D8.3– Summary and recommendations

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Deliverable 8.3   – Summary and recommendations

Project Acronym: NeXOS

Project Title: Next generation Low-Cost Multifunctional Web Enabled Ocean Sensor Systems Empowering Marine, Maritime and Fisheries Management**.**

Project Coordinator: Eric Delory

Programme: The Ocean of Tomorrow 2013 – 7th Framework Programme

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Abstract

This report constitutes Deliverable 8.3 in the NeXOS project: Task 8.7. It builds on the results of efforts made in Tasks 8.1 – 8.6, with summary and recommendations from the Integration and Validation work, Deliverable 8.1 and Deliverable 8.2. The target for the report is the subsequent Demonstration work in Work Package (WP) 9, following Validation. The NeXOS project started with preparations for more than 20 individual projects to integrate new sensors on specific existing oceanic platforms, and then to test and validate the performance. As sensor developments progressed, some adaptations were made to fit the actual requirements of sensors/platforms which emerged as the developments progressed, while still complying with the Description of Work (DoW). This included moving sensors to other platforms, merging several sensors onto the same platform, and the increase/reduction of the number of sensor replicas. In addition, the project benefited from new platforms becoming available through the course of the project. This report, Deliverable 8.3, serves as the step between the integration and validation final reports and demonstrations in WP 9, summarizing the main experiences and conclusions and compiling recommendations for the demonstrations, where the Deliverable 8.4 constitutes the Demonstration Plan. The findings in this report are divided between technical aspects and practical/user aspects. The former, derive mainly from the integration work and the latter from the validations. A list of recommendations for the demonstrations is presented. This includes the demand for timely and frequent information on the status of the demonstration, supplied to the management team of the project and other close partners.

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1 Introduction

This chapter gives a brief overview of the NeXOS project and the Work Package 8, describing how the Task 8.7 and the present Deliverable report are linked to other Tasks and activities.

1.1 Common Background and objectives of NeXOS

The NeXOS four-year R&D project is co-funded by the European Commission under the Ocean of Tomorrow programme. Twenty-one partner institutions including small and medium enterprises collaborate to develop, validate and demonstrate new marine sensors for different fields of application, with multi-functionality and cost-efficiency as main constraints. The project is user- and market oriented. Scientific research, industry and manufacturers are working together to refine requirements and performance characteristics, on basis of user scenarios containing requirements on such as functionality and data quality.

NeXOS has the following objectives:

1. To develop a new, compact and cost-efficient multifunctional sensor system for optical measurement of several parameters, including marine contaminants such as hydrocarbons and other components of the carbon cycle.

2. To develop a new cost-efficient compact and integrated sensor system for passive acoustic measurements.

3. To develop a new low-cost sensor system for an Ecosystem Approach to Fisheries (EAF) management, providing measurement of stock-relevant parameters, such as fluorescence as well as physical parameters (T, S, Depth).

4. To develop and integrate a miniaturised smart sensor interface common to all new NeXOS sensor systems. This interoperable standard interface will be reconfigurable to respond to sensor specificities and monitoring strategies, with connectability to the majority of ocean observing platforms.

5. To develop and apply innovative sensor antifouling technologies, which are the main limiting factor of sensor reliability, and to develop and test improvements based on cost efficiency, power efficiency and economic viability.

6. To demonstrate new developments in real operational scenarios collaborating with predefined scientific and oceanographic missions, observatory maintenance, industrial sea operations (e.g. Oil & Gas) and fisheries fleet operations.

The validation and demonstration components of NeXOS focus on the last objective – the definition and implementation of demonstrations in real operational scenarios. The validation and demonstration activities are focused on three regions with complementary ocean conditions: the Northeast Atlantic, Central Atlantic and the Mediterranean with replicas of each sensor type.

The project is now in its last year in the Validation and Demonstration Phases for a number of optical and acoustic sensors paired with a variety of platforms.

1.2 Work Package 8 and Task 8.7

WP 8 is in-between the sensor developments of WPs 5, 6 and 7, and the Demonstration work package, WP9. See Figure 1, for an illustration of the time sequence of efforts in NeXOS. The aim of Tasks 8.1-8.6 was to Integrate and then Validate specific sensors on specific platforms. Task 8.7 builds on the experience gained during Integration and Validation work as it progressed.

Furthermore, reference is made here to work and reports from WP1, especially Deliverable 1.5, see the list of the most relevant deliverables on Page 3.
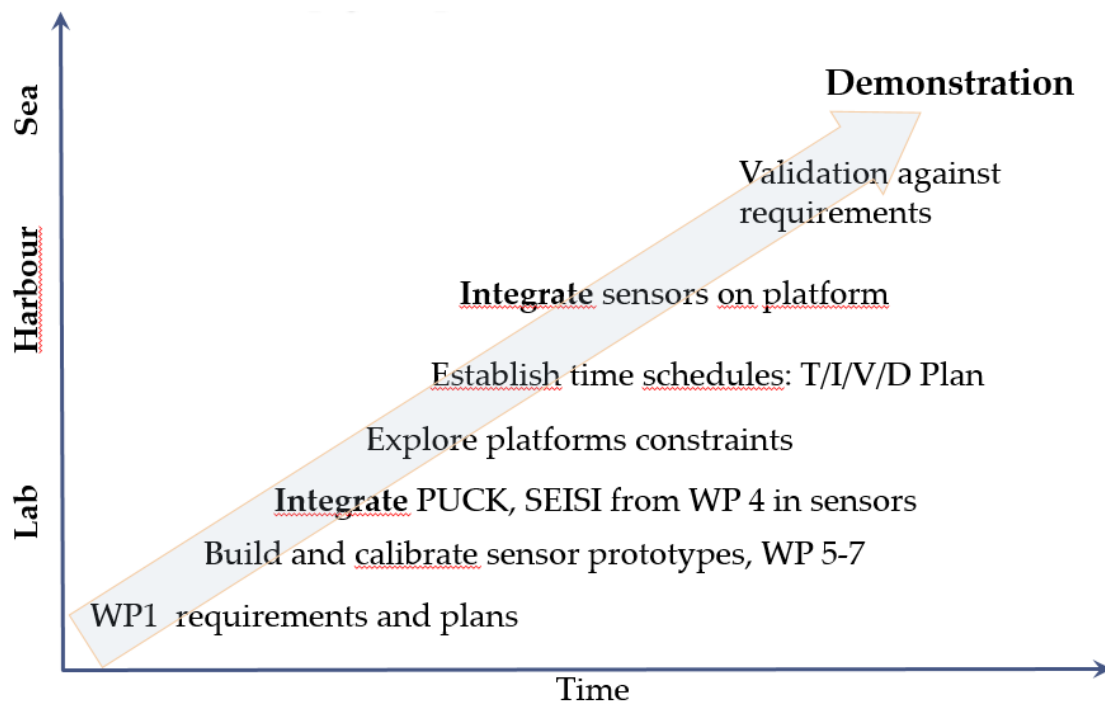
Figure 1. Timeline of different steps and stages in NeXOS sensor development from formulating the requirements and plans to the final demonstrations.

