Project contract no. 036851
ESONET European Seas Observatory Network

Instrument: Network of Excellence (NoE)
Thematic Priority: 1.1.6.3 – Climate Change and Ecosystems
Sub Priority: III – Global Change and Ecosystems

Project Deliverable D61

Workshops on logistical, engineering and technical aspects of observatories

Due date of deliverable: month 42
Actual submission date of report: month 45

Start of project: **March 2007**
Duration: **48 months**

Project Coordinator: Roland PERSON Coordinator
organisation name: IFREMER, France

Work Package 5
Organization name of lead contractor for this deliverable: **IFREMER**
Lead Authors for this deliverable: **Jean-François Rolin, Jérôme Blandin, Anne Holford**
(Oceanlab – University of Aberdeen)

[November 2010]

<table>
<thead>
<tr>
<th>Dissemination Level</th>
<th>Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006)</th>
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Deliverable D61 Workshops on logistical, engineering and technical aspects of observatories
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<th>Section</th>
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</table>

Deliverable D61 Workshops on logistical, engineering and technical aspects of observatories
Deliverable D61 Workshops on logistical, engineering and technical aspects of observatories
1 INTRODUCTION

Through various European funding initiatives we have gained experience with developing and operating technologies that are used in the implementation of deep-sea observatories. The aims of this workshop is to discuss the different concepts and technologies under development and using this experience to assess the best approach for ensuring and maintaining an integrated European capability. As a result, this workshop is aimed at research institutions with a technology and engineering bias involved in the ESONET/EMSO, KM3NeT and EuroSITES programmes.

A workshop was convened by Oceanlab in Newburgh, Scotland, on 2\textsuperscript{nd} and 3\textsuperscript{rd} November 2010.

2 LIST of ATTENDEES

<table>
<thead>
<tr>
<th>Participant</th>
<th>Email</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guy Westbrook</td>
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<td>NIKHEF</td>
</tr>
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<td>Thanasis Chondronasios</td>
<td></td>
<td>HCMR</td>
</tr>
<tr>
<td>Daniel Mihai Toma</td>
<td><a href="mailto:joaquim.del.rio@upc.edu">joaquim.del.rio@upc.edu</a></td>
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<tr>
<td>Henko de Stigter</td>
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<td>NIOZ</td>
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<tr>
<td>John Cluderay</td>
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<td>NIOZ</td>
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<td>Jérôme Blandin</td>
<td><a href="mailto:jerome.blandin@ifremer.fr">jerome.blandin@ifremer.fr</a></td>
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<td>Jean-François Rolin</td>
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<td>Eric Heine</td>
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<td>NIKHEF</td>
</tr>
<tr>
<td>Klaus Schleisiek</td>
<td><a href="mailto:kschleisiek@send.de">kschleisiek@send.de</a></td>
<td>SEND</td>
</tr>
<tr>
<td>Paris Pagonis</td>
<td><a href="mailto:ppagonis@ath.hcmr.gr">ppagonis@ath.hcmr.gr</a></td>
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</tr>
<tr>
<td>Mike G. Sawkins</td>
<td><a href="mailto:mgs@macartney.com">mgs@macartney.com</a></td>
<td>Macartney A/S</td>
</tr>
<tr>
<td>Mario Sedita</td>
<td><a href="mailto:sedita@lns.infn.it">sedita@lns.infn.it</a></td>
<td>INFN</td>
</tr>
<tr>
<td>Phil Bagley</td>
<td><a href="mailto:p.bagley@abdn.ac.uk">p.bagley@abdn.ac.uk</a></td>
<td>UNIABDN</td>
</tr>
<tr>
<td>Stewart Chalmers</td>
<td><a href="mailto:s.chalmers@abdn.ac.uk">s.chalmers@abdn.ac.uk</a></td>
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<tr>
<td>Alan Jamieson</td>
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<tr>
<td>John Polanski</td>
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<td>Anne Holford</td>
<td><a href="mailto:a.holford@abdn.ac.uk">a.holford@abdn.ac.uk</a></td>
<td>UNIABDN</td>
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<tr>
<td>Dougal Lichtman</td>
<td><a href="mailto:d.lichtman@marlab.ac.uk">d.lichtman@marlab.ac.uk</a></td>
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<tr>
<td>Kerry Adam</td>
<td></td>
<td>NERC-NOCS</td>
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3 AGENDA

