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EMSODEV

EMSO implementation and operation: DEVelopment of instrument module

REPORT ON WORKSHOP ON SCIENTIFIC REQUIREMENTS

D2.1

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1. Executive Summary

The proceedings of a meeting held in Heraklion, Greece on 23-24 September 2015 are described. The sensors already installed on 15 operational observatories of the EMSO network are documented. During the meeting there was agreement on seven core parameters that should be accommodated by the EMSO Generic Instrument Module (EGIM):

- Temperature
- Conductivity
- Pressure
- Dissolved O2
- Turbidity
- Ocean currents
- Passive acoustics

Reviewing the architecture of EGIM it is anticipated that up to 5 additional ports will be available. These can either be used to duplicate sensors or for additional optional parameters that would be selected according to the site:

- Fluorescence /Chlorophyll-A
- pH
- partial CO2 pressure
- partial CH4 pressure
- Imaging cameras.

It was concluded that all the core sensors should have a high technology readiness level (TRL) and are available commercially off the shelf (COTS). EGIM ports can also be used for development and trials of new sensors not yet at high TRL. EGIM will be designed for installation on the sea floor or in the water column, either connected to a cable or autonomous, powered by a local battery pack. The implications of different configurations are reviewed.

Information is collated on sensors required for the EGIM nodes, how they can be integrated into the EGIM package and the availability of sensors commercially off the shelf.

2. Introduction

A workshop was convened during 23-24 September 2015 in Heraklion to meet the following objectives as stated in the contract.

D2.1: Workshop on Scientific Requirements (M3): In the framework of Task 2.2 a workshop will be dedicated to update the generic parameter list. The needs of scientists and public/private users, the present situation in terms of sensors already in place in the various nodes as well as the sensor maturity will be discussed and documented.

Task 2.2 Scientific Parameter Requirements [M1 – M3]

This task will update the generic parameter requirements according to the scientific, public and private user community needs. It will be based on what is already in place at different sites plus new developments that are feasible within the time frame of the project. The performance of candidate sensors will be validated (QC/QA from ESONET and EMSO PP) against the experience of a larger community (EMSO ERIC present and future partners, ESONET-Vision ASBL), ***through a dedicated workshop****. The low level engineering data formats, time stamping, metadata, sensor metadata in terms of how they affect multiplexing within the EGIM will be collated to enable incorporation into practical design proposals. Necessary calibration procedures will be defined. An initial list of parameters could be enriched with additional parameters including pCO2, pH, pCH4, and Chlorophyll. This could be considered in case of specific needs and opportunities identified during the project lifecycle and based on additional national funds obtained by the observatory owners*.

The agenda and the list of participants are both given in the appendix.

The discussion in the meeting was structured in three parts related to the tasks to be carried out in WP2.

Session 1. Scientific Parameter Requirements (Task 2.2.)
Session 2. System Requirements of the EMSO nodes (Task 2.1)
Session 3. Off-the-shelf Instrumentation Survey and Selection (Task 2.3)

Rather than simply updating the generic parameters list this enabled the meeting to fully consider the implications of any sensor choice in terms of the system requirements to create the integrated EGIM package and whether the sensors are indeed commercially available.

For each session a plenary speaker presented an overview of the topic and this was followed by structured discussion. Additional material not available at the time of the meeting was collated afterwards in order to prepare this report through correspondence, *ad hoc* meetings and further research.

3. Introduction to the EGIM (EMSO Generic Instrument Module)

EGIM is a key component of EMSO (European Multidisciplinary Seafloor and water-column Observatory) that has installed an expanding network of observatories in the seas around Europe equipped with multiple sensors monitoring a range of environmental parameters.

Hitherto these observatories have used a variety of ad hoc or pre-existing solutions to configure the sensor suites and retrieve data back to shore. EGIM is a hardware and software module that integrates a standard suite of sensors into a package that can be deployed at the different locations. This will have advantages of improving comparability of data between stations, decreasing costs, improving reliability and accelerating implementation of the full network. The same core variables will be measured at the different stations in the most similar way feasible and EGIM will allow additional site-specific or mission-specific sensors to be added.

EGIM will provide everything required by the sensors to ensure best measurement quality and long - term reliability. The sensors will be mounted in an optimal operational configuration with energy distribution, control, time stamping, measurement sequencing and data handling. Optional hardware and software interfaces will allow EGIM to be used in different ways:

A. Attached to a sea floor cable for real-time data transmission and electrical power.
B. Attached to a stand-alone node providing on-board battery and data storage. Intermittent data link to shore.
C. Sea floor, surface buoy or water column location.

4. Present situation of instruments already in place at the EMSO nodes.

The previous paragraph gave a brief description on what an EGIM module is and where the module is going to be deployed. It is therefore necessary to give more specific information on each of the fifteen (15) EMSO sites (Figure 1) and especially the current instrumentation used for collecting scientific data. The following paragraphs refer to each EMSO node and the respective tables including the present instrumentation load of each node with information on the location and depth.

Description of sites and information on instrumentation can be found at http://www.emso-eu.org/infrastructure/emso-sites-description.html; http://www.fixo3.eu/observatory/, FixO3 deliverable D2.2, D7.2; Multidisciplinary Oceanic Information SysTem (MOIST http://www.moist.it); EMSO France (http://www.emso-fr.org/), ESONET NoE (http://www.esonet-noe.org/); Statoil / Havforskningsinstituttet Ocean Observatory (http://love.statoil.com/Documentation); Hypox D6.1 (http://hypox.pangaea.de/); Aanderaa application Support package #5: The Koljoefjord Observatory.

Figure 1. EMSO node locations

Fram Strait (Arctic) 79.0°N 04.0°E Depth range: 1000-5500 m

Description:

An array of up to 17 moorings has been maintained in Fram Strait since the 1990s. The array is jointly operated by the Norwegian Polar Institute, which maintains moorings in the Arctic outflow in eastern Fram Strait, and the Alfred Wegener Institute, which maintains moorings in the Atlantic inflow in eastern Fram Strait. Moorings and long-term lander systems since 2000.

Surface and Midwater

Hosting: Oceanographic and sediment-trap moorings can host additional autonomous systems. Annual ship operations are used for sensor installation, maintenance and data download (real-time communication projected).

Measurements and sampling: CTD, water sampling, plankton hauls, detection of zooplankton by optical systems like LOKI (Lightframe On-sight key-species Investigation).

Data: pH, CO2, Chl-a, salinity, temperature, dissolved oxygen, fluorescence.

Seafloor

Hosting: Additional sensor packages and experiments can be mounted on moored lander systems.

Measurements, sampling and observation: Microprofiler and SCOC measurements; Sediment sampling with multicorer and box corer; ROV-based sampling upon request; seafloor imaging (camera systems).

Data: Salinity, temperature, currents, oxygen, particle flux, CO2

Instrumentation	Parameter	Configuration	Depth (m)
MPI Sediment oxygen profiler	DOXY	Benthic Lander	2500
Aanderaa RCM 11 + 5 optodes	COND, DOXY, TEMP, Currents, TURB,	Benthic Lander	2500
Aanderaa SEAGUARD optode	DOXY	Mooring line	1200
SBE 37 SMP	COND, PRES, TEMP	Mooring line	50, 2500
Aanderaa RCM 11 + optodes	COND, DOXY, PRES, TEMP, TURB, Currents	Mooring line	50, 250, 1500, 2300
SBE 37 Microcat	COND,TEMP	Mooring line	50, 250, 500, 1200, 1700
ADCP	Currents	Mooring line	50, 250
Current meter	Currents	Mooring line	50, 250, 500, 1200, 1700

Celtic/Porcupine 49.0°N 16.5°E Depth range: 0-4850 m

Description:

Porcupine Abyssal Plain (PAP). Active time-series station since 1980s. Some data transmitted in near real-time by satellite.

Previous/recent activities: understanding the controls of biogeochemical fluxes in the open ocean to the deep seafloor and detecting climate driven trends from natural variability in the North Atlantic, biomass and community structure over time, C sequestration, remineralisation- estimates of respiration understanding the effect of episodic events, trace pulse events from climate and surface ocean to seafloor influences, contribute in situ data to understanding of global change.

The PAP observatory lies south of the main stream of the North Atlantic Current and is subject to return flows from this coming from the West and Northwest. An intermittent stream of cyclonic and anticyclonic mesoscale eddies cross the site extending sometimes several thousand meters into the water column. The winter condition at the site is of a mixed layer as deep as 800m driven by thermally driven convective overturning although throughout the winter there are short periods of stability during which the mixed layer may only be a few tens of meters thick.

Surface and Upper Ocean

Hosting: The surface buoy and full depth mooring can host additional instrumentation for atmospheric, air-sea interface and upper-ocean monitoring.

Data: Water column: Salinity, temperature, currents, pCO2, dissolved oxygen, nutrients, Chlorophyll-a

Sub-surface Sediment Trap Mooring

Hosting: The sub-surface sediment trap mooring can host additional instrumentation at depths between 3000 – 4800m depth

Data: particle flux and currents

Seafloor

Hosting: Lander system with Bathysnap time-lapse camera positioned on the seafloor at 4850m depth.

Additional sensors can be mounted on module. Communication with surface via acoustic modem is planned during FixO3.

Data: time-lapse photography for seafloor ecosystem studies.

Instrumentation	Parameter	Configuration	Depth (m)
Satlantic ISUS V3	NTOT	Mooring line	25
SBE 37IMP - ODO	COND, PRES, TEMP	Mooring line	25
SBE-37IMP	COND, PRES, PSAL, TEMP	Mooring line	1.75
Wetlabs FLNTUSB	CPHL, TURB	Mooring line	25
Satlantic SeaFET	PHPH, RELH	Mooring line	3000
Aanderaa 4797 CO2 optode	CO2	Mooring line	1
Aanderaa 4330 O2 optode	DOXY	Mooring line	25
Turner Cyclops fluorometer	CPHL	Mooring line	25
Satlantic OCR 507 ICSW	Irradiance	Mooring line	25
Satlantic OCR 507 R10W	Irradiance	Mooring line	25
Pro Oceanus CO2 pro	CO2	Mooring line	25
Pro Oceanus GTD pro	CO2	Mooring line	25

Osmo sampler		Mooring line	3050
Wetlabs Cycl –P Phosphate analyser	PHOS	Mooring line	25
Pro Oceanus CO2 pro	CO2	Buoy	25
Satlantic OCR 507 ICSA	Irradiance	Buoy	25
Satlantic SeaFET pH	PHPH	Buoy	25
Star-oddi CTD	COND, PRES, TEMP	Mooring line	25
Aanderaa RCM 30m ADCP	Currents	Mooring line	1
Bathysnap	Images	Benthic Lander	4800

Azores Islands 37.5°N 33.0°W Depth range: 1700

Description:

The Lucky Strike EMSO-Azores observatory is devoted to the integrated study of mid-ocean ridge processes, from the subseafloor to the water column. It is set atop an active volcano, which hosts one of the largest active ridge hydrothermal vent sites. The main scientific objectives are:

- to study hydrothermal heat and chemical fluxes to the ocean in relation with seismicity, volcanic activity and ground deformation at a diverging plate boundary.
- to study the impact of telluric, climatic and anthropogenic changes on deep seafloor ecosystems and hydrothermal communities.
- to study the dynamics of water masses in relation to the steep axial valley topography, and their impact on the dispersion of hydrothermal effluents.
- site active for more than a decade.