During the development of the project, there were some changes in the plans for platform/sensor pairing, thus reflecting the real availability in the consortium and final sensor configuration obtained during the development phase. The present report shows the selections discussed at the 8th Ordinary project meeting and General Assembly in Bergen, April 2017, and during following meetings and Telecons.

1.3 Structure of the report

A brief overview over the NeXOS project and its objectives is provided in the present chapter. Readers looking for more detailed descriptions are recommended to visit the NeXOS DoW and the many deliverables already submitted. Figure 2, shows how Task 8.7 fits in with other tasks in WP8, and other Work Packages.

In Chapter 2, the selected sensors and platforms are presented briefly, along with the planned Demonstration missions, to give the reader an introduction to the tasks completed and under way.

Chapter 3 describes the methodology for complying the present report, and the material and experiences collected from the developers and other stakeholders. In that chapter, also some principal views on what to focus on and what to expect during testing and validation in particular, are presented, just as background information. An important basis for the Integration and Validation efforts is the TIVD plan that has been updated on a monthly basis. This plan is also described in Chapter 3.

Chapter 4 treats the HSE (Health, Safety and Environment) issues related to the project.

Chapter 5 presents the main findings and conclusions from Task 8.7, with a section on recommendations for the demonstrations.
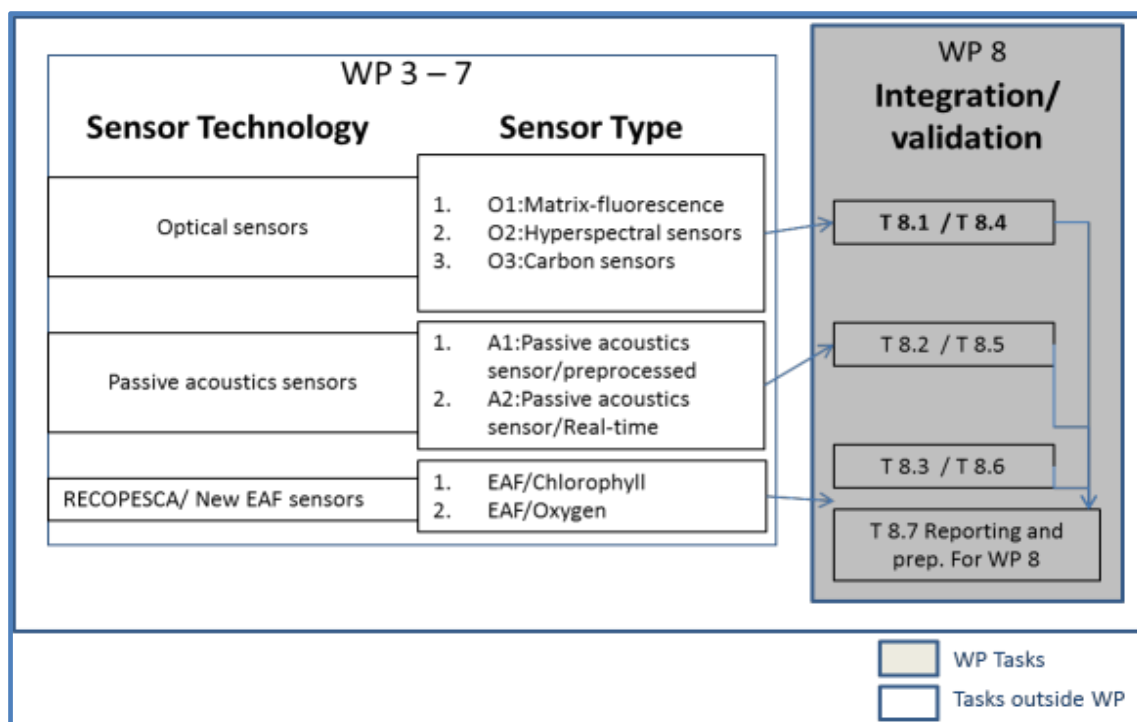
Figure 2. Schematic of the tasks in WP8, including Task 8.7, and relations to other WPs in NEXOS. Illustration from the NeXOS DoW, Part B.

2 Overview of the status of the Integration and Validation

2.1 The sensors and platforms

There are three main types of sensors in NeXOS: Passive acoustic, optical and EAF sensors. The latter are technically optical sensors, but with a new adaptation to new applications in fisheries. In addition, there is a system for anti-fouling that is primarily made to keep optical sensors clean.

The different types of sensors to integrate are shown in Table 1 and some of the platforms are illustrated in Figure 3. The sensors are described in detail in previous deliverables; only a brief overview is provided here. Table 2, shows more details on the selected platforms.

From the basic types of sensors, planned replicas have been produced, based on the equal principles, but targeted to be tested and demonstrated on different platforms or in different sea environments.

Table 1. Overview of the sensor technologies and sensor types in NeXOS, the cross-cutting technologies, and the platforms, below.

