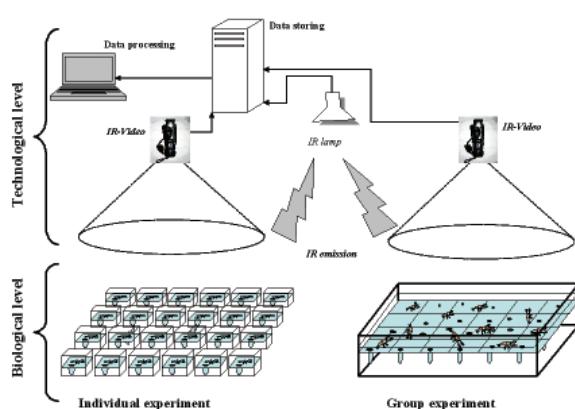




modulation of emergence rhythms in response to sex, size, isolation or grouping and the presence of food. In order to carry out these measurements technology is required. The team is multidisciplinary: the biological expertise will be provided by researchers specialised in behaviour and physiology of *Nephrops* (ICM-CSIC) while the engineering know-how will be provided by experts in telecommunications and electronics (SARTI-UPC). Experimental tanks endowed with artificial burrows will be equipped with innovative and integrated systems for the automated collection of behavioural data (Fig. 2): remote sensing (telemetry), infrared technology and video image analysis.

An infrared-sensible analogical USB videocamera connected to a USB concentrator, which in turn is connected to a PC, will obtain frames every 30 sec over consecutive cycles of 24-h light-darkness and constant darkness conditions from many tanks. An experiment with 10 tanks and 10 USB infrared videocamera is currently being developed. The image acquisition and processing software is LabVIEW. Different virtual instruments have been developed with LabVIEW to acquire image from the low cost infrared usb videocameras, and then to process and extract information about the localization of the animal. The application save this information together with other parameters. This system will be coupled with infrared sensors for the detection of movement located at different distances from the burrow entrance. Each tank is divided into 4 zones were infrared sensors have been placed to check if the animal is actually in these zones or not. The sensors



are connected to a custom electronic board designed specifically for this project. The electronics are composed mainly of the signal conditioning of infrared sensors, a set of analogue multiplexers and a low-cost microcontroller with analogue to digital converters. The microcontroller sends the information from the infrared sensors to the computer by USB where the LabVIEW application transform it into information about localization of the animal. Behavioural data will

be automatically processed by software in order to obtain time series of events per arbitrary unit of time. At present, success is guaranteed by the accomplishment of the technological objectives since those are integrated but at the same time, independent from the scientific ones. Also, some of the proposed new measuring techniques are important since they will be developed with the ultimate goal of their application in field studies. The development of new systems of remote data acquisition and their integration and adaptation into the already existing ones, will allow us to obtain smaller, more easily manageable and less aggressive devices for behavioural monitoring. With these new systems of probes and receiving hardware, a reduced level of stress to animals will be achieved, a fundamental factor when measuring all different aspects of behavioural patterns connected with emergence in this species. Also, as a result of these new systems, the measurements will be obtained with the highest precision achievable.

Design of a Submarine Observatory.

Some aspects to be considered

Abstract

This article presents the results of the preliminary study carried out to determine the main requirements and conditions to be satisfied in the design of a submarine observatory infrastructure. The main concerns and some suggested lines to pursue are presented for discussion. Project and work is also divided into specialized work units with specific responsibilities over the whole project.

Introduction

Marine research information needs increase in complexity, resolution requirements and volume of information allowing a better study capacity over a broader spectrum of phenomena as physical processes, marine meteorology, geology, geophysics, geochemistry, biogeochemistry and physics – biology interactions among others.

Traditional observation and data acquisition systems, such as ships, buoys and autonomous sensors, may present some difficulties regarding costs, poor volume of data in terms of physical extension and period of time, lack of remote control capacity to change configurations dynamically or low reliability or modularity to better adapt to any condition.



