Innovation (RTDI).
MOB	Mobile user interaction with Platform
NOAA	The National Oceanic and Atmospheric Administration (NOAA)
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
Smart Bay	A bay that is being observed and modelled on a continuous basis
SME	Small Medium Enterprise
SOS	Sensor Observation Service
SWE	Semantic Web Enhancement / Sensor Web Enablement
UC	Use Case
UGC	User Generated Content - Drop
UML	Unified Modelling Language

Abbreviation / Acronym	Description
VIS	Data Visualisation
WP	Work Package
WPS	Web Processing Service

Table 1. Abbreviations and Acronyms

Executive Summary

The marine environment is a dynamic and challenging environment for operational deployments. The ENVIROFI project presents an exciting opportunity to deliver on the emerging decision support needs of the global marine sector through leveraging of future internet technologies under development in the FI-PPP programme.

This document is a refinement of the third deliverable **[01]** of WP3 which focused on the development of a Marine Asset decision Support Tool (MAST) initially tailored for the Renewable Energy Sector. The need for alternative energy resources and development of renewable energy policies and strategies will result in the increased deployment of technologies including ocean energy devices into this high risk environment. As the marine renewable energy industry is in its infancy the outcomes of deployment and testing are often unpredictable. Next generation decision support tools will be increasingly required to assist in the mitigation of risks associated with capital investments in the marine renewable and related sectors.

The purpose of the MAST and related services is to provide marine users with the ability to manage offshore assets affected by changes in sea conditions via the internet. These decisions will be based on a variety of data streams supplied to the user from a number of data sources in an efficient manner via the MAST web portal. While the outputs of WP3 will initially concentrate on the end user requirements of the Ocean Energy Sector, it is anticipated that the demonstration of advanced service offerings of the Future Internet platforms will catalyse the translation of the ENVIROFI service offering to other marine sub-sectors including the aquaculture, marine leisure and tourism, shipping etc. Given the extent of likely resource requirements this will likely be implemented through alternative mechanisms such as national and regional funding opportunities

This document is a second iteration of the functional specification of the main pilot scenario Marine Asset decision Support (MAST) tool. MAST is described incorporating additional demonstrations in the area of marine hazard movement and future internet networks. The relationship between the requirements of the pilot scenarios and the specific enablers is illustrated. It is assumed that the specific enablers will be part of the ENVIROFI component of FI-WARE. A demonstration scenario is described in detail for WP3 and the possibility of the exploitation of the proposed technologies is explained. Some possible business plans for the exploitation of WP3 outcomes are discussed. This second iteration includes additional material on the pilot project, a planning table and a new appendix of test cases.

1 Introduction

The global marine sector generates and consumes massive volumes of data every day. Scientific, legislative and socioeconomic drivers including a need to understand the dynamic nature of the global marine resource as a critical source of food, transport and renewable energy, a need to improve the spatial and temporal resolution of existing sampling regimes and datasets to drive cost effective management of marine resources, and a need to understand the impacts of human activity and climate change on an the marine environment.

This deliverable builds on the previous work that investigated end user requirements across a range of marine sectors including aquaculture, leisure and tourism, environmental monitoring (oil spill) and renewable ocean energy. The marine scenarios articulated in deliverable 3.1 [02] identified a range of users across the marine sector the majority of which had a Primary Actor responsible for accessing data and making an informed decision based on the integration and assimilation of a range of different datasets.

This deliverable focuses on the enablement of a **M**arine **A**sset Management Decision **S**upport **T**ool (MAST) for the Ocean Energy sector. While the outputs of WP3 will concentrate on the end user requirements of the Ocean Energy Sector, it is anticipated that the demonstration of advanced service offerings of the Future Internet platforms will catalyse the translation of the ENVIROFI service offering to other users in the marine sector including aquaculture, marine leisure and tourism, shipping etc. Given the extent of likely resource requirements this will likely be implemented through alternative mechanisms such as national and regional funding opportunities

The development of wave and tidal resources as a source of energy is the subject of growing international investigation. Ireland's offshore renewable energy resources have significant development potential and are considered as being among the best in the world, with the practicable wave energy resource estimated at more than 6000MW (Figure 1).

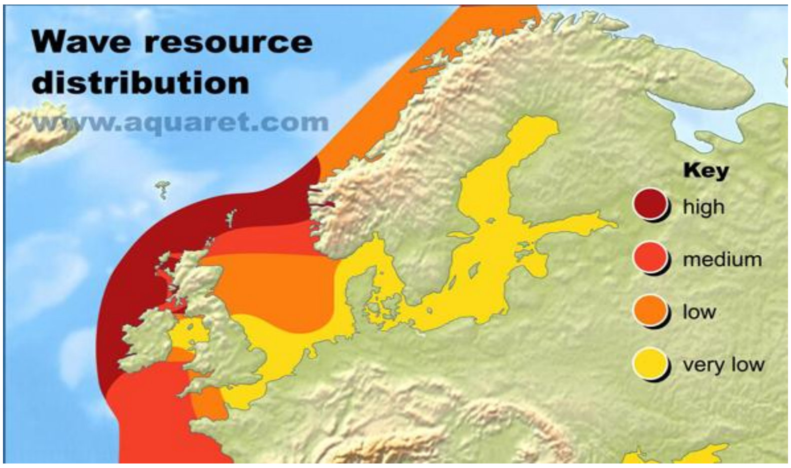

Figure 1. The wave power potential for Western Europe

To support this developing industry, a network of distributed sensors and data feeds will be required which will in turn generate huge amounts of data. It is estimated that a 20MW wave energy farm could generate and consume up to100GB of data on a daily basis. With an estimated marine renewable resource in Ireland alone of 6000MW this potential gives a figure of 30 Terabytes per day. European targets for ocean energy installed capacity are expected to increase from 245 MW in 2010 to 2,543 MW in 2020 [03]. If this estimate is realised the data generated will be approx (10 Terabytes) per day.

Currently the Marine Institute generates over 49 GB of model data daily from its operational of forecast models of the North East Atlantic. These models provide forecasts of a number of variables such as:

- Waves
- Ocean Temperature
- Ocean Current

Internet bandwidth and propriety data sets have been a barrier to the utilisation of these datasets by the wider Internet community. Recognising the potential to achieve greater service delivery to key clients and facilitate exploitation of data assets by enterprise and the research community, the Irish Marine Institute secured high speed broadband capability via HEAnet (Ireland's National Education & Research Network or NREN) who provides high-speed Internet access to academic institutions in Ireland direct to European and USA networks. HEAnet is connected to INEX via two 10 Gbit/s links, JANET in the UK via two 2 Gbit/s links, GÉANT in Europe via two 20 Gbit/s links and the General Internet via two 20 Gbit/s links. They also have several links to research networks in North America. Additionally there are several non-research links to the USA, Europe and South-East Asia. The Marine Institute now hosts a data server that provides data querying and data formatting services to key clients via a web portal.

As part of the ENVIROFI project the Marine Institute and its strategic partners INTUNE Networks Ltd, IT Innovation and SINTEF are developing a data access solution that will deliver on the key aims of the FI-PPP programme and the Digital Agenda. The solution will publish data in a way that it can be utilised by web app and phone app developers and that can be discoverable via semantic directory services. Bandwidth capabilities will be improved by INTUNE Networks Optical Packet Switching Technologies, this technology provides broadband on demand and quality of service functionality.

It is expected that these technologies will:

- Provide a resource of Marine web observations (i.e. sensor and model output in a common web service output)
- Make these web observations discoverable via semantic directory services
- Provide an ability to scale bandwidth dynamically based in priority usage
- Guarantee an Internet Quality of Service that is essential for the development of mission critical web/phone apps
- Provide a template that public organisations including the Marine Institute can use to publish their Marine observations across Europe to improve delivery of public services
- Turn research ideas into marketable products and services for the marine sector
- Play a part in establishing Europe as a leader in the delivery of smart, sustainable and inclusive growth at the interface of the marine and ICT sectors on the global stage.

2 Methodology

A concerted effort has been made to ensure that there is a consistent homogeneity between work packages 1, 2 and 3. This is most clearly seen in the use of a common Table of Contents (ToC) as well as definition of terms, glossary, and approaches to various topics, such as risk analysis and validation.

- Since the 2nd deliverable [01] the partners in WP3 have been:
- Engaging with ENVIROFI partners on a regular basis
- Refining use case and UML diagrams
- Developed some activity diagrams
- Performing risk analysis of priority Use Cases
- Selecting a pilot scenario for development
- Consulting with stake holders in the marine sector
- Identifying specific enablers for the pilot
- Designing a Graphical User Interface
- Identifying data sources for the pilot scenarios

WP3 identified and published the use cases for various marine scenarios in the 2nd deliverable [01]. WP4 published a set of abstract use cases based on their analysis of the use cases from each of the work packages. These abstract use cases served as a basis for discussion on generic and specific enablers within FI-PPP.

WP5 has extracted 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.

The result of the WP5 analysis was published in deliverable 5.2.1 [04]. This document identified the specific enablers that are required by the ENVIROFI work packages. As part of this deliverable the specific enablers that will need to be developed and by whom, have been identified for the proposed Marine Asset decision Support Tool (MAST) (Figure 8). These specific enablers are listed later in the document.

2.1 Naming conventions

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 [02] to D3.2 [01] 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 [02] have now been updated on the server to represent high level scenario areas:

UC: use case, REQ: Requirement, <workpackage>: eg marine environment (5). <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.

2.2 Validation

Validation of the Ocean Energy Pilot will take a number of forms including:

- Use Case Validation
- Test-driven development (TDD)
- Deployment and Acceptance Testing

2.2.1 Use Case Validation

A use case test process has been agreed among the ENVIROFI partners and new functionality has been added to the use case server that allows project partners to link test plans with use cases. As the development of the pilot proceeds the existing use case will be refined and developed. To validate this iterative process use case test plans will be added to the use case server. Each use case can have multiple test plans and the use case server has been set up to accommodate this.

2.2.2 Test Driven Development

Test Driven Development, or TDD, will be employed to ensure that functional units built during the development phase of the project conform to the specifications. This is low level unit testing and will be performed by the developers of the system.

In Test-Driven Development (Figure2), each new feature begins with writing a test. This test must inevitably fail because it is written before the feature has been implemented. (If it does not fail, then either the proposed "new" feature already exists or the test is defective.) To write a test, the developer must clearly understand the feature's specification and requirements. The developer can accomplish this through use cases and user stories that cover the requirements and exception conditions. This could also imply a variant, or modification of an existing test. This is a differentiating feature of test-driven development versus writing unit tests after the code is written: it makes the developer focus on the requirements before writing the code and is well suited to an AGILE development environment.

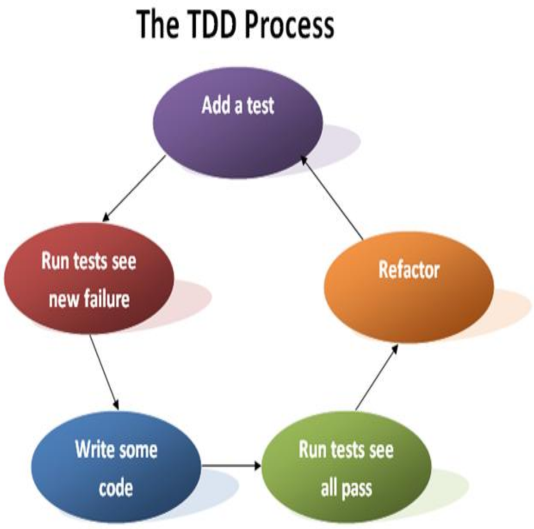

Figure 2. Test Driven Development work flow

2.2.3 Test run

Run all tests and see if the new one fails. This validates that the test harness is working correctly and that the new test does not mistakenly pass without requiring any new code. This step also tests the test itself, in the negative: it rules out the possibility that the new test will always pass, and therefore be worthless. The new test should also fail for the expected reason. This increases confidence (although it does not entirely guarantee) that it is testing the right thing, and will pass only in intended cases.

2.2.4 Code writing

The next step is to write some code that will cause the test to pass. The new code written at this stage will not be perfect and may, for example, pass the test in an inelegant way. That is acceptable because later steps will improve and hone it.