Sensor Technology	Sensor type		
Optical	O1 Matrix-fluorescence		
	O2 Hyperspectral		
	O3 Carbon		
Passive Acoustics	A1 Preprocessed		
	A2 Real-time		
RECOPESCA/EAF	EAF/ Chlorophyll		
	EAF/Oxygen		
Cross-cutting Technologies			
Smart Sensor Interface – OGC PUCK + SWE	Bio-fouling prevention		
Target Platforms			
Gliders	Drifters/profilers	Cable Observatories	Ferries
Trawlers	Nets & Lines	Other leisure	Stand alone

Figure 3. Example of platforms in NeXOS.

Table 2. More detailed overview of the selected platforms.

Platform name	Platform type	Owner	Location
Sailbuoy	Aut. SurfaceVessel	CMR	Norway
Sea Explorer	Glider	Alseamar	France
OBSEA	Cabled observatory	UPC	Mediterranean
FerryBox	Ship based obs.	NIVA	Norway
FerryBox	Ship based obs.	HZG/UNOL	Germany
Fishing vessel	Vessel	IFREMER/private	France/Norway
Provor float	Deep water float	NKE	France
Wave Glider	Aut. Surface vessel	PLOCAN	Canary Islands
ESTOC buoy	Moored buoy	PLOCAN	Canary Islands

2.2 The Integration projects

NeXOS project included an integration process of about 20 sensor/platform pairs. At developments evolved, some minor changes were made like that some sensors were shifted to other platforms, while still complying with the DoW. Integration of the sensors on the platforms were followed by validation (Tasks 8-4-8.6).

Error! Not a valid bookmark self-reference. below, represents the matrix of platforms and relevant NeXOS sensors to integrate; it describes which vehicles are available in which demonstrator sites. It includes a column to show where the sensors will undergo final demonstration. The objective of this matrix was to allocate a distribution of vehicles over the Consortium sites and to help task leaders with the knowledge of which partners and what equipment will be integrated, validated, and later be demonstrated under the WP9.

Table 4 shows the mission plan for the demonstrations following Integration and Validation.

2.3 Software integration

The SEISI interface, Smart Electronic Interface for Sensor Operability is central in the NEXOS concept, as the Communication Front End for the NeXOS. It includes the OGC PUCK code (protocol) to enable data communication via RS232 and Ethernet according to the NEXOS SWE requirements, with two-way communication operability (push/pull).

This Communication Front End with standard protocols enables Web-based sharing, discovery, exchange and processing of sensor observations, and operation of sensor systems. It facilitates data distribution, access and configuration both for the provider and end user.

SEISI is software, installed/integrated on the sensor CPU board. Figure 4 illustrates some of these concepts.

See Deliverables 4.2-4.4 for technical description and Deliverable 4.5 for the testing of the SEISI Demo unit at UPC.

Table 3. The Platform/sensor pairing in NeXOS, according to platform owner and present TIVD plan numbering. The lower two rows show new or presently not defined activity.

Matrix of platforms and sensors					
TIVD #	**Platform name**	**Platform owner**	**Type of platform**	**Sensor to Integrate**	**Target DEMO mission**
A1.4	ESTOC BUOY	PLOCAN	STAND ALONE MOORING	A1	Can4
A1.1 O1.4a	WAVE GLIDER	PLOCAN	SURFACE GLIDER	A1 O1 MatrixFlu-UV	Can1 Can2
A1.3	PROVOR	NKE	PROFILER	A1	Can3
A1.2 Mini.O1	SEA EXPLORER	ALSEAMAR	GLIDER	A1, O1 MiniFluo	Nor2 Nor1
O3.2	SAIL BUOY	CMR	SURFACE VESSEL	O3 Cbon2-sv	Nor3
O3.1 O3.4	FERRYBOX	NIVA	VESSEL	O3 Cbon2-fb O3-Cbon3-fb	Nor5
O2.1 O1.2 O1.4b	FERRYBOX	HZG	VESSEL	O2 HyABS O1 MatrixFlu-UV O1 MatrixFlu-VIS	Nor4
O1.1 O1.3	TRIOS BUOY	TRIOS	Fixed, CABLED OBSERVATORY	O1 MatrixFlu-UV O1 MatrixFlu-VIS	Nor7
EAF.3 EAF.5	FISHING VESSEL	REC	VESSEL	EAF 3 EAF-5	Nor6
EAF.4 EAF.6	FOS/FOOS vessel	CNR	VESSEL	EAF-4 EAF-6	Med3
A2.1	OBSEA	UPC	Fixed, CABLED OBSERVATORY	O3-Cbon2-sv A2	Med4 Med2
A1.e	Beacon	CNR	Moored buoy	A1	Med1
T3.2-T3.3	Biofouling test station	IFREMER	Basin/pool	Antifouling system	N/A

Table 4. Overview of the planned Demonstration missions in NeXOS.