The site has three (3) submarine nodes linked to a surface buoy with hydro acoustic modems. The nodes are:

- SeaMoN West:
  This is the station moored in the lava lake. It serves the local set of sensors and provides bi-directional acoustic communication with the surface buoy. SeaMoN West is dedicated to geophysical observations.
- SeaMoN East:
  This is the station positioned at the base of the Tour Eiffel active edifice. It serves the local set of sensors and provides bi-directional acoustic communication with the surface buoy. SeaMoN East is the EMSO-Azores ecological node.
- Locean mooring

Instrumentation	Parameter	Configuration	Depth (m)
Geodesy GPS	Coordinates, alt., geoide height	BOREL	buoy
Meteorological station	Wind speed, direction, Tre, pressure	BOREL	buoy
Iridium GPS	Coordinates	BOREL	buoy
Aanderaa 3830 O2 optode	DOXY	SeaMon East Seabed platform	1695
Temperature	TEMP	SeaMon West Seabed platform	1695
Pressure	PRESS	SeaMon West Seabed platform	1695
Broad Band Seismometer	Seismic	SeaMon West Seabed platform	1695
Ifremer CHEMINI Fe	Iron Analyser	SeaMon East Seabed platform	1695
Ifremer SMOOVE Video Equipment	Images	SeaMon East Seabed platform	1695
Wetlabs ECO BBRTD	TURB	SeaMon East Seabed platform	1695
Microcat	Cond., Press., Tre	LOCEAN mooring	1688, 1000
Aquadopp	Currents	LOCEAN mooring	1686

PLOCAN 29.17°N 15.5°W Depth range: 50-3670 m

Description:

ESTOC/PLOCAN - European Station for time-series on the ocean, operating since 1994

A multidisciplinary mooring, located in the Central Eastern Atlantic, open ocean site with over 15 years of continuous surface and mid-water meteorological, physical and biogeochemical monitoring

PLOCAN will also be starting to operate a scientific offshore platform on the East Coast of Gran Canaria. ESTOC will benefit from the platform day-to-day operations. The planning of seafloor monitoring is programmed although currently at requirement stage. It is anticipated that as a minimum, either open ports or spaces will be made available at the seafloor.

Surface and Mid-water

Hosting: Mooring can host autonomous systems (real-time communication between midwater and surface is not yet implemented). Clamp systems and other mechanical adapters can be manufactured locally upon request.

Data: Ocean-Air interface: pH, CO2, Chl-a, salinity, temperature, dissolved oxygen Water column: Salinity, temperature, nutrients, current.

Instrumentation	Parameter	Configuration	Depth (m)
Envirotech NAS 3X	NTRA	Mooring line	150
Ocean Seven OS304	COND, TEMP, PRES, DOXY	Mooring line	100
Wetlabs ECO-FLNTU	CPHL, TURB	Mooring line	100
SensorLab SP-101SM	PHPH	Buoy	1.5
Nortek Aquadopp 400kHz	Current, TEMP	Mooring line	80
Pro Oceanus CO2 pro	CO2	Buoy	1.5
Sindemar SW 03 pH	PHPH	Buoy	1.5
HS Engineers ISM 2001C	Currents	Buoy	150
Aanderaa 4835 O2 optode	DOXY	Buoy	1.5
SBE 4M CT		Buoy	1.5
Cyclops 2100 000 T	TURB	Buoy	1.5
Cyclops 2100 000 C	CPHL	Buoy	1.5
SBE 37 SMP	COND, TEMP	Buoy	1.5
SBE 37 SM	COND, TEMP	Buoy	1.5
SBE 3S	TEMP	Buoy	1.5
SBE 37 SM	COND, TEMP	Mooring line	60, 100, 150

Norwegian Margin 68.0°N 14.0°E Depth range: LoVe 255 m, LOOME 1260 m

Description:

Hovden is up and running, online for real time data and historical data since September 2013.

The Norwegian Margin region has shown slope instability with evidence of major slides which, if repeated, could result in catastrophic damage to offshore oil and gas installations as well as indirect effects of tsunamis striking the coasts of the British Isles and elsewhere.

LOOME:

Investigation of the temporal variability at an active gas emitting mud volcano covering the sequence of events before, during, and after an eruption; analysis of their effects on gas hydrate stability, seafloor morphology and the distribution and colonization patterns of benthic communities. The Snøhvit gas production field in the Barents Sea operated by Statoil is equipped with a junction capacity for a scientific monitoring node in water depths of 250-345m

Research: particular interests are detection of subsea leaks of natural gas and possible leaks of CO2 with an array of instruments, aimed to measure downwards (geo-acoustics, deep T measurements), surface phenomena (T-strings and sensors measuring DOXY, pH and ORP), and sensors for the water column (turbidity, pressure, T, salinity, DOXY, and gasflares by scanning sonar), camera.

LoVe:

Still camera, conductivity, compass, chlorophyll, turbidity, depth, acoustic backscatter, passive acoustics. This is a cabled observatory.

Instrumentation	Parameter	Configuration	Depth (m)
Aanderaa RCM 11	DOXY	Benthic Lander	1260
	PHPH	Benthic Lander	1260
	TEMP	Benthic Lander	1260
	Redox	Benthic Lander	1260
	Currents	Mooring line	1257.5
	DOXY, COND, TURB	Mooring line	1257.5
	COND, TEMP	Mooring line	1258.5
	DOXY, COND, TEMP	Mooring line	1259.5
Geophones (OBS)	Seismic	Benthic Lander	1260
Simrad EK60 70 kHz	Acoustic backscatter	Seabed Platform	255
Simrad ES70 -CD	Acoustic backscatter	Seabed Platform	255
Nortek Long ranger ADCP	Currents	Seabed Platform	255
Nortek 600 kHz ADCP	Currents	Seabed Platform	255
METAS DSF5210 camera	Images	Seabed Platform	255
METAS DSF 4365 lights		Seabed Platform	255
Ocean sonic SB35 ETH 10 – 200000 Hz	Passive acoustics	Seabed Platform	255
Seapoint	CPHL, TURB	Seabed Platform	255
Aanderaa 4112A optode	TURB	Seabed Platform	255
Aanderaa 4117D	PRES	Seabed Platform	255
Aanderaa 4319A	COND	Seabed Platform	255

Iberian Margin 36.4°N 09.5°W Depth range: 3000 m

Description:

Iberian sea observatory in the Gulf of Cadiz is a region of complexity with the junction of the Eurasian and African plates resulting in doming of the sea floor, mud volcanoes and other complex features. The interaction of the Mediterranean outflow with Atlantic waters is significant. The main aim is the set-up and operation of a monitoring seismic network in the Gulf of Cadiz for the evaluation and mitigation of hazards coupled with the capability of an early detection of tsunami generation.

• GEOSTAR - Geophysical and Oceanographic Station for Abyssal Research
• Area of geophysical activity near Eurasian and African plate boundary off Portuguese coast
• Mud volcanoes, pockmarks, mud diapers, carbonate chimneys, hydrocarbon venting and faulting

Instrumentation	Parameter	Configuration	Depth (m)
RDI WorkHorse 300 kHz	Currents	Seabed platform	3000
SBE 16plus	COND, TEMP, PRES	Seabed platform	3000
Nobska MAVS-3	Currents	Seabed platform	3000
IFSI (INAF) Prototype #2	Gravity	Seabed platform	3000
Paroscientific 8CB-4000-I	PRES	Seabed platform	3000
Guralp CMG-40T	Seismic	Seabed platform	3000
ECO-BB(RT)D 6000m	TURB	Seabed platform	3000
OAS E – 2PD Hydrophone	Passive acoustics	Seabed platform	3000

Galway Bay, Irish West Coast 53.2°N 09.3° W Depth range: 23 m

Description:

The project will facilitate the acquisition and installation of an underwater cabled observatory which will run from Spiddal to a distance of 4 5 km out to sea. The cable terminates at an underwater hub or node, which will provide power to and collect data.

The sub-sea cabled observatory includes: fibre optic data and 400v power cable, high speed communications via 4 pairs of optical fibres and a sub-sea cabled sensor platform which will host a variety of sensors and equipment which can be tested and demonstrated in near real-time.

The cable end equipment will host a total of 18 electrical interfaces (ports) capable of receiving scientific instrumentation (science ports). One of the ports will be used for earthing, leaving 17 ports available for instruments.

These ports provide electrical power (DC current at different current intensities and voltages) and two-way data links to the instruments. The data links can be either Serial (any of three Serial protocols) or Ethernet.

The CEE (Cable End Equipment) will also host a total of 4 electro-optical interfaces, and one coaxial interface (reserved for video).

The cable will also host an acoustic array on one of the optical ports; this array will incorporate 18 hydrophones (6 hydrophone lines with 3 hydrophones per line), over 2km of cable transmitting nearly 200 Mbps of data.

The observatory started its operation in August 2015.

Currently there are 12 spare ports designed into the sub-sea monitoring station(s) to allow for the testing, demonstration and validation of novel marine sensors.

There is a planned installation for May 2016 adding two (2) more sensors:

- Seabird SBE 16plus (COND, TEMP, PRES)
- Seabird SBE 43 (DOXY)

Instrumentation	Parameter	Configuration	Depth (m)
RDI Teledyne ADCP 600kHz	Currents	Seabed platform	23
Wetlabs ECO FLNTU	CPHL, TURB	Seabed platform	23
OceanSonics icListen HF	Passive acoustics	Seabed platform	23
Kongsberg OE14-522	Images	Seabed platform	23
Idronaut Ocean Seven 304Plus	COND, TEMP, PRES	Seabed platform	23

Iroise Sea - Molene Island 48.5°N 04.9°W Depth range: 20 m

Description:

EMSO-Molène is a cabled observatory dedicated to long term and high-resolution monitoring of coastal biodiversity and biomass. It is also a testing site for sensor and equipment in situ qualification.

On 13 June 2012 the pilot cabled observatory was launched off the Island of Molene, some 7 nautical miles off the coast of Brittany. The cable extended 2 km offshore from the landing point to an undersea node providing broad communication and power to an array of sensors including acoustics, current meters, underwater HD cameras and environmental parameters.