It is important that the code written is only designed to pass the test; no further (and therefore untested) functionality should be predicted and 'allowed for' at any stage.

Run the automated tests and see if they succeed. If all test cases now pass, the programmer can be confident that the code meets all the tested requirements. This is a good point from which to begin the final step of the cycle.

2.2.5 Refactor code

Now the code can be cleaned up as necessary. By re-running the test cases, the developer can be confident that code refactoring is not damaging any existing functionality. The concept of removing duplication is an important aspect of any software design. In this case, however, it also applies to removing any duplication between the test code and the production code — for example magic numbers or strings that were repeated in both, in order to make the test pass in step 3.

2.2.6 Repeat

Starting with another new test, the cycle is then repeated to push forward the functionality. The size of the steps should always be small, with as few as 1 to 10 edits between each test run. If new code does not rapidly satisfy a new test, or other tests fail unexpectedly, the programmer should undo or revert in preference to excessive debugging. Continuous Integration helps by providing revertible checkpoints. When using external libraries it is important not to make increments that are so small as to be effectively merely testing the library itself [06] unless there is some reason to believe that the library is buggy or is not sufficiently feature-complete to serve all the needs of the main program being written.

2.3 Deployment Validation and Acceptance Testing

Much of WP3 pilot system will be deployed against or on existing Marine Institute infrastructure and as will therefore have to comply with the Marine Institutes quality standards for software deployment. The Marine Institute expects that a project's testing approach will use some or all these test phases and use some of the static techniques. The specific approach will be tailored to meet the needs of the each stage of the project and the process will not impede the success of the project.

- Component (unit) Testing, used to test internals of software and is performed by the development team

- Integration Testing (in the small), used to test the interfaces of the sub-systems. The focus is on the interfaces of the sub-systems only.
- Functional and non-functional system testing used to test the functionality of the system against the functional specifications.
- Large-scale integration testing used to test the integration of all the different parts of the overall system. The testing focuses on the interfaces of the different systems, it is assumed at this stage the individual systems are functionally correct.
- UAT, used by a customer to ensure that they are getting what they want. In this case we will be testing whether the pilot software address the requirements of the proposed scenario.
- Static testing techniques should also be used with dynamic testing. These would include,
    - Reviews
    - Walkthroughs
    - Technical Reviews
    - Inspections

The Marine Institute have standard documents that will be used to create test plans and test cases at each stage of the pilot development.

2.4 Use Case Development

WP1, WP2 and WP3 have been developing the use cases (user stories in AGILE terminology) until the level where these can be used as specifications. In the 2nd deliverable [02] we identified the use cases.

As part of this process WP3 has been involved in a number of activities that have been driving the refinement and development of the use cases for WP3. These activities include:

- Collating and cataloguing sources of data
- Engaging with relevant Marine stake holders via direct meetings and forums
- Engaging with the various ENVIROFI partners

The development of the use cases and selection of the pilot scenario for development has been an iterative process influenced by a number of factors. For example:

- The outputs of WP5 specific enabler document
- The appraisal of what data will be available for the pilot
- An assessment of the added value the pilot project will add to existing data feeds
- The potential usefulness of the pilots
- The exploitability of various aspects of the pilot

2.5 Pilot Scenario Development

Once the pilot scenario was selected the work has focused on:

- Identification of priority use cases

- Development of UML diagrams
- An assessment of the added value the pilot project will add to existing data feeds
- The potential usefulness of the pilot
- Identify the relevant specific enablers

2.6 Development of Specific Enablers

WP4 has analysed the pilot related use cases and formulated a set of abstract use cases common to various environmental applications. These abstract use cases served as a basis for discussion on generic and specific enablers within FI-PPP.

WP5 has analysed the various requirement drivers from WP4 and WP5 that provide a firm basis upon which to define the initial set of specific enablers. Requirements were analysed from the deliverable D5.1.1, FI-CORE platform, WP4 use cases and architectural considerations from D6.1.1. A total of 45 specific enablers are defined following seven thematic categories:

- Federating catalogues: catalogue and discovery services to facilitate a scalable system of systems approach to environmental services. Some key standards are supported to ensure the geospatial community can make full use of the specific enabler services.
- Harvesters, connectors and mediators: collection of brokers, connectors and mediator services which support protocols and data models found in the environmental domain. This thematic class of specific enabler is there to facilitate easier interoperability between specific enabler services, encouraging agile and flexible service composition in the future internet.
- Geo-referenced data collection applications: geo-referenced observation and sample data is key in the environmental usage area. The services in this thematic class provide ways to record and archive geo-tagged measurements for later use by other specific enablers such as fusion services. The enablers in this class are designed to support crowd sourcing of environmental measurements, recording multi-author data at a scale to exploit fully the future internet.
- Semantic tagging tools: tools and services that provide support for semantic enrichment of environmental data streams and sources. This thematic class includes environmental domain ontology support, harvester services and linked data services allowing uncertainty annotation of existing measurement resources.
- Fusion tools for heterogeneous data sources: heterogeneous environmental data fusion services operating at different semantic levels. This thematic class includes pre-processing, feature extraction, situation assessment and prediction services, preparing and aggregating environmental data into formats suitable for use by human end users and automated services such as alert services.
- Event detection and notification services: services which provide a variety of notification mechanisms compatible with the environmental geospatial standards and protocols.
- Geospatial data provisioning and storage: services related to the provisioning and storage of environmental observations and measurements. This category includes a number of existing open source environmental services (e.g. from 52North) that have gained traction in the environmental geospatial community.

The result of the WP5 analysis was published in deliverable 5.2.1 [04]. This document identified the specific enablers that could that are required by the ENVIROFI work packages. As part of this deliverable the specific enablers that will need to be developed and by whom, have been identified for the proposed Ocean energy asset management pilot (Figure 3). These specific enablers are listed later in the document.

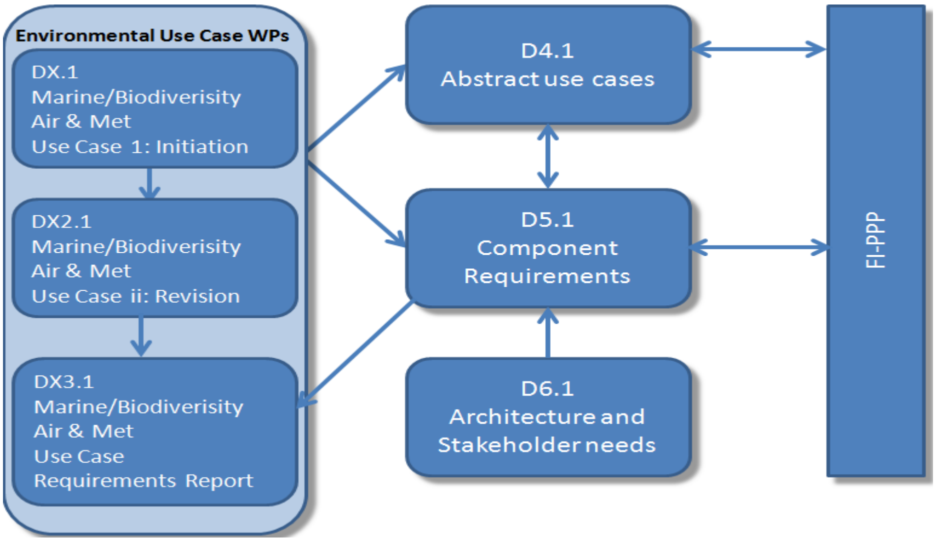

Figure 3. Schematic Overview of the Use Case Requirement deliverables in relation to the overall ENVIROFI project

3 Pilot Scenario (Detailed Scenario Descriptions)

The previous deliverable [01] listed four scenarios and their corresponding use cases. Cross functional analysis and use case refinement since then has identified core functionality that can be brought together into one pilot scenario. This pilot scenario will contain elements that are common to all scenarios described in the 2nd deliverable [01]. Outcomes from this pilot will lay down the ground work for the possible developed of the other marine scenarios in aquaculture, marine leisure and tourism and oil spill monitoring through other resourcing mechanisms. The renewable energy pilot scenario is now composed of three sub-pilots.

The first sub-pilot scenario is the ocean energy asset management use case (UC-ENV3.B-WAV-03-V03) which was identified as the prime candidate for development into the pilot scenario. There are two good reasons for this choice:

1. There is a genuine need for development of software and data sources that could be used in the management of offshore marine assets, not just in wave power, but also in wind power and aquaculture.
2. The cross functionality analysis recognised that this use case contained a lot of functionality that is common to the other marine scenarios
3. The ocean energy asset management use case is an excellent starting point for the development of functionality that can be reused in future projects.
4. The ocean energy asset management use case also has the best potential for commercial exploitation as it is address the needs of a pioneering industry.

3.1 Sub Pilot 1: Ocean Energy Asset Management

An analysis of the original Scenario A use cases identified common data and functional requirements between them. The functional specifications and data requirements of the ocean energy asset management use case (UC-ENV3.B-WAV-03-V03) are broad enough that elements of it can be reused to implement the other scenarios if needed.

Accurate, frequent and reliable observations of various properties of an offshore ocean energy array are crucial to its successful management. But data observations are not enough; the observations need to be interpreted and converted into information that has meaning to the data consumer. The type of software system that addresses this type of requirement is a Decision Support System (DSS). A DSS is an interactive software based system that supports organisational decision making activities at management, operational and planning levels of the organisation. It is particular useful in situations where information changes frequently and capitalises on the core properties of information technology:

- Computer networks for data sharing
- Computers for data analysis
- Computer graphics for data visualisation
- Database technologies for data management
- Human interface technologies for interaction with the Decision Support System

Deployment of the DSS will be on the Internet as a web portal (Figure 8). A web portal is a website composed of various web links and web widgets (also known as portlets). A widget is a discrete piece on a web page that performs a particular function and comes with its own user interface (UI) and set of features.

Examples of popular portals are iGoogle, MSN and Yahoo!, these sites provide a common theme (or in this a branded theme) to various data sources that are only linked by the likes and dislikes of the user.

The MAST portal will contain web links and web widgets that share a common theme - the management of ocean energy assets in the marine environment. In particular it will provide information that will aid in the decision making process surrounding maintenance at sea. This question is common to any offshore industry and solution proposed here will be applicable to other users of Galway Bay.

This pilot will be based on hypothetical wave farm based in Galway Bay Ireland. Most of the functionality for the widgets in the portal will come from already existing infrastructure that has come into being due to the development of Marine ICT services at the Marine Institute (Figure 4).

The premise of this use case is that the user will have access to MAST tool which will allow faster decisions to be made on how to optimize output from the wave energy farm as sea and weather conditions change.

This will be enabled by the centralisation of data streams and the conversion of data sets to easy to read formats for operational management purposes. Real time sensor information will be amalgamated with data from satellites, aircraft, predictive models and shore-based observations providing a real time picture of the conditions at the wave energy test site to aid the decision making process of site operation in terms of maximising the potential power outputs.

The Marine Institute runs a number of operational ocean models and records numerous data feeds from live sensors based on land and at sea. To date these resources have been used to address specific scientific enquiries and operational questions specific to the Marine Institutes research vessels. By using the Semantic Web Enablement techniques some of the output from these resources will be republished and used to provide some of the functionality of the web portal.

