D1.2– Final report on general system requirements; the Risk Management Strategy Report and the Report on reference model for baseline infrastructure

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THE OCEAN OF TOMORROW

COOPERATION

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Final report on general system requirements; the Risk Management Strategy Report and the Report on reference model for baseline infrastructure

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Abstract

The topics of this report are final general system requirements; the risk management strategy and the description of the reference model for baseline infrastructure. These topics together are actually encompassing the requirement framework for the NeXOS project.

In accordance to that the main focus of this report is to clarify the interrelationship between the different development activities and to harmonize the development goals. Talking about multidisciplinary sensor packages means in practical terms, that sensors can be easily combined allowing observing specific processes. The approach that was taken within NeXOS to start this integration process was to define requirements around user scenarios. This will not only address the technical aspects but also the economic aspects. Cost efficiency also includes aspects of service and maintenance that can be addressed with specific technical mean as for instance anti fouling measures.

Describing the interlinkage of these different aspects is of importance to come up with a coherent solution which is a standard approach based on systems engineering methods.

TABLE OF CONTENTS

1. BACKGROUND DOCUMENTS 6
2. ACRONYMS AND ABBREVIATIONS 7
3. GLOSSARY 7

EXECUTIVE SUMMARY 8

GENERAL SYSTEM REQUIREMENTS 10

RISK ¡ERROR! MARCADOR NO DEFINIDO.

REFERENCE MODEL 12

S&T RISK MANAGEMENT STRATEGY & RISK REGISTER 16

4. OVERVIEW 16
5. PROCEDURE 16
6. REGISTER 17

CONCLUSIONS 18

LIST OF FIGURES

Figure 1

LIST OF TABLES

Table 1 Four NeXOS scenarios. briefly described..... **¡Error! Marcador no definido.**

Table 2 Summary of input received on requirements and NeXOS response 11

1. Background Documents

This report provided a baseline for the requirement framework for the NeXOS developments and is closely related to the project implementation plan, the market assessment, and the technology readiness level reports of NeXOS.

- D1.1 Requirements framework

This report provides a summary of the diverse inputs that were received, focusing on the information that is most relevant for NeXOS.

- D1.3: Project Implementation Plan (1st release on M4)

This plan, based on a systems engineering approach, describes the concepts and the expectations for the different phases of the scientific and technical developments.

- D2.1: Market Assessment (M12)

This report assesses the current market for environmental monitoring services and equipment and the competitive position of European suppliers.

- D3.1: Technology Readiness Level Report (M6)

The aim of this report is to set the framework to evaluate the Technology Readiness Level for each of the NeXOS sensor systems, leading to basic engineering specifications so that performance can be demonstrated within the duration of the project.

- D4.3: High-level Specification of Architecture and Components (M8)

This deliverable introduces the high level Sensor Web architecture for the NeXOS project. While other core activities of NeXOS concern the development of new sensor technologies as well as intelligent sensor interfaces. The NeXOS Sensor Web layer addresses the integration of measurement data on an application level.

Further documents and references can be found in the bibliography section.

2. Acronyms and Abbreviations

AUV : Autonomous Underwater Vehicle
CBA: Cost and Benefits Analysis
CFP : Common Fisheries Policy
DoW: Description of Work, a.k.a Grant Agreement Annexe 1
EIA : Environmental Impact Assessment
EMSO : European Multidisciplinary Seafloor and water column Observatory
ESONET : European Seas Observatory Network
FIXO3: Fixed Point Open Ocean Observatories
GEOSS : Global Earth Observation System of Systems
GES : Good Environmental Status from the MSFD (See Definitions for descriptors)
GOOS : Global Ocean Observing System
GROOM : Gliders for Research Ocean Observation and Management
HSE : Health, Safety, Environment
IMO: International Maritime Organisation
IOC: Intergovernmental Oceanographic Commission
IPR: Intellectual Property Rights
JERICO : Towards a Joint European Research Infrastructure network of Coastal Observatories
MSFD : Marine Strategy Framework Directive
OEM : Original Equipment Manufacturer
OGC : Open Geospatial Consortium
RAMS : reliability, availability, maintainability and safety
ROV : Remotely Operated Vehicle
SensorML : Sensor Modelling Language
SNR: Signal to Noise Ratio
TRL : Technology Readiness Level
SWE : Sensor Web Enablement as the OGC suite of standards
TOC : Technical Oversight Committee
WOCE: World Ocean Circulation Experiment