Instrumentation	Parameter	Configuration	Depth (m)
Fluorometer	CPHL	Seabed platform	18
CTD	COND, TEMP, PRES	Seabed platform	18
Hydrophone	Passive acoustic	Seabed platform	18
Nortek Aquadopp profiler 1Mhz	Currents	Seabed platform	18
Ifremer F8842 Video Camera	Images	Seabed platform	18
Aanderaa O2 Optode	DOXY	Seabed platform	18

Ligurian Sea 42.8°N 06.17°E Depth range: 50, 1000, 2350, 2500 m

Description:

Specific conditions make the Ligurian site unique location for a multidisciplinary long-term eulerian monitoring. Scientific features are:

- Slope failure processes on a steep continental slope
- Turbidity currents in submarine canyons and their force factors
- Seismic hazard, tsunami generation and the impact of seismicity on continental slope stability
- Marine biodiversity and life in deep oceanic environments
- Lateral and vertical dynamics of water masses and their impact on biochemical budgets
- Fluxes of organic matter through the water column, their impact on regional carbon budgets

The EMSO Ligurian cabled and buoyed observatory infrastructures are:

- ODAS Côte d'Azur buoy, presently operated by Météo France.
- Var canyon experiment.
- DYFAMED long term mooring.
- EMSO-Nice cabled observatory.
- SJB cabled add on extension to the neutrino telescope ANTARES to be moved to MEUST in 2017.
- ALBATROSS additional extension to the neutrino telescope moved from ANTARES to MEUST.

Instrumentation	Parameter	Configuration	Depth (m)
Guralp CMG 3T seismometer	Seismic	Seabed platform	2400
RDI ADCP	Currents	Seabed platform	2400
Aanderaa 3830 O2 optode	DOXY	Seabed platform	1925
SBE 37 SMP	COND, PRES, TEMP	Seabed platform	2200, 2300
Aanderaa 3830 O2 optode	DOXY	Mooring line	2300
IODA6000 O2	DOXY	Mooring line	2000
SBE 37 ODO	COND, TEMP, PRES	Mooring line	350, 2000
Satlantic ISUSv3 Nitrate/UV	NTOT	Buoy	50
SBE 37 SMP	COND, TEMP, PRES	Mooring line	200, 350, 700, 1000, 1500, 2000
Nortek Aquadopp 3000	Currents	Mooring line	200, 1000

Western Ionian 37.5°N 15.4°E Depth range: 2000 m

Description:

NEMO-SN1 and OnDE seafloor observatories:

- Cabled to laboratory in harbour of Catania by electro-optical cable. Operating in real time since 2005.

In Western Ionian Sea (2100 m depth, 25 km off-shore the harbour of Catania) a cabled deep-sea observatory was set up and is operational in real time since 2005: the cabled deep-sea multi-parameter station NEMO-SN1 (@TSN branch), equipped with geophysical and environmental sensors and the cabled NEMO-OvDE station (@TSS branch), equipped with 4 wide-band hydrophones.

The site infrastructure consists of a shore laboratory, a 28 km long electro-optical cable connecting the shore lab to the deep-sea lab. The shore laboratory hosts the land termination of the cable, the on-shore data acquisition system and power supplies for underwater instrumentation.

In early 2016 a recently built junction box will be deployed at TSN. The junction box will provide four electro-optical ROV operable connectors available for hosting new stations, providing fibre-optic Ethernet connections to shore and 300 VDC power supply. Users may use electro-optical jumpers to mate with the junction box that are already available. The junction box includes an acoustic modem (connected to a ROV mateable connector for servicing) that will provide a real-time link to an instrumented mooring line deployed nearby to measure water-column parameters. The same acoustic modem could be useful to link to other devices.

Seafloor

Hosting: NEMO-SN1 modules have spare connectors to host other systems for long term real-time data acquisition. The TSN cable branch has 2 conductors and 4 fibres directly connected to shore, the TSS branch has 4 conductors and 6 fibres.

Data: temperature, conductivity, pressure, punctual vector current speed, current profile, seismics, acoustics, magnetics, gravity

Instrumentation	Parameter	Configuration	Depth (m)
Vectorial Magnetometer	Magnetic field	Seabed platform	2036.6
Guralp CMG 1T	Seismic (Broadband)	Seabed platform	2036.6
E – 2PD Seismic hydrophone	Passive acoustics	Seabed platform	2036.6
SCRIPPS UCSD DPG Differential Pressure	Pressure	Seabed platform	2036.6
SMID DT-405D(V)1 Seismic hydrophone	Passive acoustics	Seabed platform	2036.6
LandMark10 Accelerometer	Acceleration	Seabed platform	2036.6

Paroscientific APG 8CB-4000	Pressure	Seabed platform	2036.6
Marine magnetics Sentinel 3000 Scalar magnetometer	Magnetic field intensity	Seabed platform	2036.6
Nobska MAVS-3 Current meter	Water current speed	Seabed platform	2036.6
RDI Workhorse 600 KHz ADCP	Water current profiles	Seabed platform	2036.6
SBE 37 SM	conductivity, temperature, pressure	Seabed platform	2036.6
Gravity meter INAF-IAPS prototype #2	gravity acceleration	Seabed Platform	2036.6
4+4 high frequency hydrophones (96/192 kHz)	passive acoustics	Seabed platform	2036.6

Western Ionian 36°25.010 N, 15°53.660 E, Depth range: 3500 m

In early 2016 a recently built junction box will be deployed at the Capo Passero site of the Western Ionian EMSO node. The junction box will provide four electro-optical ROV operable connectors available for hosting new stations, providing fibre-optic Ethernet connections to shore and 300 VDC power supply. Users may use electro-optical jumpers to mate with the junction box that are already available.

A multidisciplinary cabled observatory, under construction, will be deployed also in early 2016 at the Capo Passero site on the seafloor (3500 m w.d.). The observatory will be the evolution of NEMO-SN1 and will host a similar set of scientific instruments, to acquire data in real-time.

Hellenic Arc 36.8°N 21.6°E Depth range: 0-4500 m

Description:

The Hellenic node site, part of the deep-sea observatories in the framework of ESONET and ESFRI-EMSO –PP, is a fixed deep-sea observatory platform that connects to land via a submarine cable providing high bandwidth data connection and power supply.

The site is located in the SE region of the Ionian Sea 15 km NW of the town of Pylos in SW Peloponnese and at 1800 meters depth.

The location is scientifically representative of the wider area of the west Hellenic arc from western Crete up to south-west Peloponnese focusing on geo-dynamics, hydrologic and climatic processes.

The observatory is located close to a moored buoy, part of the POSEIDON network, that provides semi-real time measurements for water column up to the depth of 1000 meters includes a seabed platform with acoustic connection to a surface buoy at 1680 meters depth. In this view, the EMSO cabled observatory will complement the measurements, giving a more complete picture of the processes from sea-surface to sea-bottom and underlying layers. The location is only a few kilometres far from the deepest point of the Mediterranean basin.

Surface and water column

Hosting: Buoy can host additional instrumentation for atmospheric and air-sea interface parameters. Mooring can host both real-time as well as autonomous systems.

Seafloor

Hosting: Systems can be mounted on seabed lander. Communication with surface via acoustic modem for the existing sensors and possibly for additional systems (depending on configuration and technical requirements). One (1) free serial EIA 232 ports @ 12 VDC up to 1 amp, one (1) free port on SEAGURD module for an optode sensor.

The cable seabed platform will have one (1) spare ODI wet mateable connector with 4 FO @ 380 VDC at the CTA and four (4) spare EIA232 connectors @ 12, 24, 48 VDC on the platform itself.

Instrumentation	Parameter	Configuration	Depth (m)
Aanderaa 3919A C, T	COND, TEMP	Buoy	1
Nortek Aquadopp 2 MHz	Currents	Buoy	1
SBE IM 16plus SEACAT V2	COND, TEMP, PRES	Mooring line	20
Wetlabs FLRLTD Fluorometer	CPHL	Mooring line	20
SBE 63 Oximeter	DOXY	Mooring line	20
SBE IM 16plus SEACAT V2	COND, TEMP, PRES	Mooring line	50
Wetlabs FLRLTD Fluorometer	CPHL	Mooring line	50
SBE 63 Oximeter	DOXY	Mooring line	50
SBE IM 16plus SEACAT	COND, TEMP, PRES	Mooring line	75
Wetlabs FLNTUS Nephelometer, Fluorometer	CPHL, TURB	Mooring line	75
Aanderaa O2 3975 optode	DOXY	Mooring line	75
SBE IM 16plus SEACAT	COND, TEMP, PRES	Mooring line	100
Wetlabs FLNTUS Nephelometer, Fluorometer	CPHL, TURB	Mooring line	100
Aanderaa O2 3975 optode	DOXY	Mooring line	100
SBE 37 IM CT	COND, TEMP, PRES	Mooring line	250

SBE 37 IM CT	COND, TEMP	Mooring line	400
SBE 37 IM CT	COND, TEMP, PRES	Mooring line	600
SBE 37 IM CT	COND, TEMP	Mooring line	1000
Aanderaa DCS Current meter	Currents	Benthic Lander	1700
Aanderaa 4835 O2	DOXY	Benthic Lander	1700
Aanderaa 4112 Nephelometer	TURB	Benthic Lander	1700
SBE 37 SIP	COND, TEMP	Benthic Lander	1700
CONTROS CO2	CO2	Benthic Lander	1700
CONTROS CH4	CH4	Benthic Lander	1700
AWT pH	PHPH	Benthic Lander	1700
Paroscientific 8B APG	PRES	Benthic Lander	1700
SBE 16plus V2	COND, TEMP, PRES	Seabed platform	1800
SBE 63	DOXY	Seabed platform	1800
Eco-FLNTU RT Wetlabs	TURB	Seabed platform	1800
ADCP 75khz Teledyne	Currents	Seabed platform	1800
Pressure Paroscientific Digiquartz	PRES	Seabed platform	1800
AMT pH	PHPH	Seabed platform	1800
CO2 Pro Oceanus	CO2	Seabed platform	1800
Passive acoustics icListen HF Ocean Sonics	Passive acoustics	Seabed platform	1800
Vectorial Magnetometer	Magnetics	Seabed platform	1800
Seismometer CMG-40T Guralp	Seismic	Seabed platform	1800
Gravity meter	Gravity	Seabed platform	1800
Camera IP SIDUS SS429	Images	Seabed platform	1800

Marmara Sea 40.72°N 29.38°E Depth range: 167, 380, 670 m

Description:

Devoted to mainly earthquake research, but also environmental monitoring of deep sea.

INGV, in collaboration with CNR-ISMAR and the EC project MARSITE partnership, has deployed the SN4 seafloor observatory in the Gulf of Izmit (Marmara Sea). Ifremer has deployed in the context of ESONET, MARSITE and other projects several instruments such as OBSs and the active acoustic bubble tracker BOB. CNRS IUEM has deployed a geodetic acoustic array. The goal of these missions

is to collect multidisciplinary timeseries data to study the relationships between seismic activity and fluid flow along the North Anatolian Fault.
The cabled observatory is under specification. Depth rating has been cruise dependent.