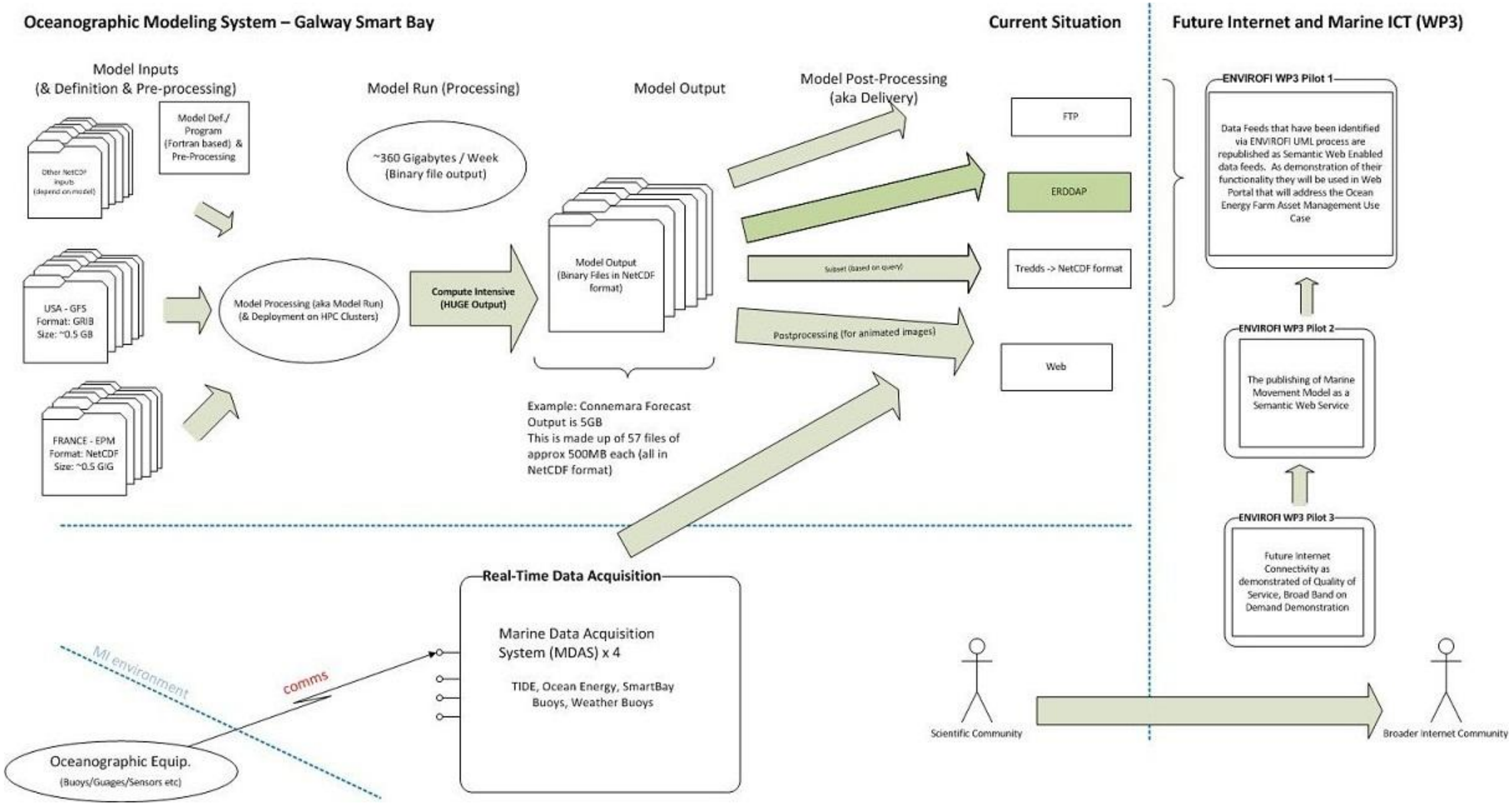

Figure 4. The flow data within the Oceanographic Modelling System of the Marine Institute

3.2 Sub Pilot 2: Marine Hazard Prediction

The next area of functionality is that of marine hazard movement. This scenario is development from the original oil spill scenario. The ability to predict the movement marine hazards and their impacts on marine environment is key requirement in management and monitoring of offshore marine assets.

This new scenario consists of the following two use cases:

- Predict Marine Hazard movement (UC-ENV3.10-PRE-01-V01): Based on data about the nature of the hazard, geography, and environmental conditions, the system will simulate transport processes and movement of the marine hazard. In the case of an oil spill, hazard data will include oil type, spill amount (or rate), and spill location, and environmental conditions will include wind and current observations and forecasts.
- Predict effects of Marine Hazard (UC-ENV3.10-PRE-02-V01): The user will predict the effects by running an extended simulation of the Marine Hazard movement. In the case of an oil spill, effects range from immediate impacts such as beach pollution, damage to birds etc to longer-term toxic effects.

These two new use cases focus on the essential functions of Scenario B, which is being able to predict the movement of a marine hazard and is effects of a marine hazard. These use cases now provide functionality that can be plugged into the marine asset management use case.

This pilot will also require user access controls and authentication features due to the sensitivity of the data involved. The pilot will have the ability to assimilate complex datasets from disparate data sources including

- Sensor inputs (weather, wave, water quality, hydro-carbon monitors)
- Predictive model outputs

3.3 Sub Pilot 3: Future Internet Network Functionality

The marine environment is not a linear predictable system but is dynamically changing all the time. The design principles for a future internet must mirror the environment and must be flexible and dynamic and responsive to the unpredictable demands of the marine environment. Currently environmental services are bundled into a fixed and non-responsive internet e.g. marine sensor devices connected to the internet via fixed internet connections. This is a problem for scaling marine or any other niche sensor network. Marine sensor data tends to be sporadic because marine applications are monitoring random events such as oil spills or wave energy. As a consequence, the niche networks (virtual private networks or even fixed point to point fibre connections) are created and over-provisioned for max data backhaul for random events. This is quite expensive and a waste of resources and money and a bottle neck in scaling sensor networks. A future internet must be able to provide dynamic network services with guaranteed service level agreements which are auditable and scalable. The core components of a future internet network include.

- Bandwidth on Demand (UC-ENV3.7-FNF-01-V02): Data collected from the SmartBay sensor network range from 50GB to 300GB and this will significantly scale in a similar fashion to Moore's, Nielsen's and Metcalfe's Laws. Future networks must be able to dynamically scale bandwidth services. E.g. a marine application will be able to request a bandwidth service for a period of time and will dynamically and instantaneously be able to scale this bandwidth up or down depending on the real-time requirements of the marine application.
- Advanced QoS mechanisms (UC-ENV3.7-FNF-02-V02): Data must be transmitted with various

levels of reliability and availability. Priorities will vary for different marine services but in general there must be contractual and auditable SLAs (service level agreements) that are not based on over-provisioning of network architectures. There should be various levels of CoS's from guaranteed quality to best effort for a pre-determined bandwidth level.

- Dynamic Network Virtualisation: Environmental sensing networks must be able to dynamically and rapidly pop-up in various locations around a country. It is not sufficient to create fixed VPN's or point-to-point networks due to the non-linear fashion of marine services. Local / national sensing networks must be able to dynamically scale in response to dynamic environmental events and conditions. A future network must therefore support dynamic virtualisation of the physical fibre infrastructure whereby environmental stakeholders could become a virtual network operator sharing the same physical network with traditional internet service providers in a similar fashion to energy utility networks. Additionally, the percentage split of networks must be able to dynamically scale in response to real-time demands in a similar fashion to spot pricing of the Amazon Web Services model.
- Open Network Control Interfaces: The current internet is built on SOAP or REST architectures particularly evident in Google's or Yahoo's architectures and this trend seems likely to continue. However national networks have yet to adopt these high level protocols but rely on SNMP or similar older standards. The Future Internet must use REST or SOAP in all infrastructures where a single XML instruction can simultaneously link to database content and configure the network to deliver the content. An environmental example of this is HD video sensors. A single URL could simultaneously link to content and configure the network for delivering this content with guaranteed SLA's. Ultimately this means that future networks will have to be opened up and their API's must be bundled with a larger cloud and compute SDK.

4 Pilot Scenario (Detailed Scenario Descriptions)

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. In table 7 we list the important priority use cases these are use cases critical to the development of the pilot scenario.

Use Case	Use case ID	Priority
Create data mash up	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

Table 2. List of important priority use case

5 Cross-cutting Use Cases

The following table is mapping the priority WP3 use cases to WP4 uses cases and directly to previously identified ENVIROFI requirements (REQ). The mappings are not one to one.

Priority Use Case	WP4 or Requirement Mapping
UC-ENV3.4-INT-01-V01 Create data mash up	**UC-ENV4-xui-01-V01** Visualization of requested data **UC-ENV4-fun-05-V01** Accesses existing observations
UC-ENV3.6-WEB-01-V02 Web enabled integrated information and new knowledge services	**REQ-ENV-KNO-01** **REQ-ENV-KNO-03**
UC-ENV3.6-WEB-02-V02 Pre-process of heterogeneous data sensors	**REQ-ENV-KNO-03**
UC-ENV3.6-WEB-03-V02 Pattern recognition in observation data from remote sensing imagery and time series	**REQ-ENV-KNO-03**
UC-ENV3.6-WEB-04-V02 Predict modelling of environmental patterns in data with uncertainty estimation	**UC-ENV4-fun-08-V01** Run simulations with observations as data input
UC-ENV3.6-WEB-05-V02 Forecast of pattern behaviours in spatial-temporal form	**UC-ENV4-fun-08-V01**
UC-ENV3.10-PRE-01-V02 Predict marine hazard movement	**UC-ENV4-fun-08-V01** **UC-ENV4-fun-05-V01**
UC-ENV3.10-PRE-02-V02 Predict effects of hazard	**UC-ENV4-fun-08-V01**

Table 3. How the priority use cases map to the WP4 and ENVIROFI requirements

The next table shows the mappings from the IT-INNOVATION specific enablers to various WP4 use case. Not all the WP4 use case are relevant to WP3 however WP5 enablers were developed to address cross work package requirements so these extra WP4 use case are included here to illustrate this.

Specific enabler	Title	Supports WP4 use cases
WP5-SE-MED-10	Mediator – Fusion toolbox	dat-01-V01, fun-01-V01 fun-05-V01, fun-05.02-V01
WP5-SE-GEO-7	Environmental geo-referenced image sample archive service	dat-03-V01, fun-03-V01 fun-03.02-V01, fun-04.V01 fun-05.V01, fun-05.02.V01
WP5-SE-GEO-8	Environmental geo-referenced audio sample archive service	dat-03-V01, fun-03-V01 fun-03.02-V01, fun-04.V01 fun-05.V01,fun-05.02.V01
WP5-SE-GEO-9	Geo-referenced sample quality assessment service	fun-03-V01, fun-03.02-V01 kno-01-V01
WP5-SE-TAG-8	Uncertainty annotation of environmental data service	dat-01-V01, dat-02-V01 dat-03-V01, fun-03.04-V01 fun-04-V01, fun-05-V01 fun-05.02-V01, tru-01-V01
WP5-SE-FUSION-1	Environmental spatial-temporal data aggregation service	dat-03-V01, fun-05-V01 fun-05.02-V01, fun-08-V01
WP5-SE-FUSION-4	Environmental asset analysis service for geo-referenced sample archives	dat-03-V01, fun-05-V01 fun-05.02-V01, fun-08-V01
WP5-SE-OGC-4	Bulk upload of sensor data service	fun-03.03-V01, fun-04-V01 fun-05-V01,fun-05.02-V01

Table 4. Mapping from specific enablers used by WP3 pilot to WP4 use cases [07]

The next table outlines WP4 use cases and ENVIROFI requirements mapped to WP5 specific enablers. The WP4 use case and requirements are the ones that address the requirements of the WP3 priority use cases.

WP4 Use Cases that apply to WP3 priority use cases	WP5
UC-ENV4-xui-01-V01 Visualization of requested data	TBD
UC-ENV4-fun-05-V01 Accesses existing observations	WP5_SE_GEO_7
REQ-ENV-KNO-01	WP5-SE-GEO-4, WP5-SE-GEO-9, WP5-SE-FUSION-1, WP5-SE-FUSION-2, WP5-SE-FUSION-4
REQ-ENV-KNO-03	WP5-SE-FUSION-1
UC-ENV4-fun-08-V01 Run simulations with observations as data input	WP5-SE-FUSION-4
UC-ENV4-fun-08-V01	WP5-SE-FUSION-4
UC-ENV4-fun-08-V01 **UC-ENV4-fun-05-V01**	WP5-SE-FUSION-4 WP5_SE_GEO_7
UC-ENV4-fun-08-V01	WP5-SE-FUSION-4

Table 5. Mapping from WP4 use cases to WP5 specific enablers

6 Pilot Planning

Because of iterative nature of project management as promoted by the AGILE philosophy we will refine existing tasks as well as starting new ones. A new set of task for the next period of project will be the start development of the information technology components that are needed to deploy MAST. Of course we will also continue to refine our use case by developing use cases test plans.