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<tr>
<td>9:00</td>
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<td>9:30</td>
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<td>1. Introduction: Infrastructure joining components (J-F. Rolin, Ifremer)</td>
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<tr>
<td>2. Junction box recommendation (J-F. Rolin, Ifremer)</td>
</tr>
<tr>
<td>3. OBSEA: expandable seafloor observatory (Daniel Mihai Toma, UPC)</td>
</tr>
<tr>
<td>4. Ythan observatory: Inductive power and data transfer (S. Chalmers, UNIABDN)</td>
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<tr>
<td>5. KM3NeT: Power and data options (E. Hiene, NIKHEF)</td>
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<tr>
<td>13:00</td>
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<td>14:00</td>
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<tr>
<td>1. Current experiences with junction boxes (problems, operations…) based on existing projects (IMI)</td>
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<tr>
<td>2. Funding future developments (ESONET WP5 cost model) (J-F. Rolin, Ifremer)</td>
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<tr>
<td>3. Discussion and recommendations</td>
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<table>
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<tr>
<td>9:00</td>
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<tr>
<td>1. MODOO Demo Mission May 2010 (H. de Stigter, NIOZ)</td>
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<td>3. Data transmission for KM3NeT (P. Kooijman, NIKHEF)</td>
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<tr>
<td>4. DELOS update (P. Bagley, UNIABDN)</td>
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<td>5. DELOS materials (P. Bagley, UNIABDN)</td>
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<td>11:00</td>
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<td>1. ESONET Label (J-F. Rolin, Ifremer)</td>
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<td>12:30</td>
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<tr>
<td>13:30</td>
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<tr>
<td>1. Update on plug and play devices and interfaces &amp; smart sensors (K. Schleisiek, SEND) (Oral presentation):</td>
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<tr>
<td>2. Use of new materials for the next generation of observatories (P. Bagley, UNIABDN)</td>
</tr>
<tr>
<td>14:30</td>
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<tr>
<td>1. Uses of gliders &amp; AUV for these observatories e.g. docking stations and their interfaces</td>
</tr>
<tr>
<td>2. Discussion and recommendations</td>
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4 TECHNOLOGY WORKSHOP MEETING

Tuesday 2\textsuperscript{nd} November 2010
Deliverable D61 Workshops on logistical, engineering and technical aspects of observatories

Morning presentations:
1) Introduction: Infrastructure joining components (J-F. Rolin, Ifremer)
2) Junction box recommendation (J-F. Rolin, Ifremer)
3) OBSEA: expandable seafloor observatory (Daniel Mihai Toma, UPC)
4) Ythan observatory: Inductive power and data transfer (S. Chalmers, UNIABDN)
5) KM3NeT: Power and data options (E. Hiene, NIKHEF)

Afternoon presentations:
6) Current experiences with junction boxes (problems, operations...) based on existing projects (IMI)
7) Funding future developments (ESONET WP5 cost model) (J-F. Rolin, Ifremer)

Discussion topics and recommendations:

➢ AC or DC
AC for short distance may be a good solution.
(Exemple of AC for Catania and Antares)

➢ Power return by sea water
Magnetic field and by products of the corrosion of the current return devices must be evaluated with respect to their environment disturbance effect. A specific biologic study is recommended over X kW or Y kW. (X and Y to be determined by bibliography).

50k€ per day or double. Factory production to deployment when a simple cable is transported by rail, others are needing . 12k€ per day.
Send is happy to work on the chlorination pollution issues.

Underwater connector is the less reliable connector.
Wet connectors must be improved and the community must collaborate on this field.

ODI, Tronics, Gisma, Seacon.
Establish a European group on wet mateable connectors for exchange of experience and sharing of qualification procedures. It should share expertise with deep offshore oil and gas providers and users.

Dry mateable should withstand open face pressure and be studied for long term ageing.