Instrumentation	Parameter	Configuration	Depth (m)
Guralp CMG-40T	Seismic	Seabed platform	167
OAS E-2PD hydrophone	Passive acoustics	Seabed platform	167
SBE 16plus	COND, TEMP, PRES	Seabed platform	167
Wetlabs Echo-BBRTD	TURB	Seabed platform	167
Franatech METS CH4	CH4	Seabed platform	167
Contros HydroC CH4	CH4	Seabed platform	167
Aanderaa 3830 O2 optode	DOXY	Seabed platform	167
Nobska MAVS-3	Currents	Seabed platform	167
Ifremer/Simrad BOB Echo sounder	Acoustic backscatter	Seabed platform	670
Paroscientific	PRES	Seabed platform	167

Black Sea 45.0°N 33.0°E Depth range: 15-2000 m

Description:

The Black Sea is one of the largest regional seas of the Eurasian continent and unique in many of its geographical, geological, biological, hydrographical and socio-political characteristics. With anoxic conditions in the deep, problems with invasive species and high sediment loads delivered to the system, this area has unique problems requiring long-term stations.
The network will monitor the western Black Sea, regarding the geohazard events, environment, and also the offshore seismic activity, through state of the art equipment.

The network comprises a total of 5 stations of which 3 installed on the Romanian and 2 on the Bulgarian site.
Water column sensors (physical and bio-chemical sensors; ADCP); water-bottom pressure sensor; deep sea seismograph; DAM.
The real-time deep-sea gauge consists of an integrated multi-parameter system that will be mounted on three levels deep. They will provide data on physical-chemical and biological marine environment.
Each station has three levels of measurement of parameters arranged as follows:
For the 3 Romanian sea-stations:

Moored 160 km E-SE of the Romanian Black Sea coast, at about 90 m water depth, operated by GeoEcoMar.

Each instrument installed offshore is equipped with a real-time, bi-directional data communication that allows management from on-shore, provided by the Operational Data Centre located in Romania (GeoEcoMar - Constanta Branch). The system records and communicates hourly oceanographic data (water current speed and direction, conductivity, temperature, salinity, turbidity), meteorological data (EUXRo01 and EUXRo02) (wind speed and direction, temperature, pressure) and also alarms, in case of special events with risk for the coastal area.

Location of the buoys:

Station	Latitude	Longitude	Depth (m)
EUXRo01	44°42.357'N	30°46.700'E	79.3
EUXRo02	44°19.070'N	30°24.812E	90.3
EUXRo03	43°58.748'N	29°56.186'E	72.1

Each of the offshore buoy consists of three main units: a Surface Relay Buoy (SRB) with sensors about 5m below sea level, an Instrumented Mooring Line (IML) and an Underwater Tsunami Module (UTM), the last two, on sea floor.

The SRBs includes a communication box with GPS receiver, radio link allowing full control of the buoy from a nearby ship, iridium bilateral link with antenna for satellite data transmission to the Operational Data Centre and reprogramming of the sensors, active and passive radar reflectors, IALA signalling light and four solar panels for recharging the batteries.

The Underwater Tsunami Module is equipped with a high resolution pressure sensor and temperature sensor, mounted in titanium housing with pressure port at sea.

Each underwater instrument pack has an acoustic communication system for transmitting the data to the SRB, which retransmit via satellite Iridium bilateral link to the coordination centre, located in Constanta (Romania).

Instrumentation	Parameter	Configuration	Depth (m)
Aanderaa - Z Pulse Doppler current sensor	Currents	Buoy, Mooring line	5, 70, 80, 90
AADI Optode 4835	DOXY	Buoy	5
AADI 4880/4880R	TEMP	Buoy, Mooring line	5, 70, 80, 90
AADI 4319B	COND, TEMP	Buoy, Mooring line	5, 70, 80, 90
AADI 4112B	TURB	Buoy	5
AADI 4646C	TEMP, PRES	Buoy, Mooring line	5, 70, 80, 90
CYCLOPS-7 Turner Design	CPHL	Buoy	5

For Bulgarian sea-stations, the following 3 depth ranges (level of measurements) will be equipped with sensor packages:

Level 1: 0 - 10 m

Level 2: 20 – 30 m

Level 3: at the oxic-anoxic interface

The systems will provide data on physical-chemical and biological characteristics of the marine environment. For each level of measurement there will be installed an underwater observatory module able to integrate measuring sensors as follows:

Level 1	Level 2	Level 3
Oxygen, Temperature, Conductivity, Turbidity, Pressure, Chlorophyll, Multiwave length excitation fluorescence photometer, Doppler Current Sensor;	Oxygen, Temperature, Conductivity, Turbidity, Pressure, Chlorophyll, Doppler Current Sensor;	Temperature, Conductivity, Turbidity, Pressure, Doppler Current Sensor

Number of sensors for each station: Oxygen (2), Temperature (3), Conductivity (3), Turbidity (2), Pressure (3), Chlorophyll (2), Multiwave length excitation fluorescence photometer (1), Doppler Current Sensor (3);

OBSEA 41.18°N 01.75°E Depth range: 20 m

Description:

OBSEA seafloor observatory

- Cabled to laboratory in Vilanova i la Geltru (UPC Barcelona Tech) by electro-optical cable
- Site Nature 2000 network Operating in real time since 2009

Obsea offers the possibility to deploy different types of measurement instruments, communication modules or scientific experiments, and allow real time communication.

Devices can be deployed at 20m depth or at the surface buoy.

Obsea offers power supply (12 or 48Vdc up to 3 amps), Ethernet (10 /100Mbps) and serial communications, and synchronization over PTP IEEE Std 1588.

Instrumentation	Parameter	Configuration	Depth (m)
SBE 16 plus V2	COND, TEMP, PRES	Seabed platform	20
SBE 37 SMP	COND, TEMP, PRES	Seabed platform	20

Bjorge NAXYS hydrophone	Passive acoustics	Seabed platform	20
Nortek AWAC AST 1 MHz	Currents, waves	Seabed platform	20
Nanometrics Trillium 120P BB OBS	Seismic	Seabed platform	20
Underwater camera OPT-06	Images	Seabed platform	20

Koljoe Fjord, west Swedish coast 58.23°N 11.58°E Depth range: 0-42 m

Description:

Koljoe Fjord multiparameter on-line cabled observatory has been installed and in continuous operation since April 2011, with remote control and data telemetry implemented in real time over internet.

Koljoe Fjord is also a sampling site of a monthly monitoring program run by SMHI (Swedish Meteorological and Hydrological Institute). SMHI data are automatically retrieved from the SMHI web database for quality checking of T, S, O2 measurements.

Weather measurements from Sven Loven Marine Research Centre (Kristineberg, University of Gothenburg) are retrieved automatically for checking surface current measurements.

The observatory consists of a main hub, which is connected by cable to communication and power systems on land with real-time monitoring of T, S, O2, CO2, currents, basin water renewal dynamics and hypoxia establishment in between renewal events (O2/Salinity/currents), spring bloom dynamics (CO2/O2/chlorophyll/waves/turbidity/acoustic backscattering).

New antifouling strategies are developed and tested in the field.

The node is prepared to host four experimental modules communicating either with Ethernet or serial protocols.

Instrumentation	Parameter	Configuration	Depth (m)
Aanderaa 4319A	CONT, TEMP	Mooring	9, 12, 15, 18, 21
Aanderaa 4835 O2, T optode	DOXY, TEMP	Mooring	9, 12, 15, 18, 21
Aanderaa 4330 O2, T optode	DOXY, TEMP	Mooring	28.5
Aanderaa 4647	COND, PRES, TEMP	Mooring	28.5
Aanderaa DCS current meter	Currents	Mooring	28.5
Aanderaa RDCP 600 current profiler	Currents	Mooring	40.5
Aanderaa 3830 O2 optode	DOXY	Mooring	40.5

Aanderaa 3919A	COND, TEMP	Mooring	40.5
Aanderaa 3187	PRES, TEMP	Mooring	40.5
Aanderaa 3830 O2 optode	DOXY	Mooring	4
Aanderaa 3919A	COND, TEMP	Mooring	4

5. Scientific Parameter Requirements

Henry Ruhl (UK National Oceanography Centre, Southampton) gave a presentation entitled: *The EMSO Generic Instrument Module (EGIM) sensor suite; Current EMSO generic sensors and future requirements*

The purposes of this presentation were to review the philosophy behind ocean observatory science, examine what is being done within current observatory projects, identify key parameters, speculate on likely near future developments and set the scene for a discussion of the scientific priorities within EMSODEV.

The aim of observatories is to monitor processes from the atmosphere-ocean surface interface, throughout the water column to the sea-floor, the sediments and earth's crust below (Figure 2)

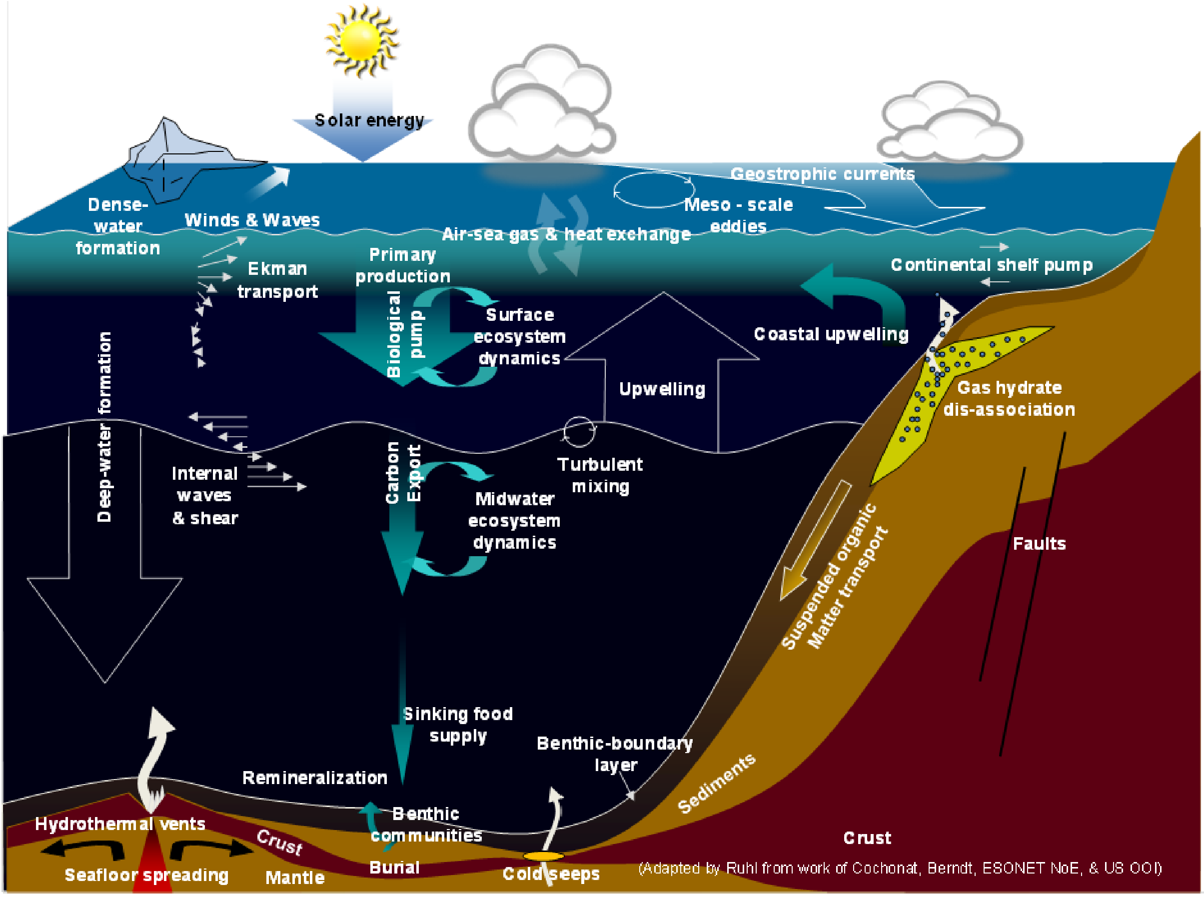

Figure 2. Ocean processes that can be studied by means of observatories

These processes are expressed on different spatial and temporal scales from molecular processes and turbulent mixing at millimetre and centimetre dimensions and time scales of seconds to minutes to climate change and mantle convection at global (10^4 km) dimensions and time scales of centuries to millennia. Fixed point observatories contribute uniquely on the temporal dimension with continuous vigilance on scales of seconds to years and decades with the spatial dimension determined by the spacing of the array, for example around Europe. The potential to monitor tsunamis as with the DART buoy system in the Pacific Ocean is a good example of a short temporal scale application (Milburn et al 1996 [1]), but with the caveat that many European marine geohazards are near-shore, and therefore need a different approach. Over the next century climate change is predicted to increase ocean temperature, decrease oxygen and pH, which will have additive effects, generally decreasing ocean biological productivity (Mora et al 2013, [2]). Sea floor biomass will decrease overall, but within European seas there may be differential effects, notably an increase in biomass in the Arctic region (Jones et al. 2014, [3]). These climate changes and the drivers producing them are amenable to detection by an effective network of ocean observatories operated over the next century.