Planning for the next phase of the project has been broken down in tasks for each of the sub pilot areas:

6.1 Sub Pilot 1: Ocean Energy Asset Management

- Create a pilot web portal, with place holders for the widgets to be replaced by specific enabler functionality as it is released.
- To collate and catalogue the existing data sources that needed as part of theWP3 pilot.
- To identify any gaps in those data requirements
- To work with our ENVIROFI colleagues to create semantic enhanced web observations out the existing Marine Institute data feeds.
- To develop test plans for the specific enablers
- To develop test plans for MAST
- To continue to engage with marine stakeholders

6.2 Sub Pilot 2: Marine Hazard Prediction

- Develop the standards describe the inputs and outputs of the marine hazard movement model
- Develop an interface to communicate with the web service enabled marine hazard model.
- Make marine hazard model outputs compatible with specific enablers.
- Develop widgets and software for interfacing with marine hazard model.
- Create test plans for marine hazard model. We intend to compare the results of the marine hazard model with results of other oil spill models.

6.3 Sub Pilot 3: Future Internet Network Functionality

Environmental monitoring services will be equipped with Bandwidth on Demand UC-ENV3.7-FNF-01-V02 and Quality of Service UC-ENV3.7-FNF-02-V02 future network functionalities.

- Video Services for Environmental Monitoring: This use-case will integrate the entire above future network capabilities into HD video monitoring environmental services. Environmental HD video services will be equipped with guaranteed SLA's. This means that even when a national backhaul network is overloaded and over provisioned during peak hours, HD video quality will never degrade but will be prioritised with advanced CoS technologies. In addition, the video services will also have the capability to dynamically scale in real-time to 100's of geographically distributed sensors in response to unpredictable environmental events. These capabilities will be enabled by a single XML instruction to the telecoms network, sent by the marine web-portal.

In Phase 2, this functionality will be hosted by FI-Ware with deeper integration of Environmental Services and applications also hosted on FI-Ware. Although this pilot will be demonstrated first with video sensors, it will also be transported and integrated into acoustic mammal detection or any other environmental monitoring service as required.

6.4 Main objectives for Pilot from June - Pilot Launch

The following table collects the list of the main tasks of WP3. This table will be updated through the course of the project

Objective	UC ID	WP4 UC	Description of the function or requirement	Applicable enabler (D5.2.1)	Responsible	Period	Status
Data Aggregation/Fusion/Prediction							
Enables user to add data from external sources	UC_ENV3.4-INT-01-V01	UC-ENV4-xui-01-V01 UC-ENV4-fun-05-V01	Visualization of requested data. Service to allow user and experts uploads of annotated sample data. Annotations will include classifications and geo-references	TBD WP5-SE-GEO-7	IT-INN.	March	
To publish data geospatial data in OGC formats. General GIS functionality	UC-ENV3.6-WEB-01-V02	REQ-ENV-KNO-01	Service that allows users to, to on-demand, fuses multiple heterogeneous environmental data sources and creates a fused spatial-temporal result set.	WP5-SE-FUSION-1	IT-INN.	October	
			Service to spatially analyse, for different time periods, sets of samples of environmental assets	WP5-SE-FUSION-4	IT-INN.	March	
		REQ-ENV-KNO-03	Environmental spatial-temporal data aggregation service	WP5-SE-FUSION-1	IT-INN.	October	
To integrate disparate data into OGC formats	UC-ENV3.6-WEB-02-V02	REQ-ENV-KNO-03	Environmental spatial-temporal data aggregation service	WP5-SE-FUSION-1	IT-INN.	October	

Objective	UC ID	WP4 UC	Description of the function or requirement	Applicable enabler (D5.2.1)	Responsible	Period	Status
To identify objects of interest such as trends and detect patterns and present the results in an app	UC-ENV3.6-WEB-03-V02	REQ-ENV-KNO-03	Analysis Functionality to be available via Portal	WP5-SE-FUSION-4	IT-INN.	March	
To predict environmental patterns from observed parameters with uncertainty control through new feed	UC-ENV3.6-WEB-04-V02	UC-ENV4-fun-08-V01	Analysis Functionality to be available via Portal	WP5-SE-FUSION-4	IT-INN.	March	
To correct predicted patterns with new observations	UC-ENV3.6-WEB-05-V02	UC-ENV4-fun-08-V01	Analysis Functionality to be available via Portal	WP5-SE-FUSION-4	IT-INN.	March	
Oil Spill Model Web Service							
Predict marine hazard modelling	UC-ENV3.10-PRE-01-V02	REQ-ENV-KNO-01		WP5-SE-GEO-7	IT-INN.	March	
		UC-ENV4-fun-08-V01		WP5-SE-FUSION-4	IT-INN.	March	
				WEB SERVICE MODEL	SINTEF	October	
Predicts effects of hazard	UC-ENV3.10-PRE-02-V02	UC-ENV4-fun-08-V01		WP5-SE-FUSION-4		March	

Objective	UC ID	WP4 UC	Description of the function or requirement	Applicable enabler (D5.2.1)	Responsible	Period	Status
				WEB SERVICE MODEL	SINTEF	October	
Alert and Notification Functionality							
User defines alarms thresholds for parameters	UC-ENV3.8-NOT-01-V02			WP5-SE-NOT-1	ATOS	March	Started
User defines level of alarm	UC-ENV3.8-NOT-02-V02			WP5-SE-NOT-1	ATOS	March	Started
User adds list of responders	UC-ENV3.8-NOT-03-V02			TBD?	ATOS	March	Started
User defines methods of notification	UC-ENV3.8-NOT-04-V02			WP5-SE-NOT-1	ATOS	March	Started
System notifies relevant personnel				WP5-SE-NOT-1	ATOS	March	Started
Responder Acknowledges Notification				TDB?	ATOS	March	Started
Generic Enablers							
User Registration	UC-ENV3.1-ATH-01-V02			FI-WARE?			

Objective	UC ID	WP4 UC	Description of the function or requirement	Applicable enabler (D5.2.1)	Responsible	Period	Status
Authenticate User	UC-ENV3.1-ATH-02-V02			FI-WARE?			
Upload Data from External Sources	UC-ENV3.2ADM-01-V02			FI-WARE?			
Edit data and information	UC-ENV3.2-ADM-02-V02			FI-WARE?			
Data Discovery Services	UC-ENV3.2-ADM-03-V02			FI-WARE?			
Download Data	UC-ENV3.2-ADM-04-V02			FI-WARE?			
Define spatial area of interest via user interface	UC-ENV3.2-VIS-01-V02			FI-WARE?			
Define Time Period	UC-ENV3.3-VIS-02-V02			FI-WARE?			
Retrieve and Display Data	UC-ENV3.3-VIS-03-V02			FI-WARE?			
Display Data in Tabular Format	UC-ENV3.3-VIS-03.01-V02			FI-WARE?			
Display Data in Graphical Format	UC-ENV3.3-VIS-03.02-V02			FI-WARE?			

Objective	UC ID	WP4 UC	Description of the function or requirement	Applicable enabler (D5.2.1)	Responsible	Period	Status
Define spatial area of interest	UC-ENV3.5-GEO-01-V02			FI-WARE?			
Geospatial Data Services Integration	UC-ENV3.5-GEO-02-V02			FI-WARE?			
Predict modelling of environmental patterns in data with uncertainty estimation	UC-ENV3.10-WEBS-02V01			FI-WARE?			
Bandwidth on Demand BoD	UC-ENV3.7-FNF-01-V02						
Advanced QoS Mechanisms	UC-ENV3.7-FNF-02-V02						
Network as a Service	UC-ENV3.7-FNF-03-V02						
Mobile User Data Download	EC-ENV3.9-MOB-01-V02			FI-WARE			
Uploads of data from a mobile device to central repository	UC-ENV3.9-MOB-02-V02			FI-WARE			
Other Tasks							
GUI Design and Mockup of Portal	Design a the portal web page		Provide a idea of the MI requirements for a portal		Intune/MI	July	Started

Objective	UC ID	WP4 UC	Description of the function or requirement	Applicable enabler (D5.2.1)	Responsible	Period	Status
Detailed functional specification with particular attention to data			Describe each of the functional requirements of the Marine Asset Management use case by using the existing MI data sources		Intune/MI	June	
Development of test cases					Intune/MI	October	Started
Collate and Catalogue the final set of data to be used			Much of the data is already hosted by the M.I.		Intune/MI	June	Started
Gap Analysis of Data for MAST Portal			Indentify gaps in data requirements and source data.		Intune/MI	July	Started
Finalize data requirements for Oil Spill model			Get requirements from SINTEF		Intune/MI/SINTEF	July	Started
Pilot A - Stage 1							
First release	First release of portal		Includes IT-INNOVATION enablers			October	
Final Release	Final release of stage 1 of portal		Includes IT-INNOVATION enablers			October	
	First Versions of Software Documentation					October	

Objective	UC ID	WP4 UC	Description of the function or requirement	Applicable enabler (D5.2.1)	Responsible	Period	Status
Pilot A - Stage 2							
First release	First release of second stage		Includes SINTEF and ATOS enablers			October	
Final release	Final release of final stage					March	
	Final Versions of Software Documentation					March	

Table 6. The planning table for the work package 3 pilot

7 Pilot Validation Planning

MAST pilot will undergo several stages of testing, typical of information technology project. These can be broken down into the following:

- Unit Testing
- Functional Testing
- End User Testing
- Regression Testing

Plans for testing the MAST will be developed for each of these stages. Test driven software development will be employed which will ensure a high degree of accuracy in terms of the functionality meeting the desired objectives. Each function will be built with a test to ensure its compliancy.

End user and regression testing will occur as each block of functionality is developed (e.g. a web widget or a specific enabler), this is preferable to waiting until the end of development to test the application in one block.

Test plans will be created for use case testing; as these tests are applied we expect further refinement of the WP3 use cases. The testing of use cases will be an ongoing process and will be linked with progress in software development.

A planning schedule will be produced once development starts and it will be revised at each of project milestones, or sooner in needed.

7.1 Demonstration Scenario

It is proposed that the operational ENVIROFI WP3 MAST system will be deployed in the SmartBay National Test and Demonstration Facility for Marine and ICT on the west coast of Ireland. SmartBay will be used to trial the key functionality of the MAST system, enabling beta testing. In its capacity as a national centre for marine ICT research and enterprise development, SmartBay will also socialise the platform with the European research and enterprise community. The data that is published using semantic web technologies in MAST can be easily compared to the existing data streams published by more conventional means by the Marine Institute. The marine hazard prediction model will also be demonstrated using Galway bay. The results from the model will be compared to the results of oils spill models that are used by the Marine Institute. Future internet functionality will be demonstrated via the Marine Institute’s connection to the Ireland’s national education and research backbone.

One of the key issues facing WP3 pilot implementation is that the Ocean Energy Sector is still at an early stage of development and no commercial wave farms are currently deployed. SmartBay has a range of deployed infrastructure assets generating in situ real time data that will be used to simulate a virtual wave farm array. The SmartBay facility is also co-located with a national ¼ scale test site for wave energy convertors. It is anticipated that ocean energy devices will be re-deployed at the site before the end of phase 1 of ENVIROFI and could be incorporated into the pilot testing for ENVIROFI subject to agreement.

Following initial demonstrations the WP3 partners will explore the integration of data from other ocean energy test facilities around Europe. This will be achieved through collaboration with large scale initiatives such as the MARINET programme. The ¼ scale test wave energy conversion test site is also part of the MARINET programme. Co-ordinated by the HMRC as part of the Irish Maritime and Energy Resource Cluster, MARINET is a new EC-funded initiative which aims to accelerate the development of marine renewable energy (wave, tidal & offshore-wind) by bringing together world-class testing facilities at all scales to offer periods of free access, coordinated research to enhance testing capabilities, common standards, industry networking and training courses in testing techniques. With costs covered by the EC, MARINET offers free access opportunities it offers to companies, research groups etc across 42 test facilities. The next call for access to facilities and data will open in July 2012 for access between January-July 2013 would provide the ENVIROFI WP3 partners the opportunity to explore challenges of scaling the MAST system to incorporate data feeds from multiple sites across Europe under phase II of the FI-PPP programme.

In addition to existing collaborative links across Europe via the MARINET network and other research and policy initiatives, the Marine Institute (in close collaboration with the Irish NREN HEAnet) will explore the possibility to utilise the GÉANT pan-European data network dedicated to the research and education community for high speed network access and data backhaul. Together with Europe's national research networks, GÉANT connects 40 million users in over 8,000 institutions across 40 countries. The key challenge will be to understand if and where the GÉANT network topology maps to that of the test facilities in programmes such as MARINET and what resourcing requirements would be required to enable access at a European scale.