➢ Joint Industry Project (JIP)
They could bring additional funding for technological developments. Oil and gas sector. The Renewable energy field is a good target.
Connectors. MacArtney OK but a level of secret must be kept. UK and Ireland some manufacturers to be approached.
The fields: Help on environmental requirements. Damage of mammals?
Deliverable D61 Workshops on logistical, engineering and technical aspects of observatories

**Wednesday 3rd November 2010**

**Morning presentations:**

8) MODOO Demo Mission May 2010 (H. de Stigter, NIOZ)
9) Acoustic modems for subsea observatories – COMMODAC 2007-2009 (J. Blandin, Ifremer)
10) Data transmission for KM3NeT (P. Kooijman, NIKHEF)
11) DELOS update (P. Bagley, UNIABDN)
12) DELOS materials (P. Bagley, UNIABDN)

**Discussion topics and recommendations:**

13) ESONET Label (J-F. Rolin, Ifremer)
(see Appendix 2)

**Afternoon presentations:**

14) Update on plug and play devices and interfaces & smart sensors (K. Schleisiek, SEND) (Oral presentation):

“Standardisation, connecting sensors from the deep-sea in the internet” (see the following figure)

- Smart sensor issue
- Ideas of standardisation, deep-sea in the internet
- Manufacturer specific dialect
- RS 232 or Ethernet or CAN

SID is straightforward. It needs controller in Java.
PUCK includes SID.
It is Sensor ML.

Firmly put up against IEEE 1451.
15) Use of new materials for the next generation of observatories (P. Bagley, UNIABDN)

Other discussion topics and recommendations:

- Uses of gliders & AUV for these observatories e.g. docking stations and their interfaces
  - Future technologies: Gliders and docking stations

MOVE, the crawler of NIOZ
Crawler from Jacobs University in Bremen is used on Neptune Canada
At the end: shuttles from observatories are usefull in some cases such as back up data transfer or sample. Although the previous developments of messengers by Japanese on uncabled observatories and Ifremer for the Geostar or ROSE projects have not found a market, the concept is to be followed up.
AUV and gliders are envisaged by NOC

5 CONCLUSION

- ESF Marine Board
A request for funding to allow meetings similar to this Technical Workshop will be launched.
One of the potential funding body could be European Science Foundation.

- Standardisation and EMSO technical issues, yearly meeting
Deliverable D61 Workshops on logistical, engineering and technical aspects of observatories

The WP8 Technical of EMSO will continue in 2011 and 2012. The WP E of KM3Net will work in parallel. A meeting in 2011 could be welcome for coordination of the experiments and discussion of the results.

- Circulate ESONET Label document

The ESONET Label draft document will be circulated in the ESONET community before the Esonet Best Practice Workshop 3 and General Assembly in Marseille (13-16th December 2010). It will also circulate among the participants of this meeting.

- Joint Industry Project

The idea of a joint industry project to enhance the technologies of subsea observatories for the marine Renewable market or the oil and gas market was presented.
Deliverable D61 Workshops on logistical, engineering and technical aspects of observatories

6 APPENDIX 1 : Power point presentations
Infrastructure joining components

Legend:
3 - Technical supervision infrastructure
4 - Onshore network
5 - Land Base termination of sea infrastructure
6 - Land sea communication segment
7 - Node from branching unit to node/extension xx
8 - Branch extension of the network
9 - Junction box
10 - Link to instruments
11 - Individual instrument

Legend:
3 - Technical supervision infrastructure
4 - Onshore network
5 - Land Base termination of sea infrastructure
6 - Land sea communication segment
7 - Junction box
8 - Branch extension of the network
9 - Link to instruments
10 - Individual instrument

Legend:
3 - Technical supervision infrastructure
6 - Land sea communication segment
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9 - Junction box
10 - Link to instruments
11 - Individual instrument

Legend:
3 - Technical supervision infrastructure
4 - Onshore network
5 - Land Base termination of sea infrastructure
6 - Land sea communication segment
9 - Junction box
11 - Individual instrument
A Broad Acoustic Transmission for Research in Oceanography and Sea Sciences (ALBATROSS)

Data transmission in the line:
- Data concentrator for each floor
- Transmission by inductive modem
- Data storage and Acoustic transmission @ 1000 Bit/s

Acoustic Data transfer:
- Distance from MII: 2000 m
- Multi channel for several lines
- Data transmission @ 1000 Bit/s

Acoustic transponder

Data transmission
- In the line
- Data concentrator for each floor
- Transmission by inductive modem
- Data storage and Acoustic transmission @ 1000 Bit/s

Acoustic release transponder

Capital and Operation expenditures are estimated in a component x function matrix

Implement subsea instruments from any scientific discipline on geographically positioned sites of key interest, on and under the seafloor and up along the water column.

Bring data/images to shore from those instruments

Provide energy for these instruments.

Coordinate instrument acquisition.

Ensure calibration and registration of instruments.

Install in the deep sea and onshore.

Maintain.

Decommission on sustainable basis.

Manage data from the above.

Build knowledge from the above and train staff.