The Overarching Science Themes are therefore

- Natural and anthropogenic change.
- Interactions between ecosystem services, biodiversity, biogeochemistry, physics and climate.
- Impacts of exploration and extraction of energy, minerals, and living resources.
- Geo-hazard early warning capability for earthquakes, tsunamis, gas hydrate release, and slope instability and failure.
- Connecting scientific outcomes to stakeholders and policy makers.

Within this framework the key question is what should be installed on EGIM? To qualify for EGIM a sensor or instrument should:

- Meets a key scientific driver
- Meets depth and endurance requirements
- Meet high TRL level
- Meet reasonable cost to implement

The Technological Readiness Level (TRL) is a concept originally developed within NASA for evaluating Space Technology. It has been widely used by various industries and organisations. Here we use the official EU table for adopted for the Horizon 2020 projects [4].

Technology Readiness Level	Description
TRL 1	basic principles observed
TRL 2	technology concept formulated
TRL 3	experimental proof of concept
TRL 4	technology validated in lab
TRL 5	technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)
TRL 6	technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)
TRL 7	system prototype demonstration in operational environment
TRL 8	system complete and qualified
TRL 9	actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)

EMSO serves a range of scientific disciplines and it is important to consider the requirements already specified by other organisations such as Global Climate Change Observing System (GCOS) Essential Climate Variables. These have been defined for Atmospheric, Terrestrial and Oceanic domains [5]. For the oceanic domain, **surface variables** are defined to include the surface mixed later usually within the 15m of the ocean and **sub-surface** are deeper measurements.

GCOS Essential Climate Variables Oceanic Domain	
Surface	**Sub-surface**
Sea-surface temperature	**Temperature**
Sea-surface salinity	**Salinity**
Sea level	**Current**
Sea state	**Nutrients**
Sea ice	**Carbon**
Current	**Ocean tracers**
Ocean colour	**Phytoplankton**
Carbon dioxide partial pressure	

Most of the commonly used sensors within EMSO have applications across a wide range of disciplines and the challenge is to come to agreed specifications regarding locations in the water column and on the sea floor, range, sensitivity, response time, and accuracy requirements.

Variable	Geosciences	Physical Oceanography	Biogeochemistry	Marine Ecology
Temperature	X	X	X	X
Conductivity	X	X	X	X
Pressure	X	X	X	X
Dissolved O_2	X	X	X	X
Turbidity	X	X	X	X
Ocean currents	X	X	X	X
Passive acoustics	X	X		X

The different disciplines also have important differences with regard to the time scale of measurements, some requiring fast responses time defined in seconds or minutes whereas for other applications daily or weekly sampling intervals are acceptable. The general operational expectation is that sensors or instruments should function for one year between servicing and recalibration. Examples of times series data already achieved on different time scales are the Station M data from the Nordic Sea showing salinity and temperature anomalies (1950-2010), bottom-water temperature increase at the Hausgarten site (2000-2008), submillimetric and sub second resolution of pressure changes in the NE Pacific measured by sensors on NEPTUNE and with the Tsunameter on board the EMSO SN-1 abyssal cabled observatory in the Mediterranean Sea. These studies show sensors that are available at TRL -9.

Data format, timing, interfacing issues and calibration procedures were also considered.

New technologies are emerging making possible completely new kinds of measurements. Apparent Oxygen Utilization (AOU) has been estimated for the Mediterranean deep sea from the difference between measured Dissolved Oxygen (DOXY) concentration and the predicted saturation DOXY concentration [6]. This raises the possibility that an appropriate network of observatories in the Mediterranean Sea could continuously measure total biological activity. Continuous acoustic and optical backscatter measurements can estimate turbulent total kinetic energy and suspended particulate matter transport for the geosciences [7]. Passive acoustics detectors arranged in appropriate three dimensional arrays can track marine mammals such as sperm whales and other cetaceans as already implemented for example on the ANTARES neutrino telescope facility in the Western Mediterranean Sea and at NEMSO-SN1 observatory in the Western Ionian. Great advances have been made in use of biogeochemical sensors for nitrate concentration, chlorophyll *a* fluorescence and p(CO_2) deployed in mid water on a long term mooring at the PAP (Porcupine Abyssal Plain Observatory) resulting in high resolution data over weekly to inter-annual time scales [8]. Time-lapse imaging is a well-established technique and major new possibilities are expected by improving digital cameras and image recognition technology [9]. Plenoptic light field camera with an infinite depth of field promise further advances.

The final question is, should the EGIM include the possibility of incorporation of new sensors or should it be focussed on existing technology well-established in 2015?

Discussion points and conclusions:

There was a wide-ranging discussion on issues raised by the talks

General specification for sensors

- Maximum depth: The required operating depth of sensors and instruments has been specified as 6000 m in order to cover all possible uses in European Seas plus a safety factor. The maximum depths likely to be encountered are 4900 m in the NE Atlantic Ocean (Madeira Abyssal Plain) and 5267 m (Calypso Deep, Ionian Sea, Mediterranean). However even in these locations sensors on mooring strings are likely to be nearer the surface than the sea floor. It was noted that insisting on full ocean depth capability would exclude many useful sensors and technologies and could make the EGIM unnecessarily heavy for shallow water or near surface deployment. It was concluded that depth ratings of individual EGIM installations could be varied according to the operational environment.

- X,Y,Z positioning of sensors: The basic concept of EGIM is a relatively compact frame, a few metres in maximum dimensions upon which all the sensors are mounted. For some applications sensors spaced out as an array are desirable. Tracking of bio acoustic sources can done by measuring times or phase of arrival of signals at hydrophones in a 3D array. It was noted that whilst large arrays are desirable, a 1.5 m tetrahedral arrangement at high frequency (200 kHz) could be effective. Vertical strings of thermistors have been very successful in detecting internal waves and other fine structure in the oceans [10]. It was agreed that the EGIM mechanical design should remain compact but if there is a mooring line, sensors distributed through the water column might communicate with the EGIM through an inductive modem using appropriate drivers.

- Service interval: It was noted that although a service interval of 12 months is desirable, arranging cruises at exact optimal times is rarely possible owing to scheduling conflicts, breakdowns or adverse weather. In practice this means a service interval of up to 18 months should be specified to maintain continuous operations.

- Redundancy (Duplicate or triplicate parameter measurements): In critical situations, to overcome the problems of instrument reliability, parallel redundancy may be an optimal solution. However, duplicating or triplicating all the sensors would use up all the anticipated EGIM input ports. Studies using replicate sensors would however provide useful information for calibration and drift, which could not be achieved any other way. This could be a promising research avenue. It was noted that many instruments include a temperature sensing capability since this forms part of the measurement algorithm, hence temperature is likely to be replicated in any typical EGIM installation.

- Drift linearity: It is generally assumed that between calibration prior to deployment and recalibration after recovery sensor drift has been linear during the intervening time period. If the drift is exponential, for example, this can probably be proved and compensated for, but more complex patterns may be difficult to elucidate. Sensor redundancy or replication seems to be the best way forward. Sharing information across the EMSODEV and wider EMSO community is important.

- Calibration constraints: The importance of effective calibration was emphasised, but it was noted that there are constraints, for example in checking calibrations at operational pressures is not usually possible. For some chemical sensors, such as pCO_2, pH, or nutrients, generating the appropriate test solutions may be very difficult. The calibration curves of some sensors are highly nonlinear, with temperature, conductivity and pressure effects requiring multi-dimensional polynomial techniques.

- Time scales: The response time of sensors varies from milliseconds to minutes. Specifications should be clear about what is possible (e.g. some chemical sensors have an inherently slow response time) and how readings are to be averaged or smoothed.

5.1 Measured Parameters

After extensive discussion a core set of seven parameters was agreed upon characterised by high TRL values, wide existing usage and relevance to multiple disciplines. The details of the implementation of these in relation to optimal measuring ranges, acquisition intervals and other factors will be determined after consultations with experts in each field of measurement.

A) EMSODEV CORE PARAMETERS

EMSO SUPPORTED CORE PARAMETERS				
Variable	**Range**	**Accuracy**	**Sensitivity**	**Comments**
Conductivity	0 to 9 S/m	0.001 S/m	0.00005 S/m	Review the range, follow physical oceanography standards
Temperature	-5 to +35°C	0.005 °C	0.0001 °C	Review response time of instruments Review sampling rate and range
Pressure	0 to 600 bar	0.1 % FSR	0.002 FSR	High frequency pressure sensor for tsunami
Dissolved oxygen	0 to 500 µM	5%	0.1 µM	Filter range to more be realistic Check different types of sensors
Turbidity	0 to 150 (0 to 50) NTU	10%	0.013 NTU	Preferably using optical back scatter[1] Wide diversity of ranges
Currents	0 to 5 m/s (50 m measuring distance)	2%	-	Review Range 0 to 5 m/s 2% of range (at least 0 – 50m) Boundary layer detection Active acoustics might lead to ethical issues[2]
Passive acoustics	20 – 200000 Hz	-	-190dB ± 3dB (re 1V/µPa)	Ideal configuration (cabled) tetrahedral configuration. 1.5 m @ 200Khz Worst case to be determined for standalone (typical 1 min recording every hour at few hertz to 50Khz)[3]

B) OPTIONAL SUPPORTED INSTRUMENTATION

[1]Turbidity measurement: There is such a great difference in values likely to be experienced in different waters around Europe that it is unlikely that one technology or one instrument would have sufficient dynamic range and resolution for all EGIM installations. Technological diversity seems inevitable

[2]Active Acoustics: It was noted that active acoustics may influence the passive acoustic measurements and could have a significant environmental impact influencing behaviour of marine animals. It is assumed that acoustic Doppler current meters are the optimum technology and processing of signals can give information on velocity profiles and abundance of particles in the water column.