A1	A2	O1	O2	O3	EAF		PLATFORM		DEMO SITE
Med1							Beacon		
					MED3		Fishing Vessel		MED SEA
	MED2						OBSEA		
NOR1		NOR2					SEA EXPLORER		
				NOR3			SAIL BUOY		
		NOR4	NOR4	NOR5			FERRYBOX		NORWAY
					NOR6		FISHING VESSEL		
CAN1		CAN2					WAVE GLIDER		
CAN3							PROVOR		
CAN4							ESTOC TB		CANARY ISLANDS
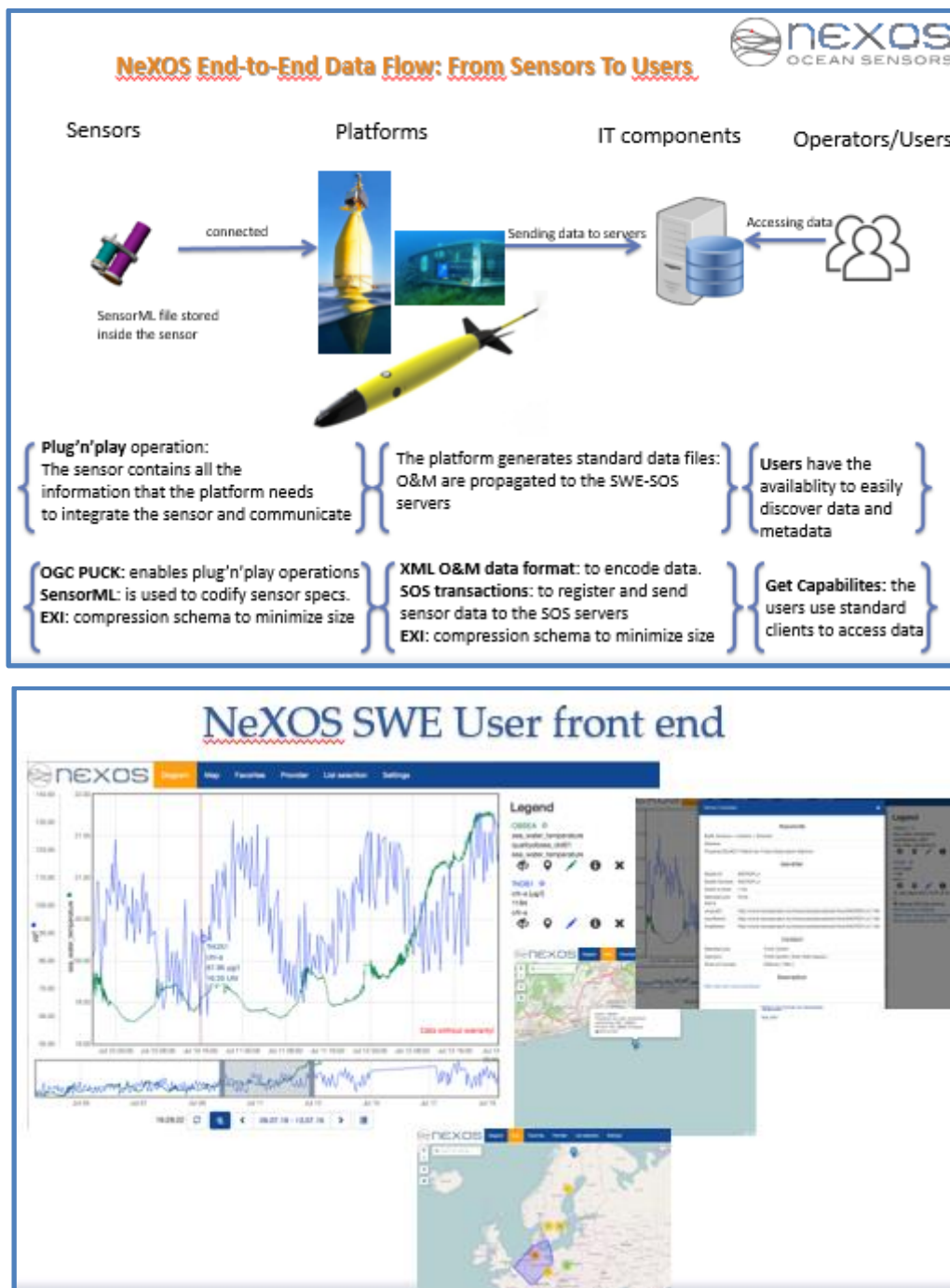
Figure 4. Illustrations of the software/hardware integration, and of the sensor Web Enablement (SWE) in NeXOS.

2.4   Validation and Demonstration

Integration work implies bringing the sensor and other hardware components together so that it matches the constraints of the platform (e.g. weight, space, power supply). This mechanical work also includes adding the necessary extra software to the sensor and/or to the platform in order to comply with the communication and data transfer requirements. This work has followed industry standards where applicable, and in-house best practice procedures. The terms Validation and Demonstration imply documenting how the sensor/platform assembly works in a

real sea environment. These involve metrological practices, as found in the literature on metrology. The extracts of definitions presented in the following have been taken, particularly from this source: JCGM 200:2012[1]: http://www.bipm.org/en/publications/guides/vim.html.

The following are summaries of definitions of Validation and Demonstration, as retrieved from the literature, and adapted to the NeXOS setting.

- **Validation** – Fit for purpose, (part of validation process is cost efficiency considering the full life cycle, also including need of personnel for maintenance, cost per data point), deployment under field conditions, use of background data for point comparison. In the context of NeXOS, Partial validation, contrary to Full validation, was the common procedure in NeXOS. This is often used in research and pilot studies, if time is constrained, like in NeXOS. Focus was laid on the new and most important attributes such as data timeliness and accuracy and actual power consumption.

- **Demonstration** – Within the NeXOS construct the term Demonstration includes: demonstrating impact of the NeXOS system of systems (multifunctional sensor operations), fit for specific purposes or applications, embedded into realistic operational scenarios, mission control services (SWE, SOS), data handling and visualization (interoperability), and lastly, demonstrating the path from sensor via sensor platform to an end-to-end approach.

2.5 Dynamic planning during Integration and Validation

The proposed TIVD Plan was introduced into the project at an early stage, in order to help keep track of the many developments and particularly the need for accurate timing during each phase of the project. It describes the overall Test - Integration – Validation - Demonstration approach for the project providing guidance for management and technical efforts throughout the development period. It established a comprehensive plan to communicate the nature and extent of testing necessary for a thorough evaluation of sensors including potential risks and mitigation plans.

This plan, managed under Work Package 1, was used to coordinate the orderly scheduling of events by providing Integration and Validation specifications and organizational requirements. It has been revised according to the actual status of developments, to make the plan as realistic as possible.

Figure 5 shows the scheduled timing of the integration efforts for the various sensors, according to the approximant status in May 2017. For most sensors, integration and validation work was completed at the time of issuing the present report.