Ensure economical operation.

Neptune Canada
Power and the Internet into the oceans

Nodes

Junction Box – OceanWorks

Alcatel-Lucent’s Cable Ship Lodbrog
Donet Japan

Dense Ocean floor Network system for mega thrust Earthquakes and Tsunamis (DONET)
- Towards to understanding mega thrust earthquakes and the Geohazard and Disaster Mitigation-

Yoshiyuki Kaneda
Japan Agency for Marine-Earth Science and Technology (JAMSTEC)
The historical EQs. around the Nankai trough

From CD area, first ruptures were starting in past two or three EQs. 1944/1964, 1954, 1707?

M8 class EQs. are occurring with interval of 100-200 years

For High Reliability System Design

The backbone cable system is based on conventional telecom submarine cable technology to secure the high system reliability of 20 years at least.

Yoshiyuki Kaneda - Jamstec

For High Reliability System Design

Several new components of backbone cable system that have to be developed for science system (such as power branching control circuit and double conductor submarine cable) will be followed to the development and evaluation method of sub-sea telecom high reliability:

Double Conductor LW cable
(Suite for ITU-T Standard Recommendation)

Outer Diameter: 29mm,
Conductor Resistance: 0.8(Outside)/1.0(Inside) Ω/km
Weight in Air: 1260kg/km, Weight in Water: 600kg/km
Breaking Strength: ≧10ton

Yoshiyuki Kaneda - Jamstec
Landing both ends of backbone cable to power the system and to recover the data using two different physical passes. A current constant DC power supply technology will be used to establish the redundant configuration against with internal or external system failure.

Yoshiyuki Kaneda - Jamstec

Hub System (Science Node) Description

The science node is a most critical part of the system because of the major development of DONET (data transmission, power distribution, and precise time synchronization) concentrate in this system.

Yoshiyuki Kaneda - Jamstec

Data transmission: Science node will directly connect to the land system using exclusive optical fiber lines (pier to pier connection) to have high data transmission capacity of 600Mbit/s and each science interface has 50Mbit/s transmission capacity.

Yoshiyuki Kaneda - Jamstec

Power distribution: The node managed the 500 watts of power from land and distributes the up to 45 watts of secondary power to the each observatory interfaces as the occasion demands. A constant current DC power was selected for secondary power output to get high system reliability and high power transmission efficiency.

Yoshiyuki Kaneda - Jamstec
Hub System (Science Node) Description

Precise timing synchronization: The precise timing information embedded in the overhead of data protocol to have the < 1micro second of accuracy without using additional data lines.

Yoshiyuki Kaneda - Jamstec

For Replaceable Maintainable and Extendable abilities

The science node and sensor system can be replaced on the seafloor using underwater mateable interfaces (connectors).

Yoshiyuki Kaneda - Jamstec

Link Cable System: Connection between Node and Observatory

The observatories plan to deploy in 10km radius area center the science node and connect using link cable system.

Yoshiyuki Kaneda - Jamstec

Sensors for broad band observations

- Strong motion accelerometer
- Broadband seismometer
- Differential pressure gauge
- Quartz pressure gauge
- Hydrophone
- Precision thermometer for sensor calibration
Buoyancy control system

- Ballast Tank
- Control Monitor
- Pump
- Servo Valve
- Filter

Future Plan

The array design is not yet fixed

Schedule Plan

- FY18-FY22 DONET1 (Red line)
- FY21 DONET2 FS
- FY22-FY26 DONET2 (Blue line)
- FY26-FY29 DONET2+ $\alpha$ (Green line)

Proposed Budget: Less than 80 million €

Antares extension

Ligurian sea
KM3Net issues for 3 nodes of Esonet EMSO

Ligurian Sea
East Sicily
Hellenic/Pylos

0 - Management of the Earth sea science infrastructure (Specific)
1- Dissemination and user interfaces (Specific)
2 - Databases (Specific)
3 - Technical supervision infrastructure (Specific except cable maintenance which is shared)
4 - Onshore network (Specific contracts with providers)
5 - Land Base termination of sea infrastructure (telescope)
6 - Land sea communication segment (Shared/telescope down to branching unit)
7 - Node (Specific)
8 - Branch extension of the network - uplink (Specific)
9 - Secondary junction box (Specific)
10 - Link to instruments - downlink (Specific)
11 - Individual instrument (Specific)