[3]For passive acoustics cabled installations could take advantage of high data rates enabling tracking of animals. For stand-alone systems such high frequency sampling and high data rates are not possible.

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If it is assumed that the EGIM will have 10 to 12 input ports, this leaves capacity for either redundancy or optional additional instruments selected according to attributes of particular sites (e.g. vents or seeps) or particular science missions (primary production). The following set of instruments were agreed to have a sufficiently high TRL and scientific importance, to be considered as eligible for hosting on the EGIM as optional instruments to be decided upon at individual nodes.

EGIM SUPPORTED OPTIONAL PARAMETERS			
Parameter	**Range**	**Accuracy**	**Sensitivity**
Fluorescence /Chlorophyll-A	0 to 50 µg/l	-	0.02µg/l
pH	0 to 14 pH unit	0.005 pH unit	-
partial CO_2 pressure	0 to 4000 µatm	±1 % of reading	< 1 µatm
partial CH_4 pressure	0 to 40,000 µatm	±3 %	< 1 µatm

Imaging systems have been used in fixed-point ocean observing systems for about 40 years and have been responsible for important discoveries such as the seasonal deposition of organic matter aggregates on the deep sea floor [11]. There is a diversity of technologies. It is possible to use white light illumination, red light that is invisible to deep-sea creatures [12], or view ambient bioluminescence with no artificial illumination of the scene [13]. Combined with rapidly advancing digital imaging technology including high definition video, time-lapse stills, event-triggered imagery, stereo systems and image recognition software there is such a variety of possibilities that it was difficult to specify a standard solution. It was concluded that imaging systems will form an important part of EMSO observatories and it is desirable that the EGIM should be able to host these as part of the optional supported instrumentation. It was noted that optical instruments such as fluorimeters emit light, which may disturb high sensitivity imaging devices.

High Definition video and Still imaging Specifications		
Resolution	1600×1200	pixels
Minimum video capture speed	20	Frames per second
Sensitivity	0.05	lux
Sensor type	CMOS	
Sensor size	0.5	inches
Output protocol	TCP/IP	
Sensitivity to IR light	850 -900	Nano metres

Lighting system		
Minimum luminosity at one (1) meter	1000	Lux
Lighting temperature	6500	K

C) **OPTIONAL NON-SUPPORTED INSTRUMENTATION**

The following instruments were discussed but were judged to be of too low TRL or scientific priority to be supported by the standard EGIM. Individual EMSO node operators may seek to install these in parallel with the EGIM. Several of these are proposals emanating from GOOS (the Global Ocean Observing System)

- Ground velocity (seismic signals)
- Nutrients (GOOS proposal)
- Trace metals (GOOS proposal)
- Suspended Particulates (GOOS)

There was discussion as to whether EGIM should provide nodes for tsunami (high frequency pressure sensors) or earthquake (seismographs) detection as part of a public disaster warning system. Whilst such sensors may be hosted by the EGIM, their operational use in warning systems is not part of the work programme. Real-time transmission of data to public safety agencies is beyond the scope of EMSODEV.

Conclusions:

The outcome of the discussion was compared with the requirements specified for the EU Marine Strategy Framework Directive [14]. The EGIM contributes to over 20 of the 64 monitoring parameters of MSFD given in the table below, either directly or indirectly. The detailed specifications of core parameters will be determined by consultations with experts. The architecture of the EGIM should be able to host optional sensors.

EGIM Contributions to Monitoring Parameters of MSFD and their relevant MSFD indicators of COM DEC 2010/477/EU

MFSD Reference Number	MFSD Parameter	MSFD Indicator	EGIM Contribution
5	Fish distribution	1.1.1, 2.1.1, 2.2.1	Imagery (optional), Active acoustics
9	Habitats'(predominant, special, protected and endangered) characteristics	1.4.1, 1.4.2, 1.5.1, 1.5.2, 1.7.1, 6.1.1	Imagery (optional), Turbidity, Temperature, Dissolved Oxygen…
16	Marine mammals actual range	1.1.1.	Processed hydrophone data
17	Marine mammals natural range	1.1.1.	Processed hydrophone data
18	Marine mammals population dynamics	1.3.1, 4.1.1, 4.3.1	Processed hydrophone data
19	Marine mammals status	1.2.1, 1.3.1, 1.6.1	Indirect using processed hydrophone data
27	Phytoplankton species compositions and its geographical and its seasonal variability	1.7.1, 2.1.1, 2.2.1, 5.2.4	Indirect (input to physical oceanography and bio-geochemical models and potentially Chlorophyll A)
38	Zooplankton species compositions and its geographical and seasonal variability	1.6.2, 1.7.1, 2.1.1, 2.2.1	Indirect (input to physical oceanography and bio-geochemical models), Active acoustics
39	Acidification	1.6.3.	Direct (pH and pCO2 Optional)
43	Currents	1.6.3, 7.2.2	Direct
44	Depth	1.6.3, 7.2.2	Direct
46	Ice cover	1.6.3.	Direct (optional) upward looking sonar
47	Marine litter	10.1.1, 10.1.2, 10.1.3, 10.2.1	Direct Imagery (optional) and indirect (input to physical oceanography models), Turbidity
48	Mixing characteristics	1.6.3.	Indirect
50	Oxygen	1.6.3, 5.3.2	Direct
51	Residence time	1.6.3.	Indirect
52	Salinity	1.6.3.	Direct
53	Seabed bathymetry	1.6.3.	Direct
60	Temperature	1.6.3.	Direct
61	Turbidity	1.6.3, 5.2.2	Direct
62	Underwater noise	11.1.1, 11.2.1	Processed hydrophone data
63	Upwelling	1.6.3.	Indirect (input to physical oceanography models)
64	Wave exposure	1.6.3.	Contribution through current meter and pressure sensor data processing

6. System Requirements of the EMSO nodes.

Jérôme Blandin of Ifremer gave an introductory presentation entitled "**The EGIM System Concept**" which he had prepared jointly with Nadine Lantéri, Julien Legrand and Jean-François Rolin.

Firstly, EGIM was defined as a module able to operate from any EMSO node, hosting a set of sensors providing measurements of the seven core parameters defined previously, plus one or several additional sensors providing measurements of further generic variables of interest (including pCO_2, pH, pCH_4, Chlorophyll *a*, and imagery). EGIM should also be able to host new sensors that are unknown today that will meet future requirements

A central feature of EGIM is to take advantage of the EMSO infrastructure to have a number of ocean locations where the same set of core variables are measured the same way using the:

1. same hardware
2. same sensor references
3. same qualification methods
4. same calibration methods
5. same data format and access
6. same maintenance procedures

If achieved there will be scientific benefits, decreases in cost, improved reliability and benefits to the EMSO partnership through mutual understanding, sharing of know-how, and costs. The EGIM module should be able to host all the different types of sensors in the same way. That will be a key point to the modularity, inter-polarity and future evolution of the system. Furthermore the EGIM should be able to operate in any EMSO node such as a:

- mooring line
- seabed station, cabled or non-cabled
- surface buoy

The EGIM module should act as a host for a set of sensors and provide all the services required to ensure the best measurement quality and long-term availability. Those services being:

- Immersion, positioning, orientation and proper mechanical setting of the sensor in the medium to ensure its optimal performance
- Protection against external aggressions, once installed and during deployment/recovery operations
- Energy distribution and control
- Measurement sequencing
- Time stamping with a common clock, with high precision where necessary

- Measurement data backup and storage
- Protection against fouling, where necessary
- Blank measurements
- Communication with the external world through the node, either locally, from underwater with a visiting/installing submersible, semi-remotely - from the sea surface with programming and test means provided by a ship, or remotely - from underwater or from the sea surface, with an operator or a data centre on shore
- Recovery and restitution to human operators, on demand

The EGIM preliminary technical requirements to be reviewed during the workshop were:

Environment

- 0 – 6000 m depth

Operation duration without maintenance

- 1-year nominal

Interfaces with the EMSO infrastructure

- Power: 300-380 V dc for cabled observatories, 10-30 V dc for non-cabled platforms
- Communication: Copper or optical Ethernet 100BASE-T for cabled observatories, serial line to acoustic, satellite or inductive modem for non-cabled platforms

Interfaces with sensors

- Power: [5 – 24 V] dc
- Data: serial line or Ethernet

Deployment

- Should EGIM be deployed independently from the EMSO node and if so how should the connection be made, in air or underwater?

Redundancy

- How much redundancy is necessary in terms of sensors, energy sources and data logging resources

The main challenges in the design of EGIM are the very diverse implementation conditions whilst keeping the design as generic as possible.

Considerable experience has been gained through a series of previous EC funded projects dealing with long term ocean sensor platforms (e.g., ALIPOR, GEOSTAR-1&-2, ORION-GEOSTAR3, ASSEM, ESONET CA, ESONET NoE, EMSO PP) leading to considering the need to implement a generic ocean sensor system is necessary. An early implementation has been achieved through the **COSTOF2** project **COmmunication and STOrage Front-end** that can serve as an example for what EGIM might be like (Figure 3). COSTOF 2 adaptation to stand alone case and some specific sensors is underway in the WP12 of FixO3, this will benefit to EGIM.

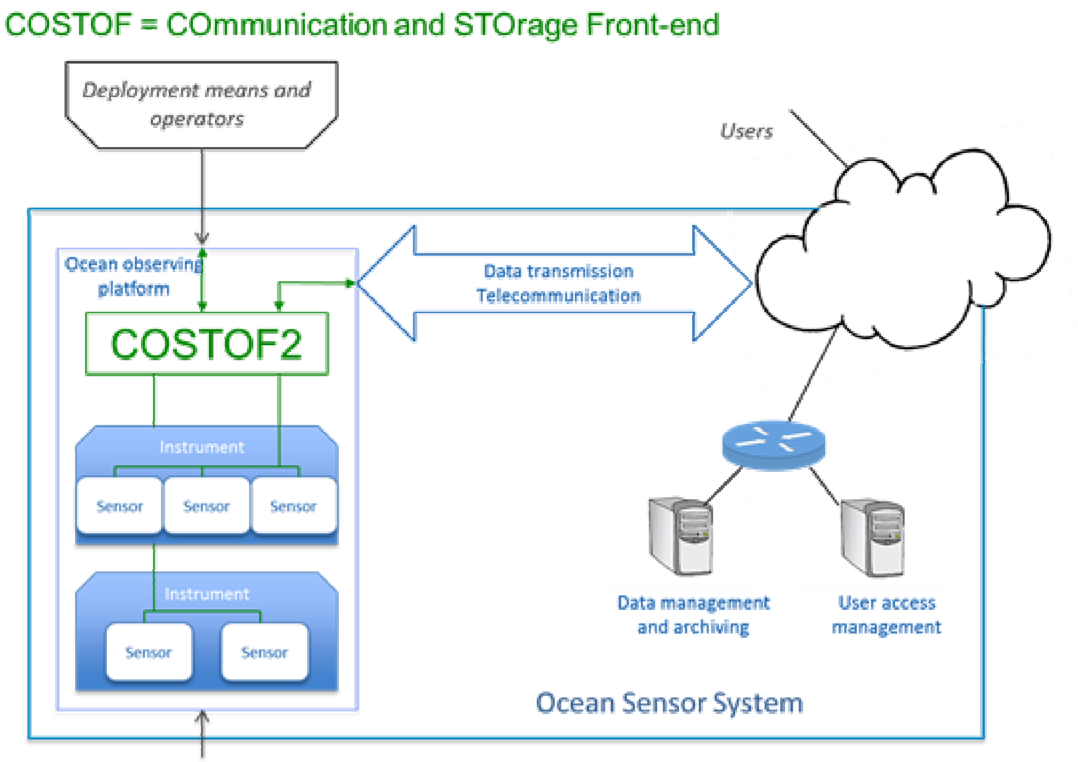

Figure 3. Conceptual sketch of a generic Ocean Sensor System

COSTOF2 provides the following sensor services

- Energy distribution & control
- Measurement sequencing
- Precision time stamping
- Measurement data storage
- Communication with the external world
- Protection against fouling (Built-in capability of micro-chlorination, ability to drive other active antifouling devices)

