

Interoperability developments for next generation multifunctional ocean sensor systems in NeXOS

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Abstract- Sensor technology is rapidly advancing, enabling smaller and less expensive instruments to monitor Earth's environment. It is expected that many more kinds and quantities of networked environmental sensors will be deployed in coming years. This work presents an approach for the smart configuration and integration of marine sensors into an interoperable Sensor Web infrastructure such that the overall life cycle cost of sensors and observing systems is reduced and data has greater societal and scientific value. In this paper some of the objectives related to sensor interface included in the project proposal NeXOS (Next generation, Cost-effective, Compact, Multifunctional Web Enabled Ocean Sensor Systems Empowering Marine, Maritime and Fisheries Management), under the European Commission's Ocean of Tomorrow call FP7-OCEAN-2013.2, are presented.

I. INTRODUCTION

European marine policy makers stated in the "Ostend Declaration" of 2010 that the major challenge is now to support the development of a truly integrated and sustainably

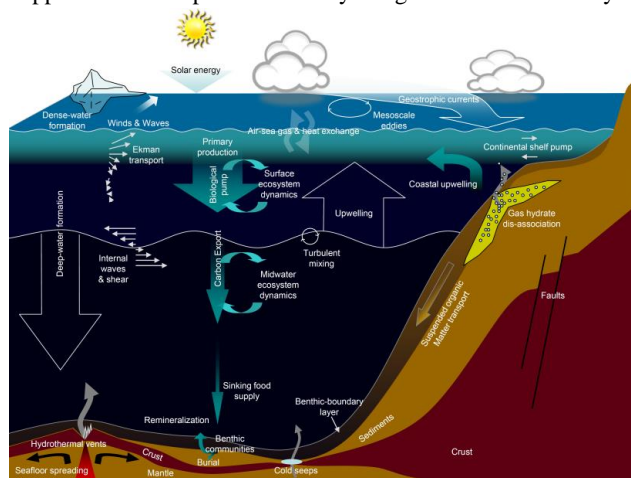


Figure 1 Illustration of major processes in the marine environment indicating the interconnectedness of atmospheric, surface of the ocean, biological pump, deep-sea, and solid-earth dynamics. Based on other similar Figures prepared by P. Cochonat, C. Berndt, ESONET NoE, and the US Ocean Observatories Initiative [1]

funded European Ocean Observing System (EOOS) to monitor key ocean processes (Figure 1).

This would form the European component of the Global Ocean Observing System (GOOS), and would continuously monitor the European seas from near-coastal to open ocean, and surface waters to seafloor. Fixed and mobile observing platforms would be used to offer real-time, or near real-time, open and standard downstream services to the public and private sectors.

This system would re-establish Europe as a global leader in marine science and technology, as well as support effective management of the European maritime environment. To achieve this, more long-term measurements of key parameters are required, but the costs and unreliability of ocean sensors remain a major problem. The increasing maturity of observing technology enables adaptive observing systems which increase access while reducing costs. Following this trend, new oceanographic observing systems are needed, which can measure several parameters with enhanced reliability.

Given the general priority for all, monitoring strategies addressing observing systems and sensor technologies to create mechanisms and technologies with greater societal and scientific value, a new sensor system is proposed to be developed that will include innovations in data accessibility, reliability, sustainability, interoperability and multifunctionality for key ocean variables. In addition, the new development will address protocol specifications to improve the processes of marine data acquisition. The protocol specifications will be developed based on existing standards that enable (1) the pull of stored marine sensor data, and (2) the real-time push for marine sensor data aligned with the OGC publish/subscribe activities. The lightweight design of those specifications based on existing solutions [2], [3], [4] will foster their utilization in practice.

II. SMART SENSOR DESIGN

A new hardware and software architecture called "Smart Electronic Interface for Sensor Interoperability" (SEISI), to enable interoperable Web access to marine sensors is proposed. The architecture will satisfy international standards, defined by

ISO, OGC, and the INSPIRE directive, to enable integration of marine sensors with existing observing systems. As shown in Figure 2 the SEISI will provide a multifunctional interface for many types of current sensors and instruments, as well as new multifunctional detectors.

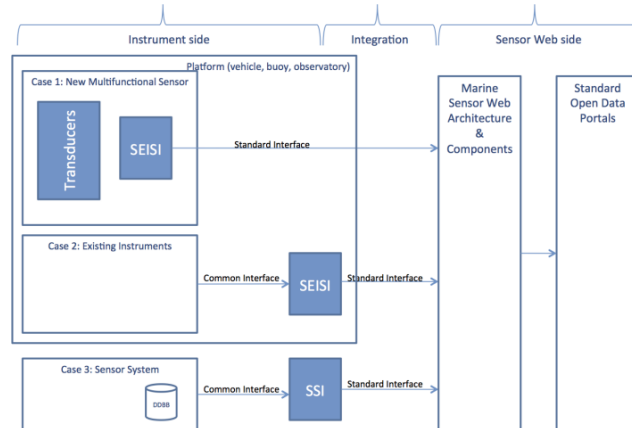


Figure 2 Oceanographic observing systems based on SEISI

Today oceanographic instruments provide proprietary instrument protocols based on standard physical layers like RS232, RS485, CANbus, etc. Therefore the design of a smart interface is proposed in order to provide communication and synchronization with proprietary oceanographic instruments, data processing and a standard communication interface with upper layers such as end users and the ocean observing system as shown in Figure 3.

Digital Instruments (Point-to-point or Multidrop Instruments)	Sensor Instruments Frontend Task	Processing and Synchronization Task	Standard Communication Interface Task
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Figure 3 Smart Electronic Interface for Sensor Interoperability (SEISI) capabilities

First, a modular sensor instrument frontend will provide communication and synchronization with actual oceanographic instruments. Three main modules compose this task:

- An analogue frontend that provides signal conditioning and analog to digital converter capabilities for different types of sensors. This module will take into account the accuracy, precision, impedance coupling and frequency sampling characteristics needed for several types of marine sensors.
- A point to point frontend will provide a modular design that is able to communicate with digital instruments when a point to point link is used e.g. RS232, SPI, I2C.
- A Multidrop frontend will provide a modular design able to communicate with digital instruments when a multi - drop link is used e.g. RS485, RS422, CANBus, USB.

Secondly, the SEISI core will be developed in order to fulfill the following design goals:

- Low power consumption to enable use in battery powered platforms;
- High processing performance to allocate specific applications and services for sensor data processing;
- Positioning capabilities through a GPS interface or external positioning information;
- Compactness to facilitate the integration in present platforms;
- High accuracy time stamping capabilities using synchronization protocols (e.g. IEEE Std. 1588 Precision Time Protocol);
- Remotely reconfigurable and upgradable
- Adaptable to new sensor developments

Thirdly, the SEISI will be the “open door” to access instrument data and instrument configuration using interoperable standards avoiding end users interaction with proprietary protocols. The objective of this task is to design and program an interface communication frontend capable of interfacing with upper communication layers following open standards such as the SWE framework from OGC or IEEE 1451 Smart Transducer Interface Standards. This interface will be modular, providing the instruments with different interface communication capabilities such as Ethernet, CANBus or even point to point for simple applications or for very low power observation platforms.

CONCLUSION

A new multifunctional Web Enabled Ocean Sensor System architecture is proposed in order to enable future development of cost efficient fixed and mobile observing platforms for real-time or near real-time providing open and standard downstream services to the public and private sectors. The design and development of a Smart Electronic Interface for Sensor Interoperability (SEISI) is also proposed in order to provide communication and synchronization with proprietary oceanographic instrument, data processing and a standard communication interface with upper layers.

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