Topic 2

Michel PACHA
Shore station

Antares Data management and Control

Power station

Antares JB

DeepSeaNet Node

BJS User

BJS User

DeepSeaNet User

More an adaptation Box than an actual « Junction Box »

BJ Antares

DeepSeaNet

SIIM

Connecteur connectable sous l'eau

Connecteur non connectable sous l'eau

BJS

DeepSeaNet

SIIM

Connecteur connectable sous l'eau

Connecteur non connectable sous l'eau
SARTI Research Group

- Centro de Desarrollo Tecnológico de Sistemas de Adquisición Remota y Tratamiento de la Información (SARTI) de la Universitat Politècnica de Catalunya
  
  - Scientific and technological development of remote acquisition systems and instruments mainly focus on oceanographic instrumentation.
  
  - Analog and uC based Electronic Designs

OBSEA Project.
OBSEA Project

- OBSEA is a project whose objective is to install a cabled seafloor observatory 4 kilometers away from the Vilanova I la Geltru coast in a fishing protected area, 20m depth.
- The objective of this project is to have a test-bed for the development of oceanographic instrumentation and at the same time to have an observatory that provides valuable information to the scientific community.
- OBSEA will be extended in the future in order to form a seafloor observatory network that covers several interesting sites. Every node will provide connectivity to several instruments (at least 8) as well as a link to other nodes.

OBSEA Location:

Eight main activities are addressed by ESONET NoE:
http://www.esonet-noe.org/

- Integration,
- Data infrastructure,
- Standardization and interoperability
- Scientific activities,
- Demonstration missions and Testing operations,
- Exchanges of personnel,
- Socio-economic users and SMEs promotion,
- Education and Outreach,
- Implementation strategies and Business Plan.
OBSEA

Topics about Obsea
- Mechanical Design
- Power Supply
- Connectors
- Electronic Design
- Communication System
- Administrative Management
- Permissions
- Deployment
- Instrumentation
- Data transmission and Management
- Access to data
- Maintenance
- Extensions

OBSEA: Offshore submarine node

Submarine node

- Lat.: 41°10'53.82"N
- Long.: 1°45'8.40"E

- Oceanographic Instruments
- Adaptation Cable
- CTD
- Up to 100 meters

- IP Camera
- IP: 192.168.1.172
- IP: 192.168.1.171
- IP: 192.168.1.168

- Switch 1
- Switch 2
- DC/DC 360/48
- Main box

- WET-MATEABLE Connectors
- DC/DC 48/12
- Auxiliar Link and reset
- DC selector

- Splice box
- Submarine cable

OBSEA: Mechanical Design

OBSEA: Offshore submarine node

Submarine node

- Lat.: 41°10'53.82"N
- Long.: 1°45'8.40"E

- Oceanographic Instruments
- Adaptation Cable
- CTD
- Up to 100 meters

- IP Camera
- IP: 192.168.1.172
- IP: 192.168.1.171
- IP: 192.168.1.168

- Switch 1
- Switch 2
- DC/DC 360/48
- Main box

- WET-MATEABLE Connectors
- DC/DC 48/12
- Auxiliar Link and reset
- DC selector

- Splice box
- Submarine cable
OBSEA: Mechanical Protection

- Designed for 300 meters depth
- Up to 8 instrument ports
- 2 ports for trunk cable connection
- One sub-rack for 16 100 x 160mm PCB cards
- 150 watt redundant 1+1 power supply at 48Vdc
- 100 watt redundant 2+1 power supply at 12Vdc
- 1+1 redundant gigabit Ethernet switch

OBSEA: Main Node

- GISMA Connectors
  - Cable Principal. Connector hybrid 8 fibres + 2 contacts for cable of 31.8mm submersible to 3500m connection in sec
  - Cable Sensors. Connector electric 7 contacts for a cable of 16mm submersible to 5000m connection at 50m
  - Cable Sensors. Connector electric 7 contacts for a cable of 20mm submersible to 3000m connection at 1000m by ROV