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[1] JCGM 200:2012: International vocabulary of metrology – Basic and general concepts and associated terms (VIM), 3rd edition, 108p.
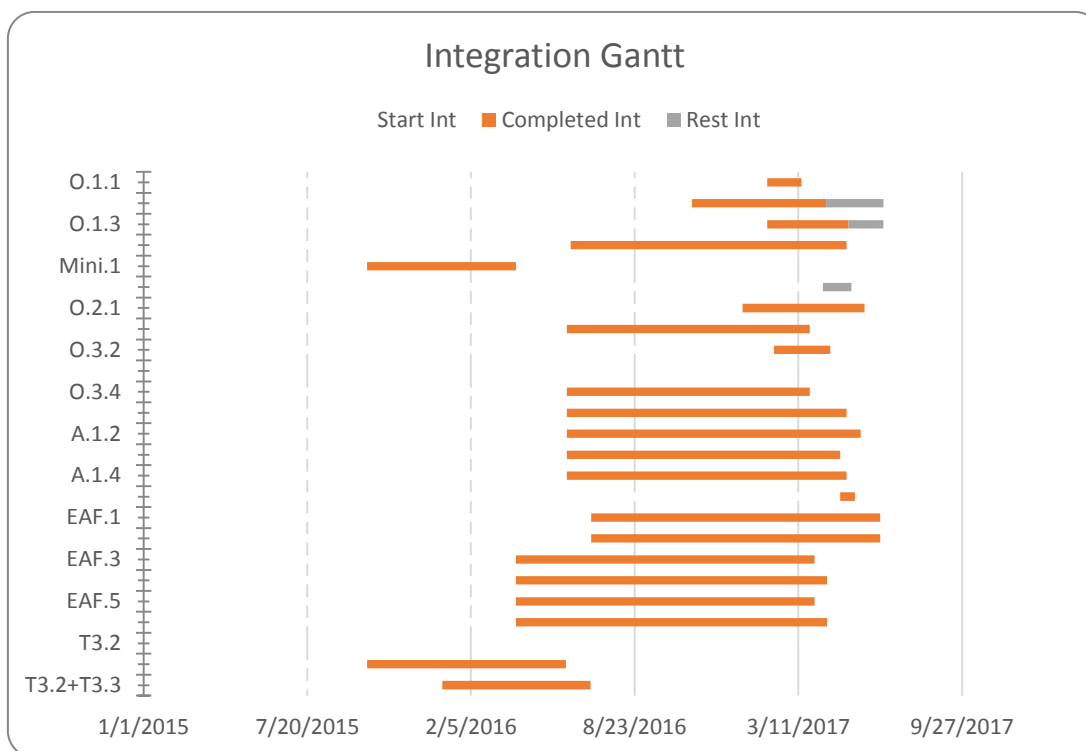
Figure 5. Timeline summary for the integration efforts in NeXOS, according to sensor type.

2.6   Examples from Validations

The initial demonstration of the O1 MiniFluo sensor was carried out in November 2016. This sensor monitors hydrocarbons in the water. The sensor was mounted on the SeaExplorer SEA003 Glider from ALSEAMAR and deployed at the Troll field in the North Sea on 18 November 2016 (see Figure 6).

This Glider "pre-demonstration" showed that gliders equipped with relevant sensors are powerful environmental assessment tools that can be deployed with relative ease and by crews with little scientific knowledge (e.g., we can easily imagine a deployment/recovery without scientists on board). The usual pre-deployment procedures at sea (radio communication with the glider and first dive with a floater attached) were withheld due to unfavourable weather conditions. The land pilot in France immediately took control of the glider while communicating with the scientists at sea. For the recovery, no scientists were on board the vessel Havila Troll. Only a few email exchanges with the Havila Troll Bridge and a phone call the day of the recovery were sufficient. The glider was switched 'OFF', rinsed and put back in its transportation case by the Havila Troll crew.

Water samples for sensor calibration were collected at the deployment station (surface, 10 m, 25m and 40 m) for further analysis in the laboratory. First the glider completed a return transect across the channel along the L1-L2 line; this was roughly delimited by the isobath 300m on both sides (see the map). Second, the glider completed a triangle delimited by waypoints because these objectives were completed relatively quickly; it was decided to repeat the line T1-T2-T1 twice. Finally, while waiting for recovery, the glider stayed in virtual mooring mode (dives at the same geographical points) at proximity of the Troll B platform.

Figure 7 shows some snapshots from the final tests and validation of the Alseamar glider off Runde Island in Norway in June 2017, during the launch of the demonstration of the NOR1 and NOR2 missions. These field efforts and others provided valuable information regarding the present report.
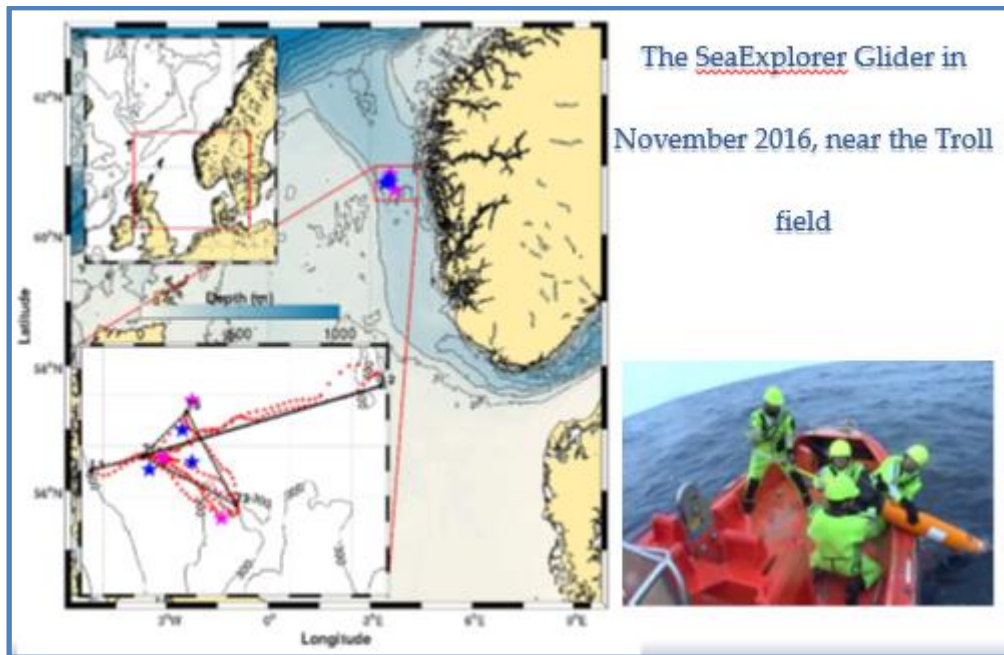