3. Glossary

Interoperability: the ability of two or more systems or components to exchange information and to use the information that has been exchanged (IEEE Definition)

Life Cycle Cost: Sum of all recurring and one-time (non-recurring) costs over the full life span or a specified period of a good, service, structure, or system. In includes purchase price, installation cost, operating costs, maintenance and upgrade costs, and remaining (residual or salvage) value at the end of ownership or its useful life.

Platform: Device that can host one or several sensor systems. A platform can be fixed or mobile. Examples of mobile platforms are gliders and other AUVs, drifters, profilers and vessels. Examples of fixed platforms are buoys, moorings, seafloor cabled observatories. Platforms with ocean sensors may be referred to as ocean observing systems

Executive Summary

With the general requirement framework the developers receive a foundation that will guide them through the steps of the development process in particular they will be able to compare and adjust their design and implementation steps to other other development tasks. For example, target specifications immediately call for testing and validation procedures that are essential to decide on the feasibility of the goals. Furthermore, the development process also takes design to cost targets and other affordability constraints into account. Just to remind what the outcome of the deliverable report D1.1. was some requirement goals are selected:

I. The NeXOS observation system framework should enable and facilitate optimized use of existing sensors and the development and incorporation of new sensors
II. Sensors shall be robust and long-term stable enabling lower maintenance costs
III. Routine and systematic sensor calibration shall be supported where feasible and consistent with platform alternatives
IV. Sensors should permit multiple use of collected sensor information
V. Sensors should be adaptable to inclusion on multiple classes of platforms through standardized hardware and software interfaces, preferably using plug-and-play formats
VI. Technology Readiness Level will be defined and assessed in a traceable manner.
VII. Common standards should be used for inputs, outputs and interfaces unless unavailable
VIII. Physical configurations should allow rapid replacement of sensors on platforms
IX. Sensors shall be web-accessible

Using the OGC Sensor Web architecture for NeXOS is an essential step to provide a cost-efficient solution for the integration of sensors and sensor data easily a web-based infrastructure. It incorporates the modularity aspect that is essential to combine NeXOS sensors for taregeted applications. This aim of a cost-efficient approach is achieved through several characteristics of the developed architecture:

- Re-Usability: The components and implementations of the NeXOS Sensor Web architecture will be as generic as possible and will follow international standards. Thus, data provider will be able to re-use the resulting architecture in multiple application contexts beyond NeXOS.
- Interoperability: Through the use of international standards, the integration of sensor data into applications will require less effort. As soon as the sensor data sets are available in the NeXOS Sensor Web, all clients compatible to the applied standards will be able to access the data immediately.
- Open Source: For each component of the NeXOS Sensor Web infrastructure at least one open source implementation will be provided. This will allow data providers to rely on free implementations. Furthermore, the open source license of the developed components will make sure that users of the software are not bound to one single vendor.

Technical risk management is an integral part of the process and includes the identification, quantification, impact assessment, and implementation of mitigation measures throughout the development cycle.

- This task shall establish and implement a risk management plan to assess variability and uncertainty in regard to requirements and needs. The plan will:

- identify potential sources of technical risk including critical parameters that can be risk drivers
- quantify level of risk, and impacts on cost (including life cycle costs), schedule and performance
- determine alternative approaches to mitigate moderate and high risks
- take actions to avoid and control risk
- make decisions for selection of specification requirements and alternative designs and solutions that factor in risk

General system requirements

General system requirements are typically describing the minimum requirements on the system to allow for a predefined functionality. For the case of NeXOS it means that the sensors that are under development are fulfilling the requirements that has been set by the technical specifications (see deliverable report D 1.1) and also taking the recommendations of the cross-cutting workpackages into account. To emphasize it again these are the

- Economic aspects
- Standardization of interfaces
- Using the described anti-fouling measures

To ensure modularity standard interfaces are defined and will be adopted by the developers of the NeXOS sensor package. The suggested architecture is closely following standards introduced by OGC as SWE, PUCK or similar. The partners UPC together with 52 NORTH are exposing the SEISI concept that is an extension of the above mentioned standards.