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<th>Description</th>
<th>Price</th>
<th>Total</th>
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<td>1</td>
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<td>2,184,42 €</td>
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<tr>
<td>1</td>
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<td>567,68 €</td>
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<tr>
<td>6</td>
<td>Connector complete cable sensors 50m. Part cable</td>
<td>532,06 €</td>
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<tr>
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<td>Connector complete cable sensors 50m. Part chassis</td>
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<td>Connector complete cable sensors 1000m. Part cable</td>
<td>3,223,64 €</td>
<td>19,341,84 €</td>
</tr>
<tr>
<td>6</td>
<td>Connector complete cable sensors 1000m. Part chassis</td>
<td>1,585,79 €</td>
<td>9,384,74 €</td>
</tr>
<tr>
<td>6</td>
<td>Joc taps protection (cables submersible cable no)</td>
<td>1,278,51 €</td>
<td>7,671,06 €</td>
</tr>
<tr>
<td></td>
<td>Total connectors station at 50m</td>
<td>15,060,52 €</td>
<td>90,381,22 €</td>
</tr>
<tr>
<td></td>
<td>Total connectors station at 1000m</td>
<td>44,838,22 €</td>
<td></td>
</tr>
</tbody>
</table>

OBSEA: wet-mate connectors (Ethernet+Power)
OBSEA: Cable

Off shore cable thanks to Telefónica:
- 5km, 6 F.O. 2 conductors
On shore cable:
- 1 km, 8 fibres monomode, 3 conductors de 10mm² de coure

OBSEA: Off shore Power Supplies

300Vdc – 11A. OBSEA power supply. A PLC is controlling a number of power sources connected in serial. The PLC is controlled and monitorized through SNMP protocol.

OBSEA: Electronics

- System based on a 32bits ColdFire microprocessor from Freescale
- Instrument Connectors Power supply management using relays.
- Power consumption monitoring.
- Batteries Management
- Temperature and Humidity information inside the cilinder.
- Communication by SNMP

2 batteries of liti-ion 22,2V and 5.3 Ah ref 393420 Amopack model 6S1P MP174865
2 Ethernet Switch RuggedCom Model: RS900G-48-D-2LC25-00
OBSEA: Instrumentation

ADCP (Acoustic doppler current profiler)

OBSEA: Serial to Ethernet converters

Conversors Ethernet (TCP) - Serie (RS232)
OBSEA connectors are designed for Ethernet communication. All the NO-Ethernet are designed with a gateway (Eth-Serie) NPORT from MOXA

OBSEA: Deployment

Administrative Permissions: local, regional, autonomic and central governments

- Demarcación de Costas del Ministerio de Medio Ambiente
- Direcció General de Pesca del Departament d'Agricultura Ramadera i Pesca (deprés Agricultura, Alimentació i Acció Rural)
- Instituto Hidrográfico de la Marina, Ministerio de Defensa
- Ayudantia de Marina de Vilanova i la Geltrú
- Direcció General de Ports, Aeroports i Costes, Departament de Política Territorial i Obres Públiques
- Ajuntament de Vilanova
- Agència Catalana de l'Aigua, Departament de Medi Ambient i Habitatge
- Assegurança de Responsabilitat Civil i de danys propis
OBSEA: On Shore general schema

25

Linux data server 192.168.1.xx
Shore Station

Remote terminal

2 F.O.

South Station

Power Supply IP: 192.168.1.72
IP: 192.168.1.105

University building VG1
Lat. 41°13'18.81"N
Long. 1°43'48.28"E

Power Supply IP: 192.168.1.105
IP: 192.168.1.100

Sw. Eth. Cisco
IP: 192.168.1.73

2 F.O.

IP: 192.168.1.72

Computing Center

3x10mm2 Cable

Ground termination

Beach manhole
Lat. 41°13'3.62"N
Long. 1°44'8.62"E

4 Singlemode F.O. 1+1 Gbps

Sw. Eth. Cisco
IP: 192.168.1.74

Computing Center

Power Supply IP: 192.168.1.79
IP: 192.168.1.72

Comms. room

Lab. 5

Internet / UPC

OBSEA: Manual management of power supply on the instrument connectors. LabVIEW application using SNMP protocol

26

48 or 12V supply control and voltage/current monitoring of each instrument connector. It allow hard-reset to the instruments. Comunication between main uP ColdFire Controller at Obsea and Onshore host using Ethernet and SNMP (Single Network Management Protocol)

OBSEA: CTD management.

27

El CTD es un equipo que utiliza un protocolo no estándar, propietario del fabricante y la comunicación se realiza vía serie RS232. Se utiliza un conversor Eth-Serie de manera que desde la red, y en este caso mediante una aplicación en LabVIEW se puede configurar y monitorizar el estado del equipo. Es aplicación sólo se utiliza en la instalación y testeo. En condiciones normales no se utiliza.