COSTOF2 performance and features

- Up to 12 sensors: Ethernet 100BASE-T (up to 4), Serial (RS232, RS422, RS485, 1-wire)
- Processing: ARM 32 bits Cortex M3 48MHz on each board
- Storage: µSDHC (up to 64 GB on each board), NAS + SSD (up to 1TB x2)
- User access through embedded web servers
- 2 time precision classes: TCXO or embedded atomic clock
- Sleep mode power: 1mW (with TCXO)
- TCP/IP connectivity (WIFI link) and non TCP/IP connectivity (Acoustic, inductive and satellite link)
- Software POSIX compatibility
- Easy sensor integration with SDK for drivers development
- Active fouling protection

- Monitoring and storage of technical parameters (Remaining energy, Voltage, Current, T°, pressure, Water ingress detection)
- Sensor and technical alarm management
- Transparent mode
- Data download and firmware upgrade through FTP

The following Sensor Drivers have already been developed for the system:

Sensor drivers already developed		
Manufacturer	**Model**	**Description**
Aanderaa	4330	O^2 sensor
Axis	Q1755	IP HD camera
Axis	Q1765	IP HD camera
Gill	Maximet	Meteo Station
Ifremer	Chemini Fe	Fe In-situ analyzer
Ifremer	CISICS	Hydrothermal fluid sampler
NKE	MP6	Multiparameters probe
Paroscientific	8CB4000-I	Pressure gauge
Seabird	SBE37SMP	CTD
Wetlabs	EcoNTU	Turbidimeter

COSTOF2 shows that the essential features of EGIM are feasible and can be achieved in a package with weight in air ca 650N and weight in water 350N mounted on a frame < 2m maximum dimension equipped with the core sensor suite as shown in figure 4.

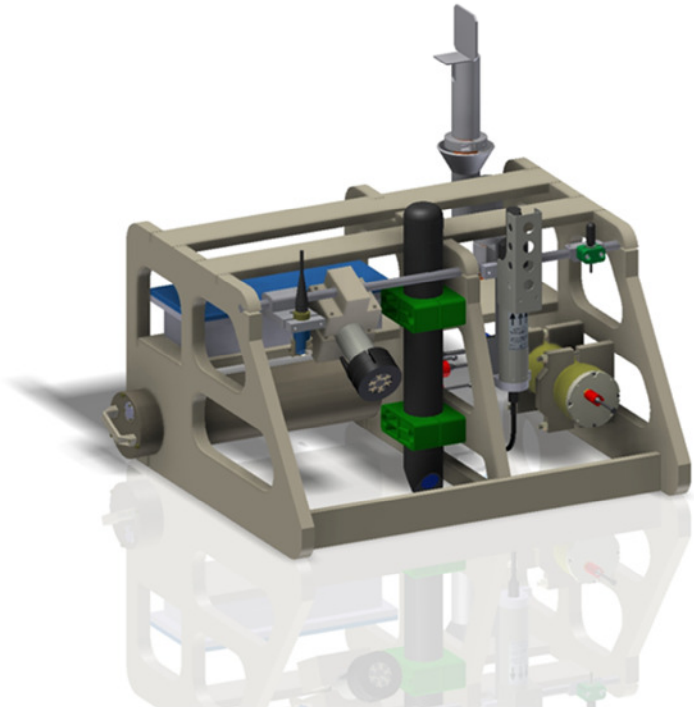

Figure 4. Conceptual mechanical configuration of the EGIM module

In conclusion, the EGIM concept, is the key to actual mutualisation of effort and technical know-how within the EMSO consortium. The time schedule for EMSODEV is quite short in which to realise a working system, but COSTOF2 provides a basis for the EGIM prototype (WP3), which can then be validated in shallow water tests (WP4).

Discussion:

A long discussion ensued to clarify issues surrounding the specification of the EGIM.

- The service interval should 15/18months instead of 12 but this might not be achievable in environments with severe fouling.
- In the case of non-cabled observatories the power supply is likely to be a Lithium battery pack but this does not form part of the EGIM module and must be provided by the user.
- The EGIM module will not support CAN-bus protocol for sensor communication
- The operating system of COSTOF2 is Free RTOS
- For synchronization the NTP can be used too, as an alternative to atomic clock for cabled applications.
- The power requirement for the atomic clock is 100mwatts
- So far reliability of COSTOF boards has been high with no failures.
- EGIM comprises one cable that goes to a junction box with Subconn connectors for the sensors.
- There are no analogue inputs on COSTOF2 and connecting an analogue sensor requires an A/D convertor. This will not be standard on the interface boards. A frame and other mechanical components will be part of the EGIM and will have to be adapted to user constraints.

- An ROV can be used to deploy/recover EGIM and additional buoyancy (syntactic foam) could be necessary to reduce the underwater weight to fit the ROV specification.
- EGIM should be deployed and connected using the standard techniques and means used on the node (ROV for deep sea nodes, small or medium boats and divers in shallow water, wet mateable or dry connectors...)

6.1 EGIM Architecture

As stated above the EGIM will provide everything that an instrument needs to function and measure. EGIM will also provide the functionalities for storing the measured data in a consistent way. EGIM will support an interface for transmitting the measurements.

The advantage will be to have a homogenous system across the EMSO nodes with the same hardware, same data format, measuring the same parameters (at least a sub set) with the same reference sensors and same qualification and calibration methods. The instruments must be seen by the EGIM the same way independent of the manufacturer. In order for EGIM to perform as expected and provide the necessary future expandability, a modular design approach will be used based on cascaded microprocessor boards that can provide the needed computational power, but at the same time consuming as little energy as possible.

General EGIM criteria are

- Must provide anything the sensor needs to produce quality measurements.
- It should be modular
- Instruments should be pluggable into any available port corresponding to its data communication standard (serial or Ethernet)
- Have no proprietary protocol
- EGIM will be common for stand-alone and cable nodes
- Size small enough to be Manipulated by the use of medium size ROV (Oceanographic)
- Lifetime of 20 years for the materials used
- 18 months of continuous data storage
- Remote maintenance capabilities (i.e. Modification of sampling parameters, modification of sensor parameters and sensor status)
- Software extension capabilities for instance triggering capabilities based on events, alarms and parameter thresholds
- Full duplex communication
- Availability 80 – 85%
- The EGIM unit should include back up batteries for shutting down in an orderly way in the case of power failure (amount of energy to be defined).

6.2 Stand alone

According to the workshop the EGIM unit should be able to be deployed on stand-alone observatories. In this configuration, minimisation of energy consumption is of paramount importance. The energy consumption is related directly to the frequency of the recordings from each instrument. These recordings must be frequent enough to be scientifically meaningful and at the same time keeping the volume of the necessary battery pack at a reasonable size and cost.

For the stand alone observatories there are two main categories:

Mooring line

In this category the EGIM unit will need to have a special mechanical cage frame that can be held in tension mooring configuration. The frame will host the EGIM unit along with the necessary battery pack. A software programme will be provided to the user to estimate the power load required by the sensor modules, deployment time and measurement rates in order to configure missions compatible with battery power and energy capacities. In this configuration the EGIM unit may provide the necessary interface for connecting an inductive modem or an acoustic modem to transmit data in semi - real time. A full data set will be stored on board for downloading on recovery of the system.

In summary the EMSO node should provide:

- alternative mechanical cage if the standard one is not the best solution for the platform
- batteries necessary to supply energy to the EGIM in the range of 10 -30 VDC.
- data link equipment (i.e. inductive modem, hydro acoustic modem)
- full connector (plug and bulkhead on the EGIM) to build the interface cables between the EGIM and the mooring equipment (data link and power supply)

Benthic platforms (Landers)

The mechanical frame of EGIM will rest on the sea floor and will be the same as that used for the cabled observatories. For benthic platforms the EGIM unit will interface for transmitting data via a hydro acoustic modem. The battery pack will be provided by the user.

In summary the node should provide:

- data link equipment (hydro acoustic modem)
- power supply system in the range of 10 -30 VDC
- full connector (plug and bulkhead on the EGIM) to build the interface cables between the EGIM and the mooring equipment (data link and power supply)

6.3 Cabled

According to the workshop, the EGIM will be able to interface to the power and data connections available on each of the cabled nodes.

The node should provide:

- input voltage in the range of 300 -380 VDC or 10-30VDC
- input current in the range of 3 – 10 A depending on the instrument setup

- copper or optical fibre Ethernet data link with a bandwidth in the range of 100 -1000 Mpbs
- full connector (plug and bulkhead on the EGIM) to build the interface cables between the EGIM and the mooring equipment (data link and power supply)

The instrumentation will be setup for a continuous mode of operation with sampling intervals of the parameters that will be limited only by the bandwidth of the available data connection.

6.4 Interfaces

The EGIM interface is split into two parts, the instrumentation interfaces for connecting the instruments and the nodes interface for connecting to the EMSO nodes.

Instrumentation interface

The instrumentation interface will be further fine-tuned, but the conclusion after the workshop summarises the following:

- Up to twelve (12) serial connections (Types: EIA 232, 422, 485 interchangeable via software) with a maximum of 115200 baud.
- Up to four (4) Ethernet connections of 100 Mbps
- Adjustable voltage per instrument in the range 5 -24 VDC
- Maximum current per sensor : 3 amperes

EMSO nodes interface

The interface for the connection with the nodes will be:

- One (1) Ethernet copper connection
- A copper-optical media converter can be added on as an interface where needed, this option is supported by the infrastructure owner (connectors, converter,...)
- One (1) Serial output for transmitting data
- One (1) Serial input for telemetry and control input
- One (1) power output (optional) for powering communication instruments such as a hydro acoustic modem

6.5 Data storage

Data storage will be performed on the EGIM for up to 18 months of continuous storage (recording of data). Data can also be stored inside some of the instruments giving a level of redundancy. It was estimated that the storage requirement will be 256 GBytes for instrumentation extended with an additional NAS server of up to 2 TBytes for video and sound recording.