The overriding aim of the project is to make Marine observations available in a standard way to wider European software development community which could potentially lead to a dramatic increase in the transport of Marine observations over the Internet and drive the development of new technology enabled services and business opportunities for the European Marine and ICT Sectors.

8 Activity and Sequence diagrams

The following section includes activity and sequence diagrams which demonstrate the flow work in the system as the web portal gets created.

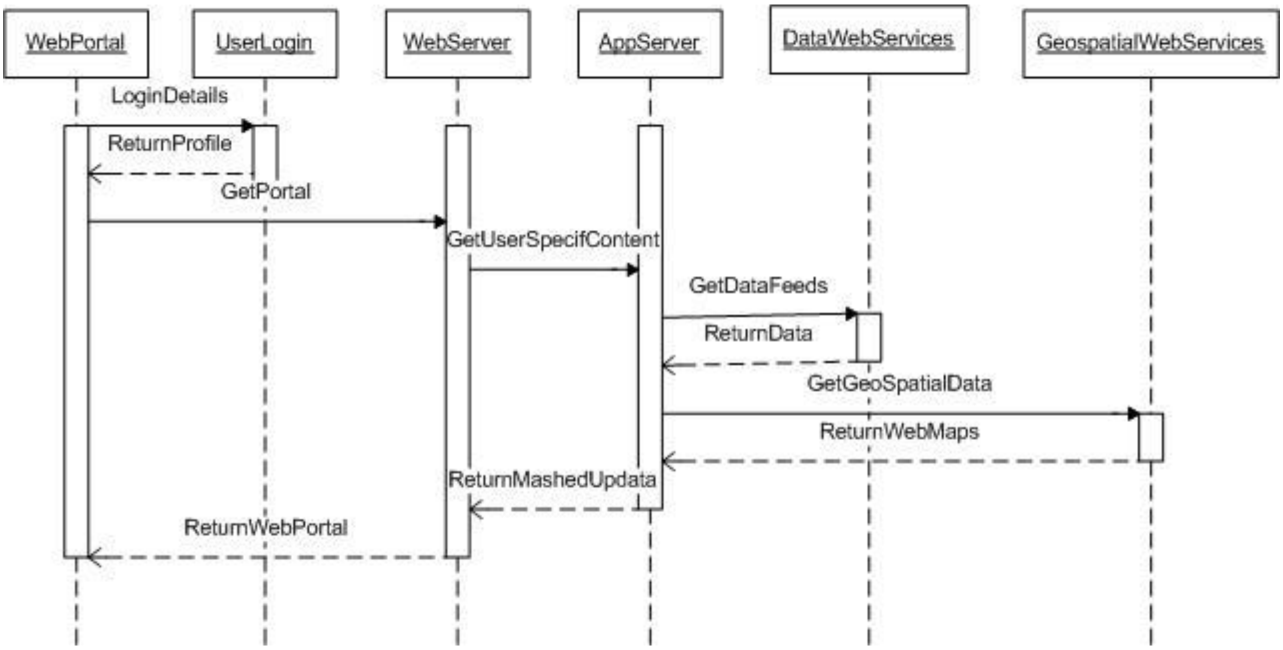

Figure 5. A sequence diagram of the creating of an instance of the web portal

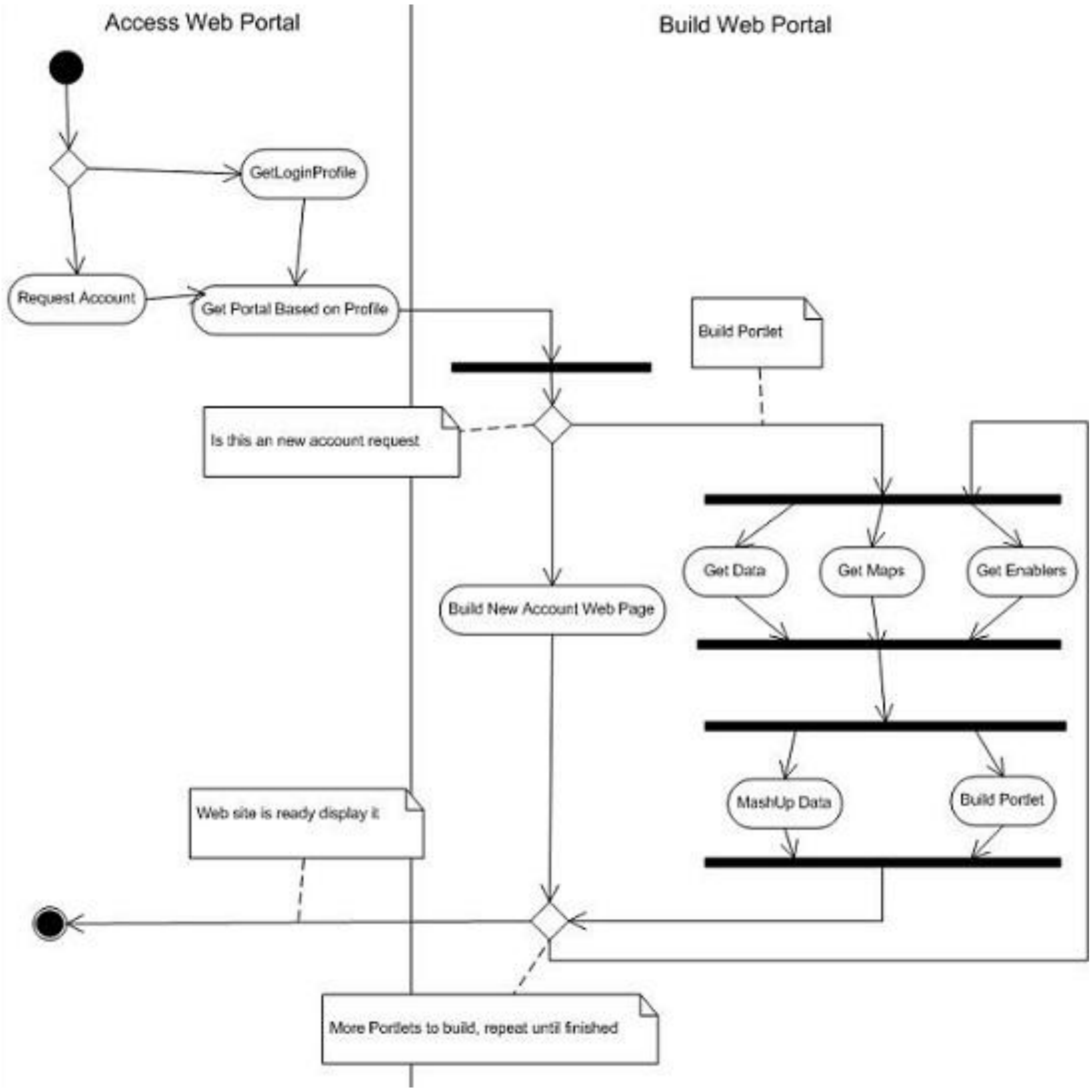

Figure 6. An activity diagram of the build portal process

9 Risk Management

The Boston Square Matrix is often used in risk assessment to visualise the combination of severity and probability of identified risks. It can help the project manager to identify acceptable risks and unacceptable risks.

Risks are identified and considered according to their likelihood of occurrence and anticipated impact severity.

Identified Risk	Description
Key partner drops out	Project partner decides to leave project during development
Non co-operation between project partners	Breakdown in communication between one or more project partners
Lack of useable data	Data acquired is substandard or not available
Issues with data formats	Data format is not in line with project requirements
Issue with infrastructure	Suitable/necessary infrastructure is not available
Issue with software	Misunderstanding between partners on desired software outcomes/functionality requirements.

Table 7. ENVIROFI identified risks

The Boston Square Matrix is constructed by creating a matrix that has the likelihood of risks related to the project listed on the horizontal axis and the severity of the risks listed on the vertical axis. Each of the elements of the matrix are coloured based on the risk classification. Finally the identified risks are analysed and placed on the matrix.

Category	Meaning
1 Very Unlikely	Very Unlikely
2 Somewhat	Unlikely
3 50/50	Chance
4 Highly	Likely
5 Nearly Certain	Nearly Certain

Table 8. The Values for each of the risk likelihood categories

Category	Meaning
1 Minor	Minor impact on cost, schedule, performance, etc
2 Moderate	Moderate impact on cost, schedule, performance, etc
3 Significant	Significant impact on project baselines
4 Very	Very significant impact on project baselines
5 Disastrous	Disastrous impact, probable project failure

Table 9. Risks to realisation of pilot

Category	Criteria
Unacceptable	A risk in this category is unacceptable and this element of the project will not proceed.
Tolerable	This risk is tolerable when mitigation is incorporated i.e. some action is being taken to minimise risk.
Broadly Acceptable	This risk is broadly acceptable. Its impact and likelihood of occurrence are minimal and have little impact on the projects outcome.

Table 10. Risk classification criteria

9.1 Matrix Outcomes

Identified risks were set out in matrix after their likelihood of occurrence and their impact severity were assessed. None of the identified risks have fallen into the 'unacceptable' class on the grid. All risks were deemed to be either tolerable or broadly acceptable. This is a positive outcome with some scope for incorporating mitigation measures. While mitigation is not required for risks categorised as broadly acceptable they have been included for illustrative purposes.

		Likelihood				
Severity		1 Very	2 Somewhat	3 50/50	4 Highly	5 Nearly Certain
	5 Disastrous					
	4 Very significant		Key partner drops out.			
	3 Significant	Non co-operation between project partners		Lack of useable data		
	2 Moderate		Issues with infrastructure.			
	1 Minor	Issues with data formats.	Issues with software.			

Table 11. Risk classification criteria (Severity / Likelihood)

9.2 Risk Analysis Outcome

Based on the analysis of identified risks (Table 6) this project is LOW RISK with only one risk rated as having a 50/50 probability of occurring.

The mitigation options outlined in Table 7 have been implemented/could be implemented rapidly should the likelihood of an identified risk to the project increasing.

Risk	Mitigation
Key partner drops out	Contracts in place, ensure all team members are content.
Non co-operation between project partners	Ensure all parties agree on project aims and objectives before work begins and review on a regular basis.
Lack of useable data	Contact a variety of data sources and ensure diverse and varied information is available to choose from.
Issue with data formats	Consider variations in data sources and plan for conversion/format change
Issue with infrastructure	Research available technology before including in project plan
Issue with software	Research available software before including in project plan

Table 12. Risk Mitigation

10 Features and Functionalities

In this section we revise the Features and Functionalities section of the previous deliverable [01] by considering that section with respect to the proposed pilot. We then list priority use case and the specific enablers that have been identified for the pilot scenarios.

10.1 ADM: Administration and Authentication

Casual users will not have to login to the MAST web portal. However serious users will be required to create a user profile and login. This functionality will 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

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.

Relevant Use Cases

- Register User UC-ENV3.1-ATH-01-V02: User visits ENVIROFI Platform and begins registration process. User creates a unique profile with login details, 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

The Administration and Authentication functionally is a common requirement across all projects in ENVIROFI and is something that should be provided as a generic enabler from FI-WARE.

10.2 VIS: Data Visualisation

Data exploration and visualisation is a critical requirement of MAST. It will be possible to view data as time series graphs or in tabular format. It will also possible to view data in geospatial formats (see GEO section later in document).

Relevant Use Cases

- Retrieve and Display Data Sets UC-ENV3.3-VIS-03-V02: Then system users require a mechanism to respond very quickly to data searches, requests for lists of datasets, and requests for information about a dataset.
- 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.

10.3 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) [05] - 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 broker between the user and various remote data servers. When a user 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 the requester.
- 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.
- Standardises the dates and 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 ENVIROFI middleware (via specific enablers) for harvesting data from ERDAAP will facilitate easier publication of Semantic Web Enhanced Data giving users and app developers more control and flexibility on how scientific data is exploited.

A 'mashup' is an innovative composition of content (often from unrelated data sources), made for human (rather than computerized) consumption. This combination of data modelling 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 mash up 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) [06].