The development of submarine observatories is an increasing alternative to deploy scientific infrastructures on distinctive areas to obtain long-term high resolution information on an enormous variety of parameters and variables. The availability of more heterogeneous observations for longer periods gives the scientists a valuable data to perform studies on many oceanographic disciplines.

Submarine observatories have to be modular and expandable to better serve the wide range of applications and requirements of both, the site and the measurement devices themselves. Modularity and expandability have to allow the structure to be adapted on many applications, deployment sites and the eventual modification or growth once on the chosen site.

Several countries are making a great effort as regards the design and deployment of submarine observatories.

The NEPTUNE project is one of the main references but other initiatives as Japanese ARENA and Italian GEOSTAR have also to be mentioned. Parallel to those initiatives, the ESONET project, willing to create a network of excellence at a European level of submarine observatories, has been approved in the context of Frame Program VI. In that context. An Expandable Submarine Observatory is proposed to be designed with the aim of service and as a resource for this network.

Expandable Submarine Observatory

This project, also known as OBSEA project (OBservatorio Submarino ExpAndible) is the Spanish initiative to design and develop a submarine observatory. OBSEA is the way to get the means and technology and the approach to offer the scientific community with a singular tool.

The design and construction of a submarine observatory is a complex task and a multidisciplinary project. Some of the previously commented initiatives have involved hundreds of highly qualified scientists and technicians, developing several technologies and solutions to solve the inherent problems related to the installation of measurement devices on the seafloor, being energy supplied and connected to a communications network.

Such a complex work implies a necessary specialization to correctly define the specifications for every part and functionality and to solve the variety of issues that may arise due to the tough environment where the systems are installed.

To facilitate the task, several working groups can be defined taking responsibility over complementary

aspects regarding the whole project. Those working groups have to have a common coordination in order to accomplish timelines, budget and prevent deviations on the project purpose, its specifications or the compatibility among several functions. OBSEA project is structured around the following working groups or work packages:

WP	Name	Group Responsibility Description
1	Physical Infrastructure	Development of new submarine nodes infrastructure connected to and accessible from a land station as a base where submarine instruments and devices can be installed.
2	Logical Infrastructure	Development of a local area network over the physical infrastructure with management and control systems as a distributed network for data acquisition from the submarine instruments and devices.
3	Measurement Devices	Development of submarine measurement and acquisition devices as geophones, seismometers, video cameras, devices to measure physical or chemical properties, having a standard interface according the physical and logical infrastructure specifications.
4	Information Treatment	Development of the information management systems in order to manage study or send the information that is obtained over the network. Generation of alerts on some events. Events early alert. Virtual distributed laboratory.
5	Promotion and Training	Promotion activities according to the infrastructure possibilities among the European scientific community increasing and optimizing the use of the facility as its main objective. Training activities associated to the infrastructure availability and gathered data from the installed equipment and scientific devices in the marine technology area.
6	Project Management	Project management in order to coordinate the different simultaneous workgroups to guarantee the achievement of budget and timelines. Check point pursue and decisions on any deviation. Infrastructure responsibility

First of all, physical Infrastructure has to solve issues related to node housing, submarine cables, connectors, power supply and control all over the network. Additionally, a base station has to be implemented and the submarine cable has to be layered out from this station to the seafloor through the shortest possible path.

Powering the system is a hard problem. Direct current has to be used to prevent reactive losses from the high capacitance between submarine cable and the seafloor. High voltage is recommended to minimize resistive losses. Therefore, the base station has to be equipped with an efficient and reliable high voltage direct current generator (HVDC) to feed the cable and supply the nodes. Every node connected to the submarine cable has to convert the HVDC to a more suitable voltage to feed the instruments and the electronic systems in the node itself. The power system has to be protected against short-circuits, over consumption and other faults allowing the isolation of faulty areas to prevent the whole structure to fail. The future addition of nodes to expand the network has to be considered from design.