Antifouling is a major issue for optical sensors even after short deployment intervals. Besides deploying these methods it is also important to quantify the effects i.e. determine the point in time when sensor signals are running out their defined specifications.

Cost efficiency is a major objective that will be addressed within NeXOS. The criterion to ensure this goal is based on questionnaires to explore the current market and by considering procurement together with operation costs.

Further elements of a general requirement framework are the definition of a reference model to formalize the structure of the integration process in the platform of interest.

During the first year of the project it also became clear that some thoughts have to be spent on defining best practices for the testing/calibration procedures. Nothing has been finally decided until now but sure enough this form an essential element of the system engineering approach that NeXOS is following. For most sensors there is no agreed upon protocol to carry out calibrations but in specific cases like CTD sensors there is. One discussion is whether the procedures used here can be abstracted and by that extrapolated to other sensor systems as well. This definitely will also bring up issues as immediately the question of traceability to fundamental measurements arises. The mitigation strategy is to use best practices and standard procedures wherever possible but in other cases just ensure that all steps in the process are well described.

The general system requirements are defining the framework in which the sensor development and related development within NeXOS are carried out. It describes the basic structure of the project and gives specific instructions on how to integrate the individual design activities. The results from inquiries carried out at different conferences and meetings have been compiled in the deliverable 1.1. report and are depicted in table 1.

The conclusion of this activity for the NexOS project is that the defined goals of the project are fully in line with what potential users will need. The cross-cutting topics like standardization and combating biofouling are of extreme importance for accelerating the development process and to lower overall costs of sensor systems and ocean in-situ observations.

Table 1 Summary of input received on requirements and NeXOS response

Requirement	Workshops summarized results	Resulting NeXOS implementation requirements
Typical deployment duration		
Optics	1-3 months	Greater than
Passive acoustics	12 months	Greater than
EAF sensors (fisheries)	12 months	Greater than
Sensor accuracy		
Optics	0.1% of full scale range	Better than, or equal
Passive acoustics	3dB	Better than, or equal
EAF sensors (fisheries)	0.1 part per thousand	Better than, or equal
Communication	real-time plus internal storage	real-time plus internal storage
Sensor purchase price (CAPEX)	5 – 15 K Euro (for all categories)	lower than
Operational costs (OPEX)	2-5 K Euro/per year (all categories)	lower than
Platform CAPEX costs (gliders, floats)	30 – 100 KEuro per year	Informative
Typical annual expenditures of research institutions for sensors	100 - 300 KEuro	Informative - improve
Data standards (Software side)	NetCDF, Metadata ISO 19115, 19139	Strongly consider (e.g. bridging, O&M-SML- GML mapping, transformation toolset, NetCDF Oceansites conventions, etc.)
Sensor web and interface standards	OGC conforming standards	implement

Hardware interface standards	Serial like RS 232, TCP-IP or mediators as for instance PUCK	implement

Reference model

The aim of this task is to develop a reference model for the multifunctional sensor system that will be used to identify the interfaces between the different functional blocks. This is necessary to allow for a modular design of NeXOS sensors, which should be seen as independent yet integrated parts of a multidisciplinary sensor package. Starting from the sensors and platforms that are under consideration different integration concepts will be evaluated and the according requirements on the interfaces then described. The work will build up on earlier work as part of for instance ESONET/EMSO and EuroSITES projects.