Relevant Use Cases

- Create data Mash up UC-ENV3.4-INT-01-V02: 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.

10.4 GEO: Geo-Spatial datasets

Geospatial data infrastructure and functionality will be a key component of the proposed pilot. There will a collection of data and enabling web services to support timely access to data and information which are critical to the sustainable development, management and control of marine and coastal offshore areas.

Relevant Use Cases

- 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 information 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.

10.5 WEB: Web Service Integration

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.

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.

10.5.1 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.

10.5.2 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”.

10.5.3 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 geo-location 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.

10.5.4 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.

10.5.5 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.

Relevant Use Cases

- Web enabled integrated information and new knowledge services UC-ENV3.6-WEB-01-V02: To generate data fusion OGC web services for geo-spatial and temporal data sets.
- Pre-process of heterogeneous data sensors UC-ENV3.6-WEB-02-V02: The pre-processing of data is to inspect and format raw data and present data into an SOS.
- 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 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 client's 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).

10.6 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/organisations 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 [07]. These use case highlight some of the common functionality requirements in designing such a system.

Relevant Use Cases

- 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 potential 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.

10.7 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. It is also anticipated that some functionality will be repurposed to make it more useable on mobile devices.

Relevant Use Cases

- 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.

10.8 PRE: Predictive modelling

Predictive modelling is a component of the MAST pilot. Predictive modelling of marine hazards will be served to pilot web service. Formatting and display of data from the predicative model web service will be done by specific enablers that address visualisation of data, integration of heterogeneous datasets, geo-spatial datasets and web service integration.

Relevant Use Cases

- Predict marine hazard movement UC-ENV3.10-PRE-01-V02: Use case summary: 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: Use case summary: predict the most likely effects (environmental, ecological and economical) of the Marine Hazard - The user will predict the effects by running an extended simulation of the marine hazard.

10.9 Involved Information Resources and Desired Representations

A key concept of the marine work Package of ENVIROFI is that the data needed to address the requirements of our use cases to a large extent already exist and given the evolving technology roadmaps for the marine sector is likely to significantly increase in volume over the coming years. Some data is already being published on the Internet, but not in a format that can be easily used by App developers, while other data exists on servers but is unpublished. It is our intention to take existing data sources and republish it as web services that can be consumed by the various web widgets in the web portal.

A portal that presents application functionality to users is the front piece of a server configuration that includes some connectivity to the application server. This embraces existing metaphors of n-tier decision support systems except that the architecture here is a Service Orientated Architecture (SOA) and the deployment platform is the Internet. The application server performs the actual functions of the application (Figure 7).

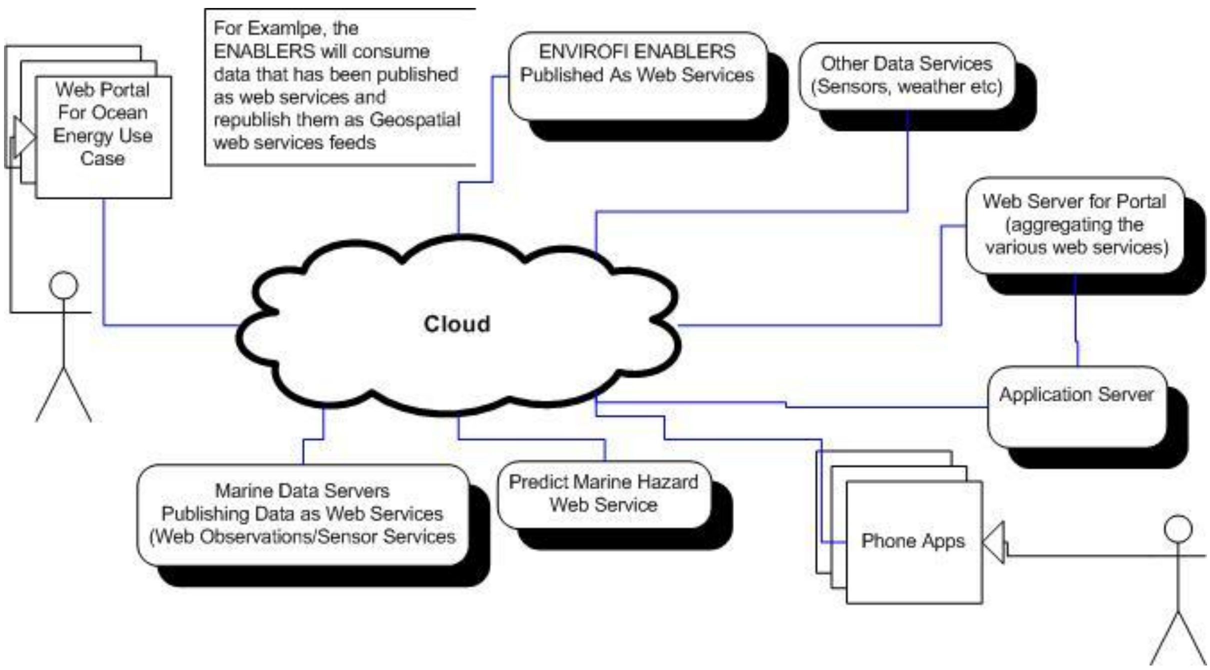

Figure 7. Conceptual architecture of the proposed web portal. Data feeds and functionality served as web services

The potential of the semantic enhanced data will be demonstrated by means of prototype phone App, probably based on the significant wave height forecast functionality on the portal.

10.10 Graphical User Interface (GUI)

To address the functional requirements of the Ocean Energy Asset Management use case and to demonstrate the functionality of Marine Hazard Movement use case we propose to build a decision support system (DSS) that collects the functionality into one place. A DSS is interactive software based system that compiles useful data and presents it as information that helps decision makers. The type of

DSS proposed here is a passive one. A passive DSS aids process of decision making but cannot explicitly make or evaluate a decision. Deployment of the DSS will be on the Internet as a web portal.

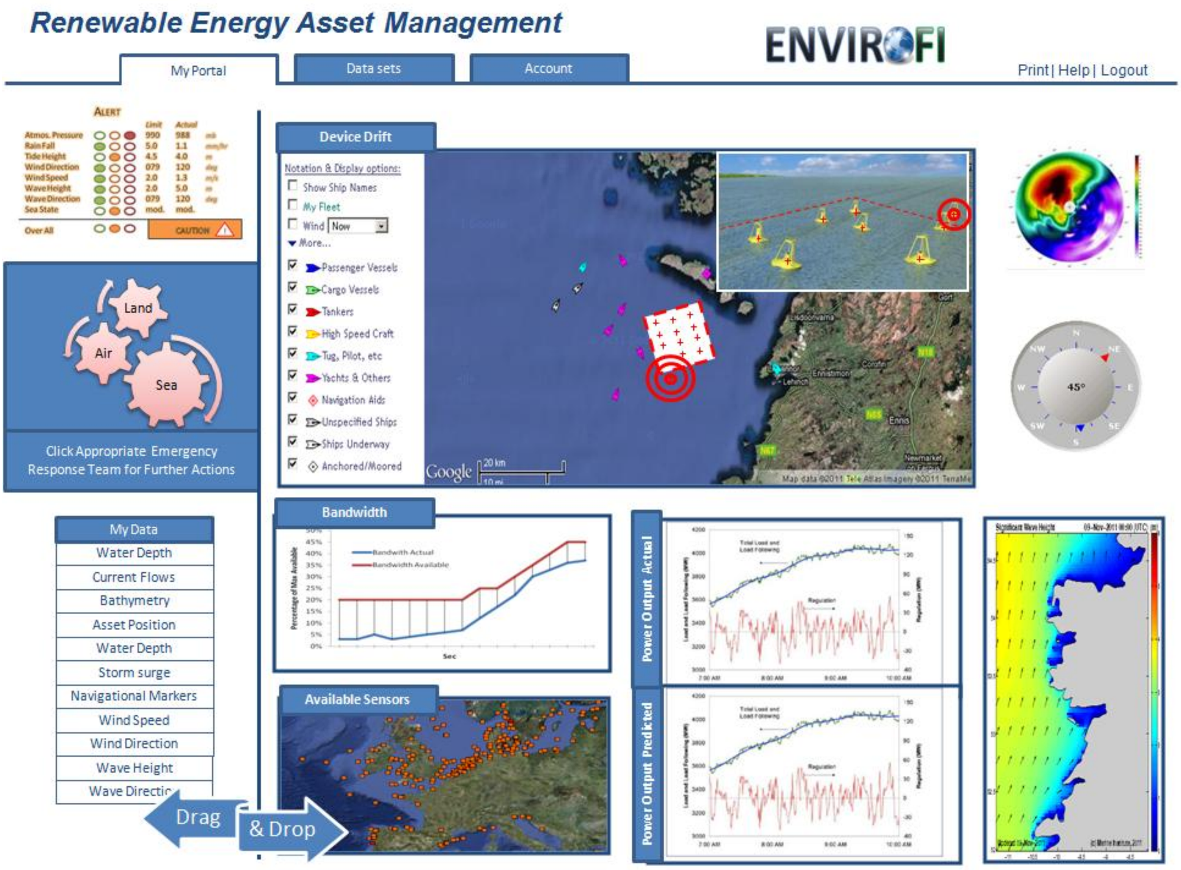

Figure 8. A mock up of the proposed web portal, with each of the information/data streams published as widgets within the portal

The MAST portal will contain web links and web widgets (Table 12) that share a common theme, that it the management of ocean energy assets in the marine environment. The site is made up of a number of widgets that are simply small chunks of code that publish data/functionality from an application server or web services. Each of the widget will have the normal functionalities associated with a web page. Users will be able to close, resize, move or add a widget.

The will also be a "mobile" edition of editing of the portal. This will be targeted at smart phones and will contain focused functionality, for example core functions may be republished as a mobile phone app.

Each of the widgets of the portal is described in the next sections. Required functionality that is not described is security, profile management and online (cloud) storage which at the moment we are assuming will be provided by FI-WARE

10.10.1 Notification Widget

Figure 9. A mock up of the Alert and Notification widget of the portal.

This widget (Figure 9)will contain a table of alerts for parameter being monitored, such as site drift atmospheric pressure, tide height, wind direction, wave height and wave direction. The widget will be a dashboard to the notification web services being developed by ATOS. There will be two roles for this widget, an administrator role and a normal user role.

Administrator Role:

- The user selects the parameters to be monitored.
- Setup the threshold criteria for raising the alert and the corresponding type of alert being raised
- Setup the monitoring frequency
- Add a list of actors to be notified when an alert is raised
- Setup the methods of notification for each of the actors

Normal User Role

- The normal user can view the alert status dashboard (see Figure 9). In some situations the normal user may trigger a notification event based on an alert status.

The data for this widget will come from:

- Local weather sensor
- Official weather forecast (weather warnings)
- Sensor drift, from Marine Institute sensor drift alert system
- Significant wave height from Marine Institute wave forecast

10.10.2 Region of Interest Widget

Figure 10. A mock up of region of interest widget of the portal. The video widget is included in the top right hand corner

This widget presents the geospatial information of the region of interest. It will be a mash-up various different sources of geospatial data. The core mapping functionality will come from a standard mapping service. Other geospatial data will exit as layers on the map. The default information in the widget will be:

- A base map of the area around the renewable energy farm
- Ship and other marine traffic passing near the renewable energy farm will be tracked using Automatic Identification System
- Forecasted tidal flow around the renewable energy site
- Marine Hazard Movement Prediction
- Site assets
- Other marine hazards
- Bathymetry and shipping navigation information (i.e. admiralty chart style data)

This widget will have two states that will be activated by tabs. The first state will be the current conditions the second state will be the forecasted conditions. In addition the user will be able to see historical data i.e. ship tracks.