Figure 1 shows the general aspect and structure of the observatory, while figure 2 represents a possible power layout:

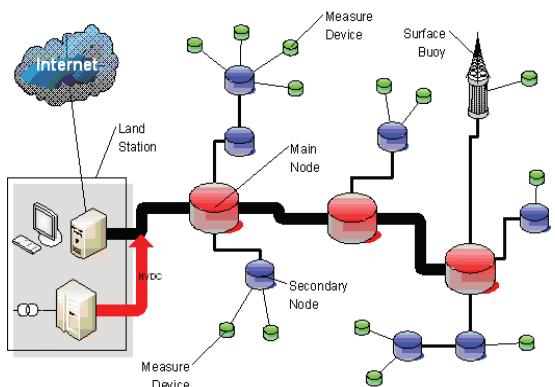


Figure 1. OBSEA's Simplified structure

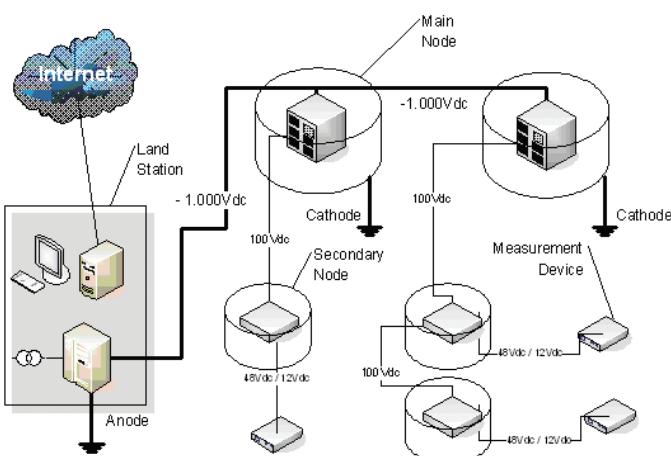


Figure 2. Power supply layout for OB

Submarine cable and other connection cables have to be designed to tolerate the marine environment for a long period of time such as 20 or more years and, eventually, to bear the traction effort during the deployment and further manipulations. Connectors at the sea side, have to be wet-matte, ROV (Remote Operated Vehicle) operated and designed to carry energy and communications. The minimum number of different connectors is desirable to achieve some level of standardization and reduce costs by minimizing spare parts.

Physical infrastructure has to come out with a topology that allows Logical infrastructure to build a submarine network. The structure shall permit a future growth according to the user needs.

Logical Infrastructure has to design a network, supported by the physical infrastructure, to give connectivity to all the devices, once installed on the observatory and provide the necessary services for upper layers. The network has to be realizable and scalable to be able to grow as more nodes or measurement devices are installed. First design has to anticipate future bandwidth requirements while being cost affordable.

All the information has to be collected at the land station where the system is controlled and configured, giving transparent access to the Information treatment layer to any instrument on the seafloor.

All the required connectivity may be achieved by a proper combination of layer 3 and layer 2 switching among the land station and submarine nodes, allowing the control, management and configuration of the network from the land station while keeping nodes as simple as possible. The structure deals only with physical, link and network layers, while upper layers are managed either by the Information treatment layer either by the final user application.

A group related to both the physical and the logical is the Measurement devices group. From one side, a common physical interface has to be defined, being convenient to the majority of applications and situations. Interface to submarine nodes from the measurement devices will be made of a submarine cable and wet-matte connector. The type of connector, pin-out, nominal voltages, currents permitted and communication specifications have to be specified.

Measurement devices types and needs in terms of energy and communications comprehend a wide range of possibilities (i.e. geophones, video cameras, CTDs, etc). However, it is mandatory to simplify connectivity keeping the flexibility and adaptability as high as possible. The resulting interface will be common for all the measurement devices willing to be connected to OBSEA.

Next figure shows a possible submarine cable structure that carries several optical fibers and a conductive core to supply the energy to the nodes. The external wire frame gives the structure the required strength to support traction from the boat when deploying or recovering the cable.

The number of optical fibers is well beyond the initial needs but they don't increase significantly the cable cost and permit a certain redundancy and some additional channels for future applications.