The following projects have been checked and evaluated for their relevance of the NeXOS standards approach:

- Architectural initiatives and frameworks for data services (e.g., INSPIRE, GEOSS, GMES, or GOOS).
- Ocean specific data portals and policies in regard to how interoperability for the parameters under consideration can be implemented (e.g., MyOcean, MSFD, CFP, WISE).
- Existing standards, in particular Sensor Web Enablement (SWE) of the Open Geospatial Consortium (OGC), such as SensorML, Sensor Observation Service (SOS), and related ISO standards, such as Observations & Measurements (O&M).
- Standard protocols at instrument side and its utilization of actual instrumentation (e.g. OGC PUCK Protocol, IEEE 1451), applicable to fixed and mobile platforms and observatory networks (under consideration are ARGO floats, EGO (gliders), GROOM (gliders), FixO3, EMSO initiatives, etc.).
- Common data frame formats and commands used in marine instruments.

Other general recommendations for the data flow came out of workshops organized as part of the OOI in the USA. In figure 3 on the ocean observatory reference model some essential elements are listed that also are reflected in the NeXOS reference model. Specifically the following aspects are addressed:

- All sensor specific tasks/processes shall be performed close to the sensor
- The system shall not be affected by the installation of new sensors
- The system should contain and deliver metadata for all sensors like serial no., calibration data etc

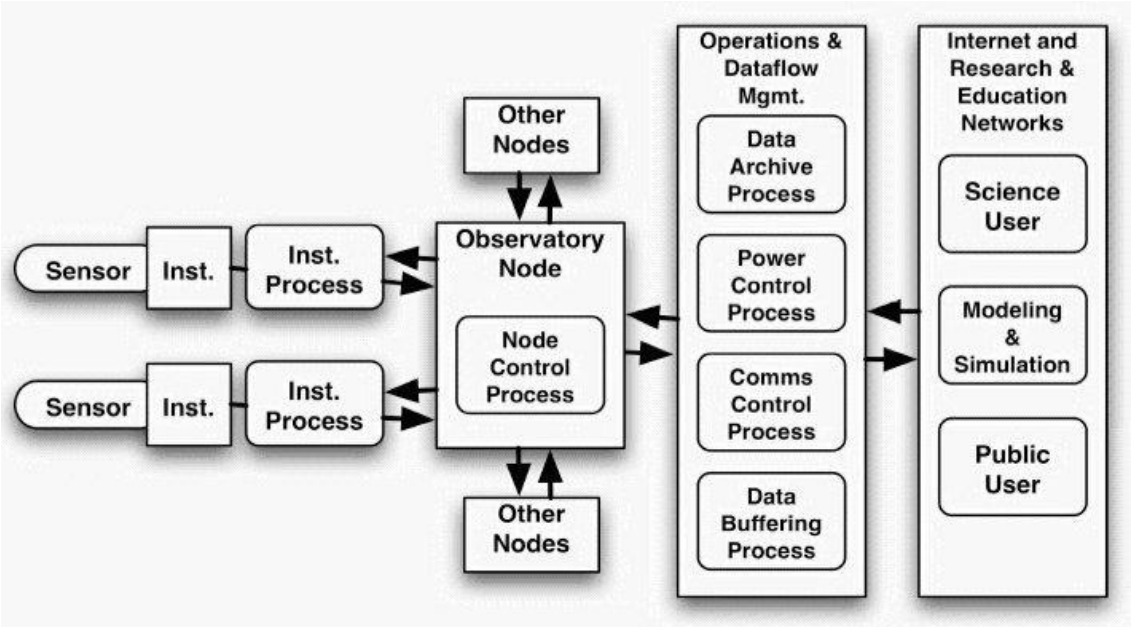

Figure 3: Ocean observatory reference model (MBARI)