The data for this widget will come from:

- Marine Institute existing resources.
- AIS data servers
- Other published sensors

10.10.3 Wave Forecast

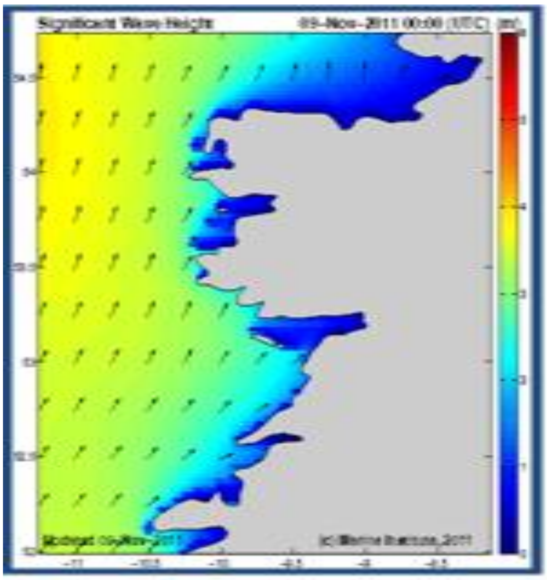

Figure 11. A sceen grab of the Marine Instiute wave forecast

Primarily this widget will display a web map of the forecast of significant wave height. This information is used to determine windows of access to the offshore energy site. Work boats can only access such a site if the sea conditions are within certain parameters i.e. the work boat cannot operate if wave height is greater than that for which it is rated. The widget will contain the following information:

- A zoom-able map of the significant wave height forecast animation
- A selection of layers that can be switch on containing other relevant data such as wind speed, wind direction, tide and current flow

The will also be functionality that allows the user to set wave height rating thresholds.

The data for this widget will come from:

- The main source of data will be from the Marine Institute wave forecast. Currently this is published as an animation
- Other data will come from same sources as is used in the other widgets

10.10.4 Power Output Widget

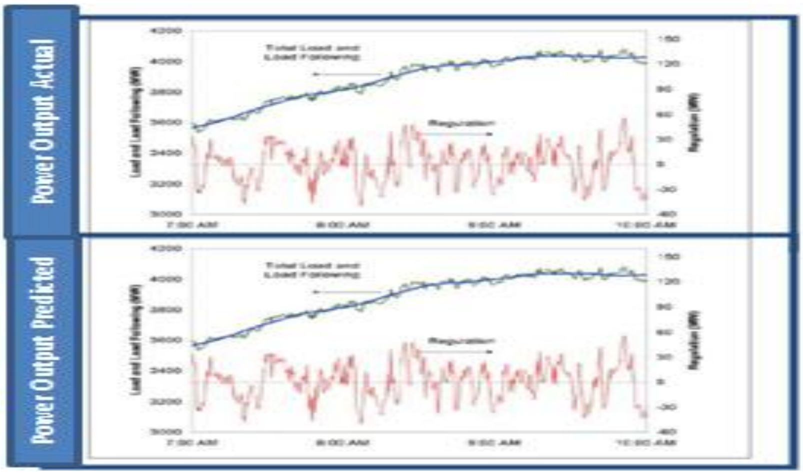

Figure 12. Trend graphs of current and forecasted power output

In order to ensure that renewable energy farm is operating efficiently it is important that the user can monitor its power output. An additional important function is it to be able to forecast energy production, based on forecasts of sea state. In order to meet these requirements the widget will have dual functionality:

- It will display time series data of the power being produced by the renewable energy devices
- It will display forecasted power output based on the characteristics of the renewable energy devices

At the present there are no functioning wave energy devices; calculations for this widget will be performed by a virtual wave energy device algorithm.

The data for this widget will come from:

- Wave forecasts from the Marine Institute
- A wave energy model, which may be hosted as web service elsewhere

10.10.5 Available Sensors

Figure 13. Representation of the map layer with a collection of other sensors

This widget will display web mapping services of additional sensors. The sensors may not be in the area of interest or are may not be directly related to the domain of interest, but could still provide useful information to the user. For example:

- Special Interest Groups that aggregate data publish it as a web mapping service
- Private Companies that collate and publish sensor data as geographic point sources on a web map of the Earth
- Public Bodies that publish public sensor data in web map, for example the marine buoys of the Irish Marine Institute

The data for this widget will come from numerous yet to be finalised resources such as:

- Irish Weather Network (http://www.irelandsweather.com/)
- Pachube (www.pachube.com)
- Marine buoy network

Summary information about the data points should be available when mouse hovers over the observation point. Clicking on the observation point will open the web site for that point.

10.10.6 Radar Widget

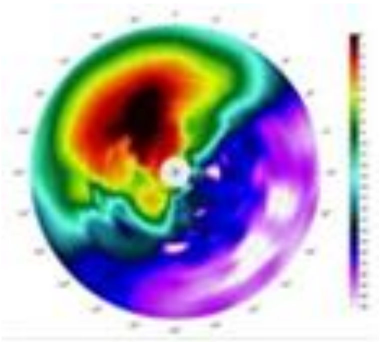

Figure 14. Radar widget concept

This widget display live radar data coming from marine radar based in Galway Bay.

- It will display a base map of the bay, a layer containing the radar output will be displayed on top of this
- The use will be able to switch on predefined layers, such as AIS

The data for this widget will come from a radar station based in Galway bay. This data is collected on a server details of which have yet to be determined.

10.10.7 Meteorology Widget

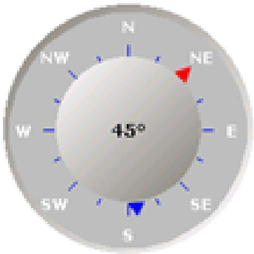

Figure 15. Weather senor concept

This widget will display forecasted current weather conditions. There are many weather widgets already available and we propose to use an existing one.

- Widget displaying the weather forecast for the region
- A widget display live weather conditions
- Rainfall radar should also be displayed

10.10.8 Network Quality

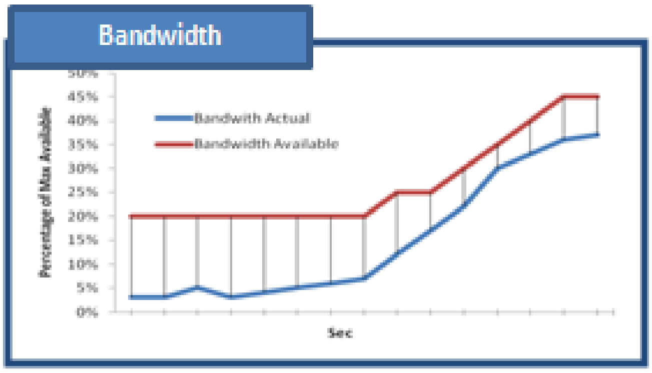

Figure 16. Trend graph of network bandwidth usage

To have confidence in the Internet platform as a provider mission critical decision support the user needs to be assured that Internet connection is reliable.

The widget will supply details of bandwidth and quality of service. The source of the data for the widget has yet to be determined.

10.10.9 Oil Spill Model Widget

The outputs from the oil spill model will either be displayed in its own widget or as a layer in the Region of Interest widget. The user will be able to click on map to select a location where an oil spill occurs and to trigger and oil spill model run. The output from the oils spill model will be display as an animation in the widget.

The data for this widget will come from:

- The SINTEF oil spill model web service
- The Marine Institute for inputs into the oil spill model (water currents etc.)

10.10.10 Video Feeds (in separate box)

A video feed of the wave energy site will be relayed via widget.

11 Non-functional Considerations

In the following section we consider some functional considerations.

11.1 Data Persistence

The issue of retention of personal data of users is dealt with in a later section, this section is about the storage of environmental and system data. Most of the data for the MAST prototype will be hosted by the Marine Institute. Much of this data will have originated from the Marine Institute's archives. The Marine Institute is the de facto national oceanographic data centre for Ireland, and as such it will continue to host semantic enhanced marine data after the cessation of the ENVIROFI project. It is also expected the much of the new functionality developed during the ENVIROFI project will continue to be used by the Marine Institute after the project ends.

11.2 Quality of Network Service

The high quality of network service is important if mission critical decision support systems are to be deployed on the internet. This is an issue that is being addressed in the pilot scenario through 3^{rd} sub pilot.

The statistics of the existing network connections will be collected and analysed to test the hypothesis that existing network infrastructure is not suitable for the deployment of mission critical decision support systems. Data on speed, capacity, reliability and timing will be collected.

11.3 Common Actors and Roles

The common actors of the Marine Asset Management Support Tool are listed by Users, Data Providers and Interest Organisations.

11.3.1 Users

A fresh set of actors were defined (Table 13) as part of the development process of the use cases for the pilot scenario. These new actors targeted the pilot scenario use case.

Actor Name	Requirements / Wants	Generic Actor
Ocean Energy Manager	What is the current state of the farm? Is the farm orientated optimally? What is the forecasted power output? Are there alerts? Do I need to make any alerts? I want to update information on the system I want to add in a new data source	User Administrator
Ocean Energy Worker	What is the current state of the farm? Is the farm orientated optimally? What is the forecasted power output? Are there alerts? Do I need to make any alerts? I want to update information on the system I want to add in a new data source	User Administrator
Regulatory Body (Environmental/Marine)	What is the status of the farm? Will there be conflict between the farm and some future event? How are environmental conditions around the farm? Are farm operations infringing on other marine users?	User
Citizen	Is my environment affected by the farm Are there marine use restrictions as a result of the farm that concern me? Are there alerts that I need to be aware of?	User

Table 13. Specific actors for the marine use, including the equivalent generic actors

11.3.2 Data Providers

WP3 leverages a large body of data assets. As WP3 leader and a public agency, the Irish Marine Institute is eager to support the realisation of additional socioeconomic value from these data assets by making them available to the ENVIROFI consortium and by extension the broader FI-PPP community. The trial of the MAST system via the SmartBay test and demonstration facility will enable the beta test and further refinement of the system and associated service offering to a broad community of users in the ocean energy research and enterprise sector in association with other partners such as the Irish Maritime and Energy Cluster and MARINET consortium. Key data assets for WP3 Ocean Energy scenario include:

- The Marine Institute
    - Wave Rider buoys deployed at sea.

- Meteorological buoys deployed at sea.
- Ocean model data.
- Meteorological data
- Sensor data (tide/water quality etc.)

* Galway Harbour Master/Commissioner Of Irish Lights/Irish Coast Guard
  - Automatic Identification System for Ships

* EUMETSAT
  - Satellite Data

WP3 also intends to collect information on the equivalent list of data providers would be an EU wide level.

11.3.3 Interest Organisations

The interest organisations are entities that may have an interest in some of the ENVIROFI outputs from WP3. Listed here are those groups and what they may have an interest in:

Irish Government Departments

Department of Communications, Energy and Natural Resources

- Monitoring the output of devices to inform placement of future developments
- Establishing capability of communication technologies
- Monitoring sea conditions and water quality and meteorological data
- Compiling and expanding marine statistics through monitoring – wildlife no's, average sea conditions etc.

Department of Environment, Community and Local Government

- Ensuring interests of local groups and residents are considered.
- Monitoring environmental impacts of offshore marine installation.

Ocean Technology Developers

- Information on sea conditions and meteorological data to allow developers to plan operation and maintenance activities during appropriate weather windows.
- GPS information. If a device breaks its mooring the developer will know as positioning information is relayed back online allowing the developer to react minimising risk of device damage.

- Navigation/positioning information to ensure device(s) are not in high collision risk areas i.e. shipping lanes etc.
- Monitor generation from device to provide insight into actual potential at farm location and possible inform decisions on site in future.
- Getting fault alerts.

Coast Guard/Naval Service/Port Managers

- Navigation/positioning information.
- Information on sea conditions and meteorological data.

Local fisherman

- Getting up to date, accurate information on sea conditions.
- Forecasting sea conditions and meteorological data for planning activities during appropriate weather windows.

Aquaculture

- Getting up to date, accurate information on sea conditions.
- Forecasting sea conditions and meteorological data for planning activities during appropriate weather windows.
- Monitoring water quality for optimum output.

Recreational Users- Divers, surfers, community organisations, swimmers

- Sea conditions and meteorological data to allow them to plan their sea use according to forecast to make sure conditions are at their optimum i.e. a surfer wants above average wave height, little wind and preferably a dry day – this information will be available through the project.

11.4 Mapping of Users to Common Roles

Analysis of the pilot scenarios use cases 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. These actors are collected in Table 14 and mapped to user categories and generic actors.

There are potential business models which could be exploited relating to these different levels of requirements and interaction and these are also included in the table.