6.6 Communication systems

The supported communication systems providing the link for data transmission will be the following three:

- Serial Hydro acoustic modem
- Serial Inductive modem
- Ethernet

The EGIM unit will **not** include the hydro acoustic and inductive modem communication systems.

6.7 Function and control requirements

According to the workshop the function and requirements of the EGIM unit will be the following:

- Full duplex communication with the node and the sensors
- Configuration via a web interface
- Separate acquisition interval for each measured parameter (or to be clarified)
- Software extension capabilities (parameter dependant): Threshold for each measured parameter with the ability to fire alarms and events such as increasing the sampling frequency. The alarms can interact from instrument to instrument (i.e. triggering an increased turbidity sampling rate in case of a specific event detected with ADCP)
- Transparent mode of control providing a direct link with each connected instrument
- Software extension capabilities for data processing on board the unit (parameter dependant)
- Data storage and transmission in ASCII (.csv) or binary format.
- Control of active anti-fouling devices (electro-chlorination , uv lights, poison TBT, wiper...)
- Possibility of using smart enabled sensors using sensorML
- Time precision clock with +/- $2x10^{-6}$ drift (~1 minute per year) for time stamping
- Atomic precision clock with +/- $5x10^{-11}$ drift (~ 1,5 ms per year) for time stamping
- Synchronisation with NMEA + PPS and/or NTP
- Remote maintenance capabilities such as modification of sampling parameters, modification of sensor parameters and sensor status.

6.8 Redundancy and backup systems

According to the workshop, redundancy will be provided in terms of data by using 2 separate storage locations inside the EGIM and a third being the internal memory of some of the instruments. Redundancy in terms of measured parameters will be provided for some parameters that overlap within different instruments (Duplicate or triplicate parameter measurements).

7. Off-the-shelf Instrumentation Survey and Selection

Nick O'Neil (SLR) gave a presentation entitled

Availability & Market for Commercial off the Shelf (COTS) Sensors and Components for EMSO.

Sub-sea instrumentation has diverse applications. Oceanographic research is a small fraction of the total activity as exemplified by results from a market review done within the EU NEXOS project:

Market Assessment for Ocean Instrumentation and Sensors (EU NEXOS Project)					
Aim / Market	R&D	Industrial/ Economic Perspective	Legal	Role of Sensors	
Sensor aim from the perspective of market sectors				Today	2020
Monitoring and Environ-mental Quality	√	-	√	**	***
Offshore Oil & Gas	√	√	√	**	***
Industrial water quality measurements	-	√	√	**	**
Oceanographic Research	√	√	√	**	**
Fisheries	√	√	√	*	**
Aquaculture	√	√	√	*	**
Ocean Renewable Energy	√	√	-	*	**
Deep Sea Mining	√	√	-	-	***
Port Security	√	√	√	*	***

Sensors are utilized in multiple sectors and their role is predicted to increase over the rest of this decade. For observatory infrastructures such as EMSO, this means that suppliers are not wholly dependent on one group of clients but they design their products with multiple users. This creates a mature market for some sensors, which EMSODEV can benefit.

A general classification of the sensors in marine industry is:

1. Sensors in which the technology is mature (High TRL) and there is more than one compliant manufacturer.
2. Sensors where the TRL is intermediate and there may be only one leading technology with other manufacturers trying to improve their product.
3. Sensors with no off- the- shelf supplier and support.

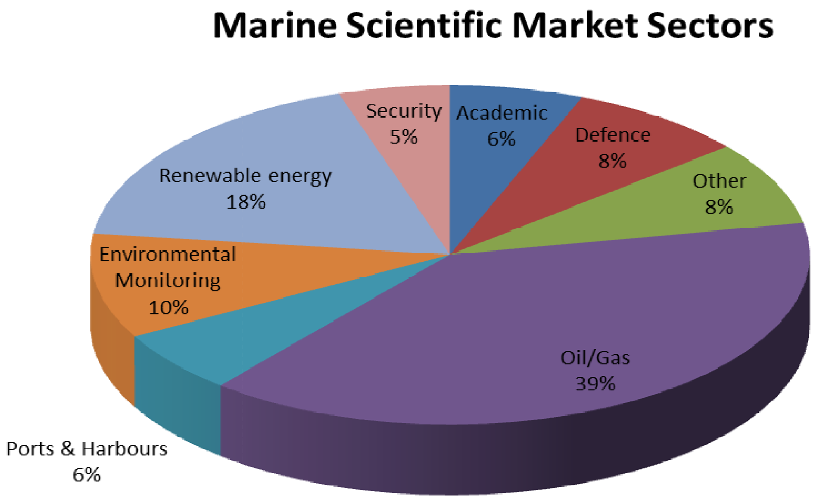

Figure 5. The Market in Marine Science and Technology (Annual Review of Marine Scientific Industries 2013)

In terms of overall market activity for marine science and technology, Oil and Gas remains the largest sector according to a survey of the UK Marine Scientific Industries with geographical growth anticipated in Asia and South America (Figure. 5)

The Oil and Gas Industry together with Renewable Energy, Defense and Environmental Monitoring concentrate mostly on "mature" technologies of equipment and sensors. This is driven by the industry need to use robust and tested equipment with high TRL. These high-level clients are fundamentally not interested in purchasing a sensor or particular set of hardware, their interest is in the information and services that those items can provide. This has resulted in development of a value chain within the field of environmental monitoring services with intermediaries known as integrators generating the services required. A simplified supply chain diagram for Oil and Gas Environmental and Monitoring reveals how the market has developed into multiple tiers, with instrument manufacturers sourcing components, the instruments being packaged into operational systems, operators managing the systems, data banks archiving and processing information and service providers delivering products to the final users. The total market is much larger than the value of the hardware deployed in the ocean.

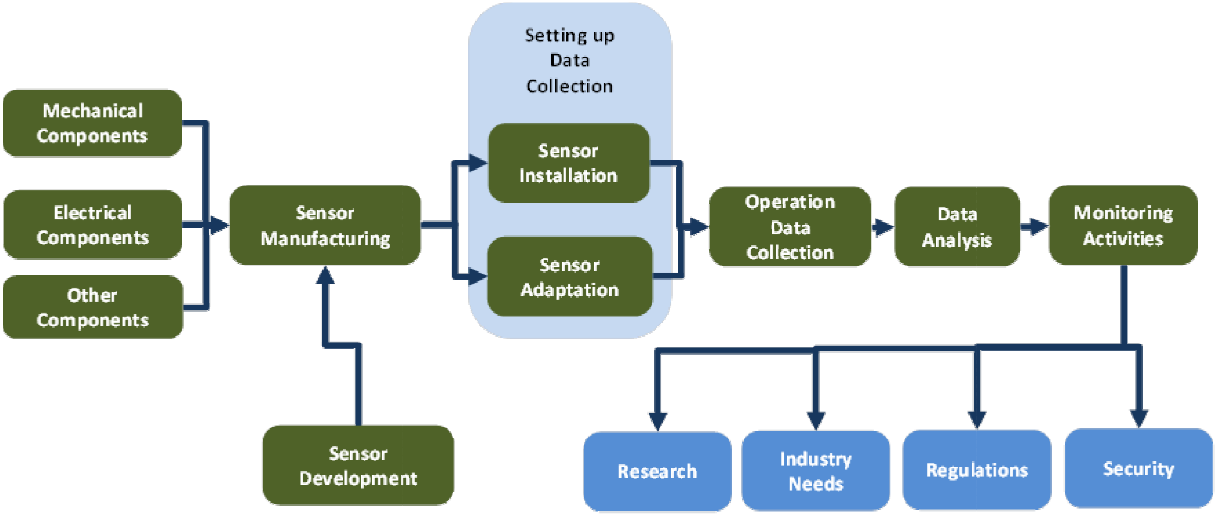

Figure 6. Value Chain of Environmental Monitoring Services. (Based on EU NEXOS project)

With all this development there is a mature market able to supply Commercial off the Shelf (COTS) sensors for most of the anticipated EGIM-EMSO core variables. This is demonstrated by the commissioning of two DELOS (Deep Sea Long Term Observing System) platforms on behalf of BP to provide environmental information at 1400m depth off Angola in an area of oil and gas exploitation. This now functions as part of the FixO3 network. Since the system is part of an oil field installation it uses entirely tried and tested COTS instrumentation modules, sensor and equipment that can be serviced within the routine operations of the oil field. The DELOS platform hosts a full suite of 11 instruments [15].

The challenge therefore for the EMSODEV project in relation to commercial sensors will be:

- Sourcing
- Validation
- Selection

There are a number of tools available to provide market intelligence on what is available and to provide necessary information to a potential sensor user.

Webpages for instrumentation		
Title	**Link**	**Info type**
ESONET Yellow Pages	www.esonetyellowpages.com	Sourcing Selection
Marine Technology News	www.marinetechnologynews.com	Sourcing Selection
Hydro International	http://www.hydro-international.com/companies	
Alliance for Coastal Technologies	http://www.act-us.info/	Sourcing Validation Selection

The EMSO community itself has considerable experience and know-how. It is important to record what type of equipment the partners are using in their observatories.

There are opportunities for the European ocean observatory infrastructure to be used to introduce sensors that are not yet at a high TRL. This will improve the technology and the performance of the sensors, accelerating development towards meeting user and industry requirements. The scientific community also needs to develop links with the 'Integrators'; the companies and organizations that assemble sensors and instrumentation into systems to deliver solutions to their clients in the private and industry sector.

Discussion points and conclusions:

There was an extensive discussion on the issues arising from this presentation.

- It was felt desirable to promote European manufacturers of sensors and equipment.
- It was thought that maintenances cost would be reduced if the EGIM components come from European industries. However, some US and other foreign manufacturers have developed effective support infrastructures in Europe. European-based agents or integrators using imported components could not be excluded from tendering processes. Purchasing decisions would generally be based on technical and value for money criteria.
- It would be desirable for the EMSODEV community to interact with the Alliance for Coastal Technologies, the ongoing process to build related European organisations (I3 JERICONEXT) and similar portals.
- The ESONET Yellow Pages will be used as the primary reference for the sensors, but needs to be continually updated.
- It is important that the EMSODEV community collates and shares information in order to facilitate good procurement decisions.

8. CONCLUSIONS

During the WP2 workshop the partners had the opportunity to extensively discuss all the key issues identified and described in the DOW. In particular, regarding the scientific parameter requirements, core parameters were agreed while their detailed specifications will be determined through a consultation with experts.

All the core sensors have a high TRL and are available commercially off the shelf (COTS). The market for the optional sensors is developing. EGIM ports can also be used for development and trials of new sensors not yet at high TRL. EGIM will be designed for installation on the sea floor or in the water column, either connected to a cable or autonomous, powered by a local battery pack. The implications of different configurations are reviewed.

Information is collated on sensors required for the EGIM nodes, how they can be integrated into the EGIM package and the availability of sensors commercially off the shelf.

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