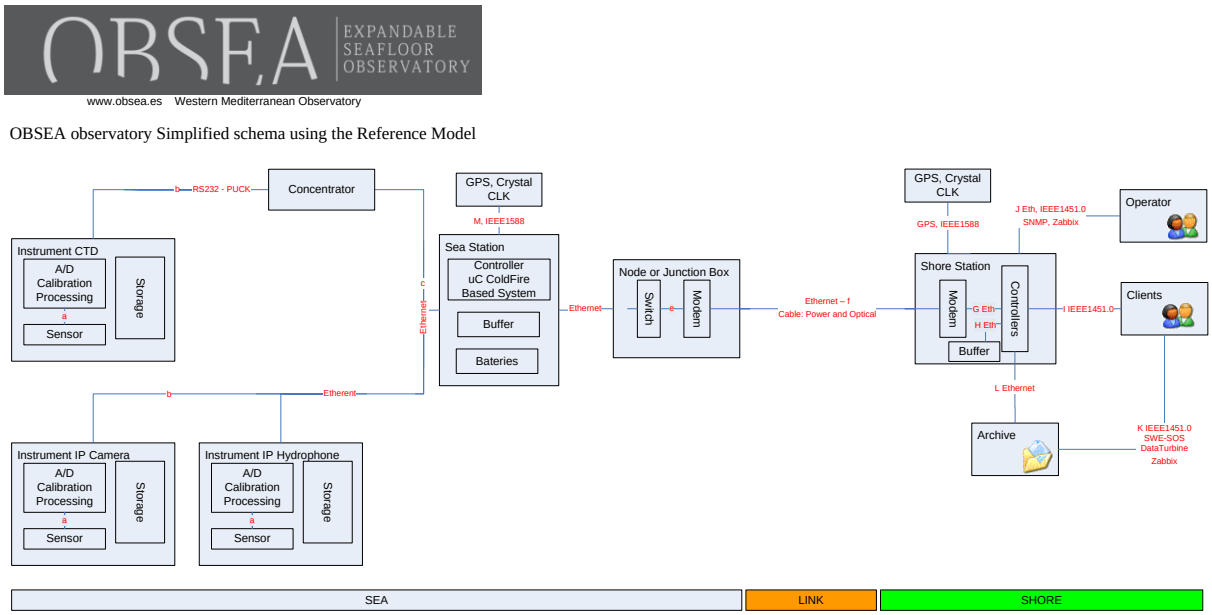

Figure 4: OBSEA reference model (ESONET)

Figure 4 shows the reference model for the OBSEA system that was developed as part of the ESONET project. It is in many aspects more specific as it is based on a more hardware driven perspective while the MBARI model focusses on the software processes inside the system.

NeXOS Reference Model

Based on these concepts an overview of the abstract components needed to fulfil the requirements for the NeXOS Sensor Web architecture was developed (figure 5). It contains specific elements that take the different infrastructure conditions into account. For instance a Sensor Bridge allows the integration (of potentially bandwidth and connectivity constrained)

non-SEISI Sensor Systems into the NeXOS Sensor Web (either through a direct database connection of through transactional operation of a Web service) several functional elements are needed (see deliverable report 4.3). First, the Observation Database needs to be mentioned which is a core element to store all collected data. Based on this Observation Database the interoperable pull access to sensor data can be achieved through a dedicated Web Service for Pull Access. In addition this service also offers a standardised transactional interface which can be used by SEISI Sensor Systems to publish their measured data in a standardised way. The Web Service for Pull Access can subsequently be used by client applications such as Data Viewers which allow the users to explore and visualise the collected observation data. At the same time a Web Service for Push Delivery of observation data is needed, as well. This service allows users to subscribe to new observations that are of interest to them. To ensure the implementation of such a push service in existing infrastructures a so called feeder will be necessary that checks the available data store (i.e. the Observation Database) regularly for new data. If new data is available, this feeder component will forward the data to the Web Service for Push Delivery to be further processed and delivered to the corresponding subscribers. Finally a Web Service is available which allows the configuration of sensors (e.g. changing the sensor parameters).