User Category	Ocean Energy Asset Management System Pilot	Marine Hazard Prediction Web Service Pilot	Business Model Category*	Generic Actors
System administrators	Ocean Energy Manager	Oil spill response team Manager	3	User Administrator
Decision makers with Domain Expertise	Ocean Energy Manager Ocean Energy Worker Electric Grid operator Regulatory Body	Oil spill response Manager, Shipping Company Manger, Oil Company Marine Experts	3	User Administrator
Responders and Field personnel	Ocean Energy Field technicians Whale Dolphin Interest Groups Harbour Authorities Coast Guard Aquaculture farm operators Commercial Fishermen Scientists	Coast Guard Civil authorities Military Authorities	2	User
Non-critical marine stakeholders	Leisure Fishermen Water Sports Enthusiast	Harbour Authorities Whale Dolphin Interest Groups Wildlife protection groups	2	User
General Interest users	General Public	General Public	1	User

Table 14. Common roles, marine actors and business model category

* We have categorised the list of potential marine users of the ENVIROFI system in terms of the pilot scenario 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: 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
ATH: User Administration and Authentication	Low
ADM: Data Administration & Storage	Low
VIS: Data Visualisation	Medium
INT: Integration of heterogeneous datasets	High
GEO: Geo Spatial datasets	Medium
WEB: Web Service Integration	High
FNF: Future Network Functionality	Medium
NOT: Alert and Notification functionality	Medium
MOB: Mobile user interaction with Platform	Medium
PRE: Predictive modelling	High

Table 15. Summary of the functionalities of highest value to marine stakeholders

11.5 Business Models[1]

11.5.1 Current Market

The map shows sites of ocean energy production which have a clear concentration in European waters. The Europe marine market is constantly expanding (Figure 9). Each site highlighted on the map requires support tools to facilitate successful marine deployment. These 'support tools' include data, resource records and an asset management systems.

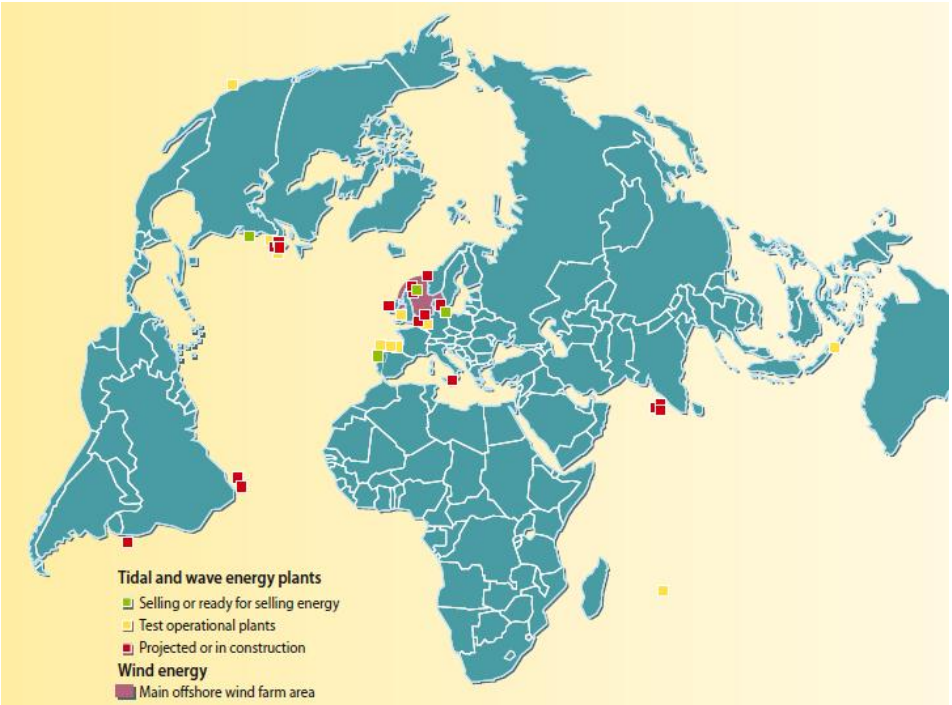

Figure 17. Map of Global Ocean Energy Production.

The current market offers limited services in the OE sector; the majority of the technologies are not yet commercial. Developers need an easily accessible, reliable solution to support their activities. ICT companies are beginning to recognise the enormous market potential for marine asset management systems and are exploring the translation of their current technologies to the Marine ICT sector.

The 'on demand' nature of the Marine Asset decision Support Tool (MAST) lends itself to a number of applications including data services, smart phone applications, notification services, and marine asset management.

11.5.2 Data Services

Data would be based on severe weather warnings, changes in sea conditions and structural failures among others and would enable the developer/manager to take action in good time. This service will allow an OE developer/manager to subscribe to weather and sea condition updates online. They use

[1] Project Business Models and exploitation strategy are described in D7.1.x Exploitation Plan deliverables

this information to design an operations and maintenance plan to service their device based on sea conditions predicted through analysis of the data stream. Users would subscribe to this service and pay an annual fee to receive information.

11.5.3 Smart Phone Applications

It is envisaged that the data collated through ENVIROFI will be used to develop apps for Smart phones. A range of apps have been suggested for use across a variety of sectors including ocean energy, tourism & leisure and navigation. An app based on significant wave height would be useful to each of these sectors. A surfer could use this information to inform their decision when and where to go surfing based on the information supplied through the app. This app would generate income through a one off fee for download. Further development such as historic data and future predications could be included based on user needs.

11.5.4 Notification Service

An important expansion of the data subscription service could be specialised notifications/ alerts. The early discovery of faults is imperative for the survival of OE devices which are often deployed in volatile conditions at sea. When changes are detected by the MAST system sensors a notification is sent via text to the subscriber. Images may also be included to provide more detailed information regarding the fault. This in turn would allow user to put in place a plan based on the severity of the fault and its impact on the device. Again this would be a subscription service with a variable fee linked to the data requirement of the user, the requested frequency of notifications and no. of devices.

11.5.5 Marine Asset Management

The MAST system supported and developed through ENVIROFI will allow remote management of marine assets by users. The combination of data services, subscriptions, apps and alerts will allow a user in Dublin to shutdown a device in Galway if a severe change in sea conditions is predicted to protect the device. The significant wave height app would then allow the user to monitor the situation and power up the device once conditions are favourable. This integrated management system will support the commercialisation of OE devices by reducing the risks associated with the 'deploy and monitor' approach supported by the industry. This system can be applied to a variety of marine assets including buoys, offshore structures, and navigation systems. Income would be generated through licensing the system to users for a fixed term.

11.6 IPR and Privacy[2]

11.6.1 WP3 and Privacy

WP3 will be developing a web portal and a mobile phone application that will demonstrate how future internet technologies can be used to provide information technology solutions to marine asset management.

In Ireland 'Personal data' on computers is are subject the Irish Data Protection act 1988, which was updated in 2003 to fully implement the EU Data Protection Directive 95/46. Any dataset that contain information about individual must be registered with the Data Protection Register. The act of collection of personal data triggers a legal set of obligations on the collector of the data.

It is not the intention ofWP3 to collect personal information on users. However the desire to provide tailored services to individual users via a login and user account may necessitate the need to some collect user information. If this turns out to be the case WP3 will fully comply with the Irish Data Protection act.

11.6.2 WP3 and IPR

The Ocean Energy Asset Management use case depends on the successful semantic web enrichment of existing data sets that are published by the Marine Institute. It is a fundamental duty of the Marine Institute to collect, maintain and disseminate information relating to marine matters (Marine Institute Act, 1991). Datasets collected and maintained by the Marine Institute are one of its most important assets. A large proportion of data collected by the Institute are directly related to the provision of core scientific advisory services. The Marine Institute recognises that data sets are a resource in their own right and have potential to be re-processed and re-used for a variety of purposes.

The Marine Institute will not under normal conditions sell the intellectual property rights (IPR) to data. Charges are levied on a cost recovery where costs are incurred to supply data for a specific purpose. The Marine Institute will generally license the data for a particular purpose and either provides the data or access to the data [08].

11.6.3 Data Access with respect to ENVIROFI

It is the intention of WP3 to use Monitoring and Research data that is held by the Marine Institute and that is subject to the Marine Institute's Open Access category (as defined in the Institute's data policy) [08]. The data used will be data that is owned wholly by the Marine Institute or owned collectively by EU/Marine Institute/Other state agencies which has been licensed for distribution. Open access data are subject to the Marine Institute's standard license agreement [08].

Below are sections from the Standard License Agreement for Use of Marine Institute Digital Data that relevant to ENVIROFI WP3.

(Extracts from Standard License Agreement for Use of Marine Institute Digital Data)

<u>3. Ownership and Intellectual Property Warranty</u>

[2] A discussion paper about "Security and Privacy in VGI Applications" was provided in the first iteration of the deliverable as a common Annex to the 3 scenario specifications with more information on this topic

"3.1 All intellectual Property Rights in the Data belong and shall belong to the Licensor and the Licensee acknowledges that it has no ownership claim or rights whatsoever in the Data."

7. Value Added

"7.1 This agreement does not allow the dataset to be sold or form part of any application or development which is intended to be sold. Where data is used in manipulated or value added form, to provide a product for a consultancy or to prepare a tradable commodity for open sale, a royalty may be due to the Marine Institute based on the nature of the product and the number of copies sold. Any such use of the dataset must be discussed in advance with the Marine Institute."

12 Conclusions and Future Work

This report is the second iteration of a document that has summarized the process of the refinement and the selection of those priority use cases suitable to the successful development of the scenario of Ocean Energy Asset Management. This scenario was selected because:

- The cross functionality analysis recognised that this use case contained a lot of functionality that is common to the other marine scenarios.
- There is a genuine need for development of software and data sources that could be used in the management of offshore marine assets, not just in wave power, but also in wind power and aquaculture.
- The ocean energy asset management use case is an excellent starting point for the development of functionality that can be reused in future projects.
- The ocean energy asset management use case also has the best potential for commercial exploitation as it is address the needs of a pioneering industry.

Risk analysis of the priority use cases supports their inclusion as no severe risks were detected as all the use cases fell within acceptable risk levels.

The specific enablers suitable the development of the WP3 pilot has been identified and selected.

Data has been sourced that will serve the initial stages of the development of the portal.

Some activity diagrams have been developed

Business plans for the exploitation of ENVIROFI outcomes have been reviewed.

ENVIROFI partners have been engaged with on a regular through the Internet and face to face meetings.

In the next stage of the project we will be:

- Develop the prototype web portal.
- Source and collate the data needed for the pilots.
- Work with partners to develop the specific enablers.
- Continue to engage with marine stakeholders and feed findings back into project.
- Develop test plans for use case validation
- Start semantic enhancement of existing data feeds.
- Develop test cases for software system.
- Expand on business plans and perform risk analysis of the plans.
- Start development of a mobile phone prototype app.

13 References

	References
[01]	WP3 Use Case Requirements Report Deliverable 3.2.1 (Final version) - V2.3
[02]	WP3 D3.1 Scenario Description and Use Cases Specification v1.0
[03]	Mapping Renewable Energy Pathways towards 2020, EU Roadmap. Available at: http://www.repap2020.eu/fileadmin/user_upload/Roadmaps/EREC-roadmap-V4_final.pdf
[04]	D5.2.1 Specific Enablers for Environmental Domain v1.0
[05]	ERDAP Easier access to scientific data. Available at: http://coastwatch.pfeg.noaa.gov/erddap/index.html
[06]	Chase N. (The ultimate mashup - Web services and the semantic Web (2006). Available at: https://www.ibm.com/developerworks/xml/tutorials/x-ultimashup1/x-ultimashup1-pdf.pdf
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[08]	Marine Institute Data Policy. Available at: http://www.marine.ie/NR/rdonlyres/D1C5614C-2D25-4686-9E56-07558CBCCAF3/0/MIDataPolicyJune2011.pdf
[09]	ENVIROFI Consortium, 2012. “D7.1.2 – Exploitation Plan II“

Table 16. References

14 Annexes

For the collection of the use cases in the three scenarios, a dedicated server has been setup by Fraunhofer IOSB at http://envirofi.server.de with restricted access to the Consortium members. The report with the use cases is automatically generated from the content of the ENVIROFI Use Case server and provided as a separate Annex to the three scenario deliverables. The server has been also extended in order to cope as well with Test Cases.

14.1 Overview of Use Cases

Provided as separate Annex

14.2 Overview of Test Cases

Provided as separate Annex