Figure 6. Map of the North Sea and the trajectories of the Alseamar glider during the pre-demo in November 2016.
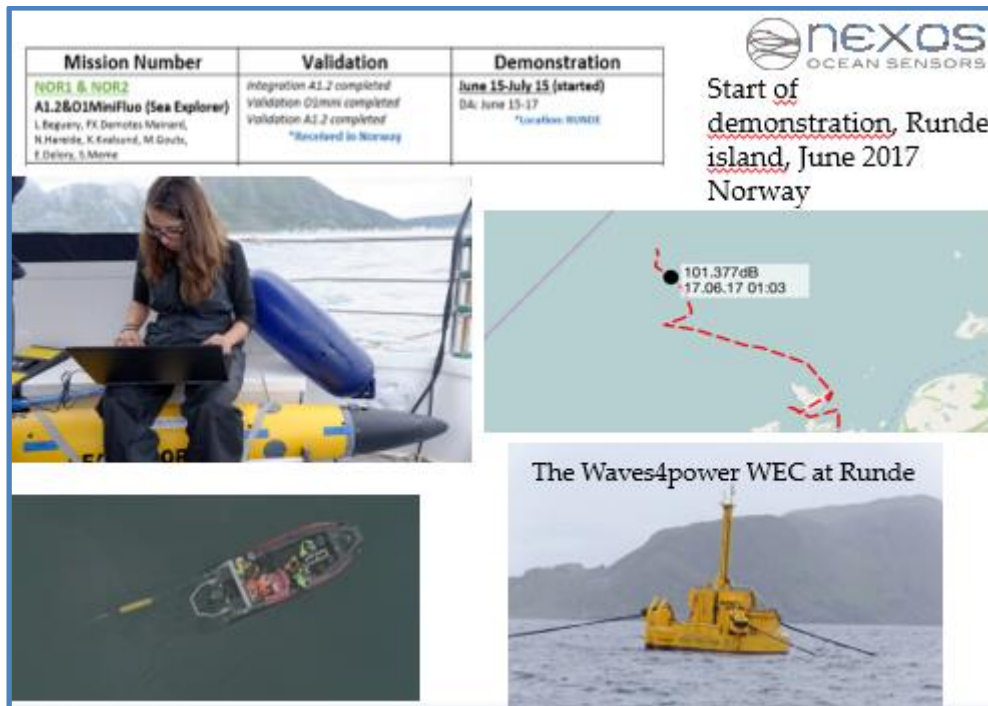

Figure 7. Snapshots from the start of the demonstration missions, NOR1 and NOR2, with the Alseamar glider at Runde in June, 2017.

3   Methodology

We used diversified material and information when compiling the summaries and recommendations:

- Feedback from the developers on the "Risks and issues" part of the questionnaires
- Discussions during Telecons
- Discussions during meetings
- Email distributions, hundreds of emails.
- Individual telephone calls
- Practical results and issues met, during tests and validations

There was one questionnaire returned from each integration effort and one for each validation. Template forms were used for simplicity and to facilitate comparisons and evaluations. On the following page, an example of the validation report is shown. The Integration questionnaire was similar to the validation report shown, where the different teams of developers and platform owners working together were asked to fill in the following items, as appropriate for each case:

Software, as necessary

- Developer software for control and operation
- NeXOS SEISI (PUCK protocol, Sensor ML, communication gateway, antenna connection)
- Photos of internals; schematics

Hardware

- Sensor hardware and integration as covered in WPs 5-7, describe briefly only the main parts.
- Show a photo of sensor internals, and externals
- Describe the platform briefly, including photo and design, and any sensor control unit.
- Describe the mounting of sensor on platform, with power cables and connectors

Tests and assessments

- Describe the location for the integration and testing
- Mechanical and technical performance, comments, with photo
- Data timeliness and quality assurance, short examples, comments and evaluation
- Smart interface and SWE operation, short text with comments and evaluation
- SOS server and web display functioning, short text with comments and evaluation
- Any concerns and risks
- Evaluation and recommendations for validation and demonstration.

The returned forms formed the basis for reporting on the Integration and Validation efforts, respectively in Deliverables 8.1 and 8.2.

The Risk Register on the NeXOS INTRANET contains actual issues, mostly technical problems, that were encountered and dealt with in the project in various Work Packages https://sites.google.com/a/plocan.eu/nexos/dynamic-documentation/risk-register-1. Some are relevant examples of issues that may occur also during the forthcoming demonstrations.

Regarding HSE and safety, information was based on interviews with personnel involved and oral reports, mostly.

NEXOS **Validation report, for Deliverable 8.2**	
Sensor acc. to TIVD	*Sensor owner*
Platform acc. to DEMO plan	Platform owner
Validation plan	
Insert short text about the validation plan: Location, time, duration, procedures etc.	
Report from the Validation	
Technical validation	
Hardware validation (Operational functionality, deployment and recovery operation etc.)	
Software validation (On-board programming, Data output format, SWE performance, timeliness of data etc.)	
Scientific validation	
(User friendliness, field performance and data quality)	
Remarks and risks identified, towards Demonstration	
Date completed	Sensor developer, person name
Doc. version	Platform operator, person name

4   Safety and HSE issues

Both laboratory/factory developments, Integration, testing and Validation in the project should be performed with no safety risk, and leaving as minimum environmental footprint as possible. The activities taking place in the project during Integration/Validation were considered to be low-risk or no-risk, regarding Health, Safety and the Environment (HSE). The following table lists examples of operations that theoretically still might pose a risk of damage, spills or injury. We have noted with a **V** where a potential for such incidents might occur.

Work in the lab/factory	Damage	Spill/leak	Injury
Lifting/transporting parts	V		V
Welding/soldering			V
Painting, surface prep.		V	
Chemical baths, cleaning		V	V
Pressure testing	V		V
Packing and transport	V		V
Work in the field	Damage	Spill/leak	Injury
Loading/offloading equipment	V		V
Traverse by sea	V	V	V
Deploying equipment	V		V
Recovering equipment	V		V
Inspecting containers	V		V
Diving			V

It appears that most operations would imply a certain degree of risk of injury to people. Spills of chemicals and liquids were less likely to happen, due to the nature of the project and the operations with no or only small quantities of mostly non-hazardous liquids involved. Damage to equipment or infrastructure might occur in some instances. Based on the HAZID and the Safe Job Analyses the work plans were investigated and revised, to eliminate any risks, prior to major operations.