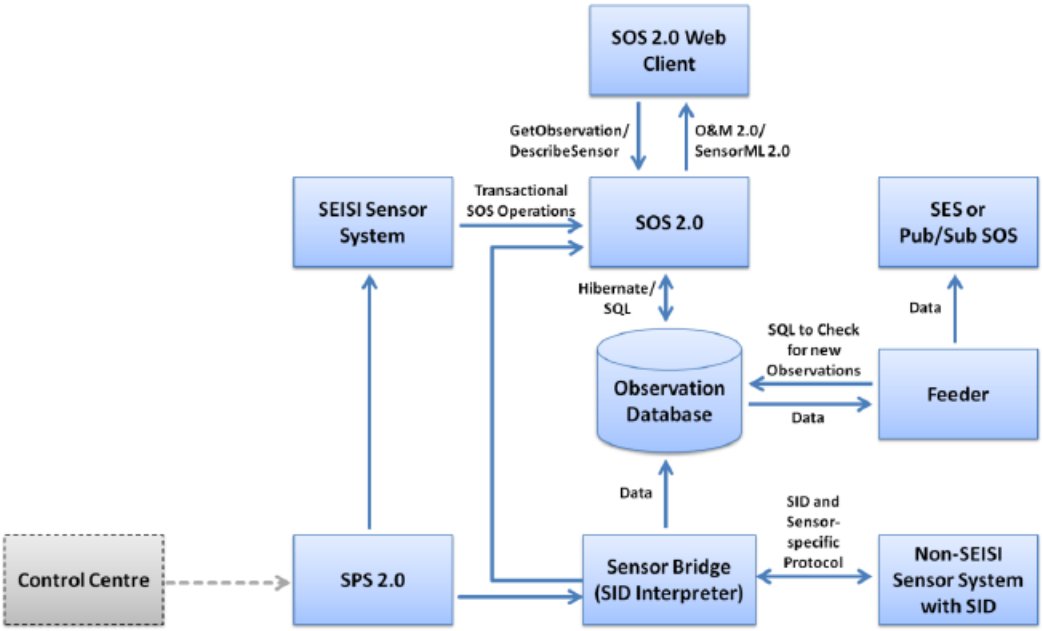

Figure **5**. Concept on how the subcomponents shall be integrated into a standard architecture

Implementation Approach

For integrating existing infrastructures with the Sensor Web framework, different strategies can be followed. Generally, the first step to achieve this integration is to make the collected sensor data available through an SOS server. This way, all further SWE components are able to access the observation data and use it for further purposes (e.g. event processing, visualisation, and analysis).

To allow the provision of the collected data through a SOS server, two main scenarios need to be distinguished:

a) the observation data shall be gathered from the sensors and is not yet put into a central data store

b) the collected data is already available in a database

For realizing scenario a) technologies such as SID and appropriate SID interpreters can be used to decode the data delivered by the sensors and to push it into the relevant SWE services. Such an interpreter can be included in a bridge component that connects individual loggers or sensors to Sensor Web data stores.

This approach will be pursued as part of NeXOS and it has to be proven that this leads to the expected outcome.

S&T RISK MANAGEMENT STRATEGY & RISK REGISTER

4. Overview

NeXOS requires a permanent scientific and technical coordination that will constantly deal with scientific and technical risks identification and the planned implementation of responses and/or contingency measures. This role is taken in NeXOS by WP1 Leader, the Project Chief Scientist, assisted and supported by WP3 Leader as Project Chief Engineer.

On a general basis, S&T risk management requires to:

• identify potential sources of technical risk including critical parameters that can be risk drivers

• quantify level of risk, and impacts on cost (including life cycle costs), schedule and performance

• determine alternative approaches to mitigate moderate and high risks

• take actions to avoid and control risk

• make decisions for selection of specification requirements and alternative designs and solutions that factor in risk

Mitigation measures will include redistribution of funds between the tasks, adaptation of requirements (if specifications are not feasible) and rescheduling of development tasks.

5. Procedure

Management of risk is established as a systematic process based on a proactive identification, assessment and control of risks that might affect the delivery of the project´s objectives. The aim of the risk procedure is to support better decision making through a good understanding of risks, their causes, likelihood, impact, timing and the choice of responses to them.