The information acquisition and recovery is an issue to be addressed by Measurement devices and Information treatment groups.

Information treatment group is responsible of the information management on the submarine observatory. Many alternatives are already available on the study of distributed sensors and mobile applications and agents. Obviously, the OBSEA project will represent a clear opportunity to put in practice the technologies and to improve the know how on those research lines.



- 1.- Optical Fibers
2.- PBT Tubes
3.- Vetroresin
4.- Hydrogen Absorbent
5.- Aluminum Tube (0.5 ohm/km)
6.- High Density Polyethylene (internal 2 mm, external 3 mm)
7.- Steel Wires Covered with Aluminum
8.- Aluminum Alloy Wires
9.- Water Blocking Tape

Diameter: 25.6 mm
Weigh: 730 kg/km
Resistance: 0.5ohm/Km

Aluminum tube is designed as one phase conductor and the external frame can be used as return conductor.

Both conductors can be used as redundant circuits if the return is connected to sea ground in a DC supply schema.

Cable is designed for a nominal DC voltage of 1.000V up to 10KW power capacity having a voltage drop of 5% at 5Km. It can also be used for feeding AC 220V mono phase loads (using both conductors) although it is not optimized for this supply.

Maximum short circuit current is rated to 5KA at 1s

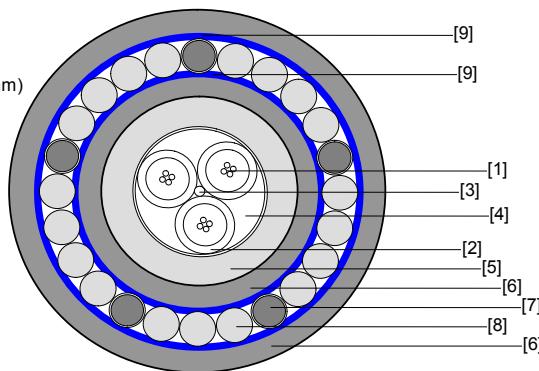


Figure 3. Suggested submarine cable

The effective use of the infrastructure and the correct exploitation of the resources, the promotion and information outreach are responsibilities for the Promotion and training group.

The international community has to be informed about the observatory technical and service possibilities and also communicated with the last events, developments and results.

The works taking place and the studies performed on the infrastructure will serve as training material for several programs and studies. General public, institutions and government have to be informed about the results to take conscience on the importance of the marine technologies and oceanographic research.

Finally, the necessary coordination and latter responsibility over the whole project and operation belongs to the Management group.

At the development phase, this group deals with the coordination of the project and the other groups work. At the operational phase, it has the responsibility over the infrastructure management and further developments.

Conclusions

The development of a complex project as a submarine observatory demands the coordination of several expert groups dealing with a variety of issues to be solved from the remote supply of elements to the information management passing through the infrastructure maintenance and operation.

This project will build up a singular infrastructure that could be profited by the scientific community and will

help to develop and increase the know how on marine technologies covering a broad spectrum of requirements and achieving a platform very attractive for training purposes.

Other experiences are taking place in other countries that will result in valorous infrastructures to the science development and technology improvement. This is an opportunity that may not be missed.

References and Bibliography

ARENA: http://homepage.mac.com/ieee_oes_japan/arena/arena-E.html

ESONET: <http://www.oceanlab.abdn.ac.uk/research/esonet.shtml>

NEPTUNE: <http://www.neptunecanada.ca/>

<http://www.neptune.washington.edu/pub/techno/tech.html>

VENUS: <http://venus.uvic.ca>

GEOSTAR: <http://www.ingv.it/GEOSTAR/>

ASSEM <http://www.ifremer.fr/assem/index.html> Array of sensors for seafloor monitoring of geohazards)

MABEL <http://geostar.ingv.it/mabel.htm> Multidisciplinary Antarctic Benthic Laboratory

HUGO Geo-Observatory

<http://www.soest.hawaii.edu/GG/DeepoceanOBS/SMES/smets.htm>

ESONET Project <http://www.ifremer.fr/esonet/>