No accidents or spills or damage occurred during I/V, as attention was paid to HSE during all work and operations, from laboratory to the ocean. The small scale of the projects, involving only a few persons each, and mostly only small instrumental units, and mostly routine work, would imply low risk. The use of materials and chemicals that might pose environmental concern, were on the order grams-kilos.

Some operations, especially those at sea and those involving lifting or high-pressure testing on-shore, still had intrinsic potential for accidents. So in those cases, each developer would follow

their own in-house safety procedures, by running through a Safe Job Analysis, and a quick HAZID[2] desktop exercise, to reveal any component or any work task that might represent risk of damage, leaks to the environment or injury to people. In case issues were identified as imposing a risk, measures would be taken to minimize or eliminate the risk.

4.1 Message for the demonstrations

The successful track record from the I/V work, forms a basis for preparing for safe Demonstration operations, to follow. The demonstrations will be similar in nature to the validations, but with somewhat extended risks due to longer deployment period (1 month) and longer transfer distances at sea (and on land in some cases). Longer period will mean more likely risk of incidents, and similarly for longer voyages. In most cases the same teams as performed the validations, will conduct the demonstrations. This will ensure that the safety philosophy and procedures will be carried over to the demonstrations.

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[2] Hazard Identification, identifying hazards in order to plan for, avoid, or mitigate their impacts.

5   Summary and recommendations

The Integration and Validation (I/V) work comprised of many projects combining sensors with platforms, and integrating the software with new protocols. As the NeXOS project evolved, things changed as some I/V adjustments and adaptation have been carried out to respond to actual requirements of sensors-platform. Finally, the number of questionnaires for Integration, versus Validation (as reported on in D 8.1 and 8.2) are not equal in terms of number of sensor-platform reports due to the fact that not all the sensors have been validated in each of the platform available.

5.1   Reported Risks and Issues

We have extracted the Integration and Validation feedback on risks and issues in the two tables below. Let it be noted, that there were significantly fewer risks and concerns identified during Validation, relative to Integration. This could be seen as a positive assessment to this report and relative to the demonstrations to follow.

This report makes note of "Risks" identified in NeXOS will not necessarily be the same risks as an industrial developer might face, when doing own, in-house developments, targeted for the market. Such a developer can choose their own schedule, and determine the release date. In a project like NeXOS, the time constraint of 4 years in this case, implies a very a serious constraint. Developments running late for various reasons may likely be dropped if they do not meet the requirements, within a set time, for successful tests and demonstrations in the project.

Table 5. Returned comments on the Risks and issues related to the various Integration projects.

Mission	Risks and issues identified during Integration work
1. ESTOC buoy and A1.1 sensor	Two main issues have been identified so far: Buoy availability in PLOCAN facilities and existing weather conditions for final deployment in open waters of the East coast of Gran Canaria. Acquisition of the custom fixation bracket for the sensor unit could be an issue, due to it has to be manufactured on demand. The delivery from the company provider could take longer than expected.
2. Sea Explorer Glider and A1.2 sensor	Validation test are in progress to validate the software integration. The mechanical test for the mechanical integration are planned by mid-February, in order to be able to start trials at sea by March.
3. PROVOR Float and A1.3 sensor	Delivery of the sensor will be delayed with respect to the original plan. The reasoning for why integration on the Provor float is currently underway.
4. Wave Glider and A1.4 sensor	Two main issues have been identified: Acquisition of the custom cable for the tow-body unit could be an issue due to the requirement of manufacturing on demand. The delivery from the company provider could take longer than expected. Specific flotation frame for the A1.1 as part of the tow-body unit. A recommendation from the sensor manufacturer should be requested.
5. Wave Glider and	One main issue has been identified:

O1.4 sensor	Acquisition of the fixing bracket could be an issue due to the requirement of manufacturing on demand. The delivery from the company provider could take longer than expected.
6. Sea Explorer glider and O1 Mini.1 sensor	The implementation of MiniFluo integration into the SeaExplorer glider is ongoing. There will be a few weeks delay between the work done for defining implementation steps (Deliverable 8.1.) and integration achievement because of technical difficulties for integrating the converter. Integration was started later than planned in NeXOS agenda because the Minifluo (MFL) was an "off the shelf" sensor at the start of the NeXOS project. The communication system was intended for communication with the SeaExplorer glider platform in "I2C proprietary mode". This was first developed during validation field tests to be sure that the Minifluo was performing according to specification (for Minifluo the main scenario is to detect oil printings at sea) lagging behind for the integration phase. The integration phase will be completed by April 2017.
7. SailBuoy and O3.2 sensor	It's not clear from CMR if the vessel is ready for navigation.
8. FerryBox and O3.1 sensor	The box was supposed to be provided with internal power supply. Yet, for safety features and avoiding further complexity on the prototype, it now needs an external power supply unit to obtain the 24V required by the CO_2 sensor with further conversion inside the box.
9. FerryBox and O3.4 sensor	The box was supposed to be provided with internal power supply; however, for safety features and avoiding further complexity on the prototype, it now needs an external power supply unit to obtain the 24V required by the CO_2 sensor with further conversion inside the box.
10. FerryBox and O1.2, O1.3 and O2.1 sensor	Building SensorML and SEISI part of FERRYBOX software just began one month ago; completion will take more time. This could be identified as a risk, however, validation was initially planned for May 2017, leaving time for preparation and testing. No further funds needed. Controlling all sensors due to this system is not included yet, personnel or autonomic controlling possibly prior to deployment necessary.
11. Fishing vessel and EAF.3/EAF.5 sensors	Delivery of the sensors will come later with respect to the original plan due to the failure of one of the laboratory test. This is the reason why integration is not yet started at the present date.
12. Fishing vessel and EAF.4/EAF.6 sensors	Delivery of the sensors was late with respect to the original plan due to the failure of one of the laboratory test. This is the reason why integration was delayed.
13. OBSEA platform and O3.3 sensor	This mission is delayed with respect to the original schedule. It will benefit from the outcomes of the O3.2 sensor, yet will be less problematic in terms of continuously available power supply from shore. A field work session with UPC needs to be scheduled. Custom clearance papers need to be prepared.