The concept of risk is, based on the PRINCE2 methodology applied to NeXOS, any *uncertain event or set of events that, should it occur, will have an effect on the achievement of objectives*. It consists of a combination of the probability of a perceived threat or opportunity occurring, and the magnitude of its impact on objectives. **Threat** is used to describe an uncertain event that could have a negative impact on objectives while an **Opportunity** is an uncertain event that could have a positive impact on objectives.

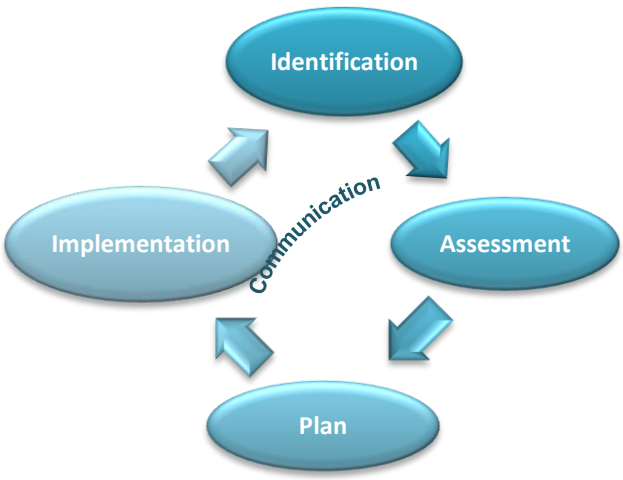

FIGURE 5.1 NEXOS RISK MANAGEMENT PROCEDURE

1. **Risk Identification**: This step is to recognize the risks (threats & opportunities) that may affect the project´s objectives.

In NeXOS, through formal and informal communication means, the risks can be raised to the Project Management Team by work-package leaders (e.g. within the periodic Check-Point Reports - CPRs) and any person involved in the project. The PMS will then include the new risks in the Risk register.

2. **Risk Assessment:** This step is to assess the threats and opportunities to the project in terms of their variables of probability and impact. The risk proximity is also analyzed to estimate how quickly the risk is likely to materialize if no action were taken.
   Management risk assessment will be coordinated by the Project Management Team. The PC or the PMS will require punctual and/or specific support to determine the probability/impact and proximity of each risk to other members of the consortium when relevant.
   Technical risk assessment will be coordinated by the Project Chief Scientist in the framework of Work Package 1.

After the assessment of each variable, the results will be registered to the Risk Register.

3. **Response Plan:** The primary goal of the Plan is to prepare specific responses to the threats and opportunities identified and assessed, ideally to remove or reduce the threats and to maximize the opportunities. The Project Management Team will provide responses to management risks while the PCS, in the framework of WP1, will provide potential responses to technical/scientific risks.

4. **Response Implementation:** The goal of this step is to ensure that the planned risk responses are implemented, their effectiveness monitored and contingency actions executed if the planned responses do not solve the problem.

When managing the risks, clear role and responsibilities are necessary:

- *Risk owner*: the person responsible for the management, monitoring and control of all aspects of a particular risk.
- *Risk actionee*: the person assigned to carry out a risk response action/s to respond to a particular risk.

6. Register

Risk management activities will be recorded in the Risk Register, hosted by the project Intranet. The Project Management Team will review and update the Risk Register as part of their activities throughout the management Stages.

5.-Dynamic documentation >
Risk Register

The risks' detection in the project is carried out by all the project members (information about risks will be given by the Work Packages Leaders in the Checkpoint Reports). The Project Management Team will update the Risk Register on a regular basis.