14. Beacon and A1.3 sensor	The Document of Work planned to have an A2 sensor integrated onboard a fishing vessel with the EAF.4 and EAF.6. After evaluation, it was understood that this is not possible due to incompatibility of the A2 sensor with the fishing operations, the Senigallia pylon was chosen as an option and an A1.hybrid sensor was selected instead of the A2, for technical compatibility.
	The integration of the sensor has not been planned in the Document of Work, so there is a risk of failure for contingent technical aspects during the installation that cannot be foreseen at this time.
15. Glider/Basin and Anti-fouling system	No deviation identified.
16. OBSEA platform and A2 sensor	The deployment of A2 sensor is not trivial, where both absolute position and attitude (inclination and orientation) have to be known in order to compute accurately the position of the source of sound.
	On the other hand, the algorithms to compute the angle of arrival and range of a sound using arrays of hydrophones are well studied during last decades, however many challenges still open due the complexity of the underwater channel. Especially, in areas with important multipath environments such as OBSEA.
17. Trios buoy and O1.1, O1.3	Due to some failures in the power supply, the power supply had to be rebuilt in the beginning of 2017.

Table 6. Returned comments on the Risks and issues related to the various Validation projects.

Mission	Risks and issues identified during Validation work
1. Wave Glider and A1.1 sensor	
2. Wave Glider and O1.4 sensor	
3. Sea Explorer glider and O1 Mini.1 sensor	Given the description made above, the sensor should work according to specifications during the demonstration. We however, advise to take water samples for in situ calibration of the MiniFluo.
4. Sailbuoy and O3.2 sensor	
5. FerryBox and O3.1 sensor	
6. FerryBox and O3.4	

sensor	
7. FerryBox and O2.1 sensor	
8. Fishing vessel and EAF.3/EAF.5 sensors	Each deployment on fishing gear poses a risk for the probes
9. Fishing vessel and EAF.4/EAF.6 sensors	The last part of the validation phase performed directly onboard the fishing vessel was crucial in verifying potential problems during the demonstration phase to be carried out from May to September 2017. Major risks are connected to the robustness of the probes and potential unexpected impacts with the fishing gear itself and with the bottom (e.g. to improve the performance of the temperature sensor in the O2 probe, this has been put in a more exposed position). Additionally, there is the risk to lose the probes during the normal fishing operations. It was also verified that the collaboration of the fisherman is important in case of the need to restart the system due to power supply problems or occasional default of some of the components.
10. OBSEA platform A2.1 and O3.3 sensor	
11. Glider/Basin and Anti-fouling system	Services of buoy include its recovery and re-deployment are time consuming. Currently, the finished service took approximately 3 months due to new power supply installation and further changes in setup. Although electronics for new communication interfaces etc. have been carefully arranged prior the re-deployment, entire functionality cannot be guaranteed, additional delays are possible.

5.2 Common issues from the Integration

There were several common issues reported, as shown in the list below. Delays were reported on from several teams. However, most of those were dealt with in due time. Relative to the forthcoming demonstrations, the actual nature of those issues may be less relevant. Nevertheless, they underscore the importance of considering possible delays when preparing for demonstrations.

- Delivery of the sensor is delayed
- Delivery of ordered parts is delayed
- Weather can delay work
- Lack of personnel resources
- Breakdown of power supply and other parts
- Incompatibility between sensor operability and the platform operating environment

5.3 Common issues from the Validation

The validations were like "mini-demonstrations" and thus the experience gained will be quite relevant for the full demonstrations. Below are some examples of issues and concerns raised. Those commonly refer both to the performance of the sensor/platform and to the conduction of operations by operators during the validation phase.

- Risk of damage to sensors when in operation
- NeXOS validations running parallel with other projects on the platform, risk of conflicts
- Crucial with close communication with the fishermen during EAF sensor validations
- Water samples collection for calibration, when possible

5.4 HSE and Safety issues

Operations at sea, and those involving lifting or high-pressure testing on-shore, have some potential for accidents. In these cases, each developer should follow their own in-house safety procedures, by running through Safe Job Analysis, and a HAZID exercise, to reveal any component or any work task that might represent risk of damage, leaks to the environment or injury to people during the demonstrations.

5.5 Recommendations for the Demonstration phase

The first demonstrations have started with results obtained from e.g. the O1 MiniFluo on the SeaExplorer glider and from the O3 Cbon2-fb sensor on the R/V "Heincke". These early examples show that demonstrations in NeXOS, when well prepared, will be launched and conducted safely according to the Demonstration plan; risks have been dealt with and eliminated.

For the final phase of NeXOS with remaining demonstrations, the additional demonstration of the data links for real time web-based data access will be completed and the NeXOS software will provide user real time access to the measurements. This requires a timely focus on the data quality and data products of the SOS server.

The issues raised by the I/V teams, as described above, were based on their own experiences. Other issues like status information flow was not covered, as this was a concern by other people in the project that relied on frequent updates. Therefore, not only data flow but also information flow within the project is very important and needs to be handled appropriately in the demonstration phase.

As a short list of recommendations for the demonstrations, we propose the following:

- Inform colleagues and project management on the status of the preparations close to the launch
- Brief your team on the preparation status on a daily basis
- Get started as soon as possible
- Review and, if necessary, revise the Demonstration plan for the mission
- Prepare for technical or logistical issues, with back-up plans and resources
- Observe data on the SOS server frequently basis and assess that quality is adequate
- Keep colleagues and project management informed on the status of the demonstration on a daily basis.
- Keep logs on progress and any events updated
- Maintain high level of awareness on safety and HSE issues, and perform HAZID and Safe Job Analyses prior to the demonstrations.