NeXOS_Risk-Register

Ref.	Author	Date	Risk Category	Description	Probability	Impact	Proximity	Response Category	Response	Status	Owner
1	PLOCAN	2/7/2013	Threat	Problems in the project procedures for partners (e.g. failures of accountability, internal systems and controls, organisation, etc.)	Low	Medium	Within project	Reduce	This risk is considered with low probability since all the partners have long experience in working in the context of FP Projects. Possible problems will be reduced throw an early shared of the Project Management Guidelines (D.11.1; M2) and the periodic monitoring and control of the Project Management Team (PMT).	Active	PLOCAN
2	Uni-HB	2/7/2013	Threat	Excess of additional requirements identified in WP1 The project may propose additional sensor requirements not foreseen at proposal stage. This may result in unattainable objectives.	High	High	Within stage	Reduce	The development team will be continuously interacting with WP1 to reduce the definition of unattainable objectives.	Active	Uni-HB
3	PLOCAN	2/7/2013	Threat	Unforeseen delays may occur in the development of the sensor components, which would impact the execution of subsequent activities	Low	Medium	Within stage	Avoid	Interim reporting within WPs will permit early identification of bottlenecks. These will be handled with diligence as soon as they are identified in order to mitigate the risk of delays	Active	PLOCAN
4	PLOCAN	2/7/2013	Threat	Validation or demonstration activities are delayed due to meteorological or operational reasons	High	High	Within stage	Avoid	The project was purposefully scheduled on four years to provide sufficient time margin for rescheduling these activities	Active	PLOCAN
5	IFREMER	2/7/2013	Threat	Innovative biofouling protection is disturbing one of the wavelength necessary for an optical sensor	Medium	Low	Within stage	Avoid	Use local chlorination for this specific sensor. The biofouling protection control can be applies as well in this case	Active	IFREMER
6	IFREMER	2/7/2013	Threat	The first biofouling protection control experiment provides results too dependent on the biology of the site (WP3) to convince the market.	High	Low	Within stage	Reduce	Experiments in WP8 and WP9 will allow comparison between several sites.	Active	IFREMER
7	PLOCAN	2/7/2013	Threat	Platform unavailability for validation or demonstration due to unforeseen operational events	Medium	Medium	Within project	Fallback	NeXOS would reassign resources to other partner of the consortium, who owns platform of similar characteristics	Active	PLOCAN
8	PLOCAN	2/7/2013	Threat	Integration and validation significantly delayed due to incomplete or delayed assembly	Medium	Medium	Within stage	Reduce	Several units will be prepared for integration and validation. If one is delayed, remaining units will be validated according to plan, and progression of the project will not be significantly affected.	Active	PLOCAN

Sheet1

Open NeXOS_Risk-Register

FIGURE 6.1 SCREENSHOT OF NEXOS RISK REGISTER ON THE PROJECT INTRANET

The register, as captured on FIGURE 6.1, consists of the following items:

Ref: Unique reference for risk identification

Author: The partner who creates the risk

Date: The date that the risk was registered

Risk Category: This item describes whether the risk is a threat or an opportunity

Description: A short description of the risk

Probability: This item describes the probability of the risks in terms of how likely they are to occur.

Impact: The impact of each risk in terms of how they will affect project objectives.

Proximity: The proximity of the risk with regard to when the risk might materialize.

Response category: This item describes the type of response plan for each risk

Response: A short description of response implementation for each risk.

Status: This item describes if the risk is still active or has been closed.

Owner: The partner who is in charge of the management, monitoring and control of the risk

Actionee: The partner who represents the main responsible to carry out the risk response action or actions.

Summary

This report is aimed at harmonizing the development tasks with the high level goals of the NeXOS project. Besides setting the scene for the general requirement framework the reference model for integrating the individual sensor systems into a multidisciplinary package is described that also takes the data user persoective into account. Finally a risk mitigation strategy completes the picture from the mangement side to allow for a flexible response to upcoming issues.

Sensor development is a very demanding task as users typically do not immediately recognize the benefits and drawbacks of specific measuring systems. Introducing a TRL is a first step to deal with this issue. However, as is pointed out in the deliverable report D 3.1 determining the TRL is not an easy thing. And even if this task has been succesfully completed there are still some fundamental issues that are related to calibration issues left.

The exercise of going through all these aspects is important to directions to the development work and will help achive the goals of NeXOS.

References

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