OBSEA: Hidrophone

28

HTTP configuration and TCP, or UDP point to point data transfer. A dedicated application receive dataframes from the hydrophone and re-send them to other applications.
Each instrument has its own instrument driver application written in C, C++, JAVA or LabVIEW. The instrument driver is reading the instrument data and generating an NMEA style dataframes that are broadcasted to the network using UDP. Other services or applications get this information:

"NMEA style" data frame broadcasted by UDP.
$OBSMET,HHMMSS,DDMMYYYY,DATO1,DATO2,DATO3,ETC....

Services picking up these data frames:
- DDBB archive
- Raw data archive
- Web services
- Zabbix interface
- Data Turbine interface
- IEEE1451.0 Data Server
- OGC SWE SOS services

**OBSEA: Standard Data accessibility**

- Web SOS Client
- Web IEEE1451 Client
- DataTurbine Client RDV

**OBSEA Server** (esonet.epsevg.upc.edu  147.83.140.20)
- HTTP IEEE1451.0 - SWE SOS – DataTurbine

**CTD_1 RBR PuckEnable Payload (SIAM, SensorML,IEEE TEDS)**

**CTD_2 Seabird PuckEnable Payload (SensorML, IEEE TEDS)**

**OBSEA: Zabbix, alarms management and archive**
OBSEA: Data Turbine or IEEE1451.0

RDV: http://code.google.com/p/rdv/
  • IP obsea data turbine server: 147.83.159.140 Port: 1335

IEEE1451.0 server status
  • http://sites.upc.edu/~www-sarti/OBSEA/genera_map.php

OBSEA: SID

Data Acquisition System runs on

Instrument Protocol
  RS232, USB, Ethernet

uses

belongs to

SID Interpreter
OBSEA: Precision Time Protocol utilization

- Cabled OBS using PTP for time synchronization
- Improve Zabbix configuration to ensure Data Quality
- Improve Zabbix configuration for alarms generation
- Development of the OBSEA Ontologies
- IEEE1451.0, IEEE1451.2 and STWS implementations
- PUCK protocol testing
- OGC-SWE standards implementations
- Deployment of a lighting system
- Installation of a surface buoy with a Meteorological Station connected to OBSEA and a Iridium Communication to test low bandwidth communications protocols

OBSEA: Ongoing tasks

- General Reference Model for Ocean Observatories:
- Aging tests for dynamic marine cables for “green energies” at sea
- SeaDataNet... NetCDF access to the information

OBSEA: Thanks for your attention.

OBSEA: interesting links

- www.obsea.es
- http://sites.upc.edu/~www-sarti/OBSEA/genera_map.php
- http://www.openoios.org/real_time_data/gm_sos.html#
- http://www.openoios.org/real_time_data/sos_esonet.html#
- www.aceytuno.com
- http://147.83.140.20:8081/redmine/projects/obsea/issues
Inductive Power and Data Transfer

Ythan Observatory

S.J. Chalmers, A.J. Jamieson, P.M. Bagley, J.R. Polanski, I.G. Priede,
Oceanlab, University of Aberdeen

Objectives

To Investigate methods of non-electrical contact in achieving:

- Power Transfer
- Bidirectional Data Transfer

Secondary Objectives

- Investigate “Plug and Play” Interfacing of Sensors (e.g. MBARI PUCK, IEEE 1451)
- Data Presentation to the Internet (e.g. Open Geospatial Consortium SOS, XML etc)

Position of Observatory
Proposed System

Date: 20/05/2009 Issue: 1.0
Originator: Stewart Chalmers

Ythan Observatory Hardware

Block Diagram

Subsea System

Date: 20/05/2009 Issue: 1.0
Originator: Stewart Chalmers

Ythan Observatory Hardware

Instrumentation Module

Subsea Instrumentation Module

Date: 20/05/2009 Issue: 1.0
Originator: Stewart Chalmers

Ythan Observatory Hardware

Instrumentation Module

High or Standard Definition Camera (Optional)
System Under Test in Oceanlab Seawater Tank

Conclusion

• System has been built and tested on the bench
• It has been shown to work continuously for 20 days in the Seawater Tank

Next Stage

• Deployment in the Ythan Estuary
• Streaming Live Data to the Internet
KM3NeT
Power and data options

Power network
Communication network
Quantification of a concept
AC/DC
Converters
Cables / connectors
Feasibility

Eric Heine
Nikhef Engineering, Research & Developments

Network options

Detection unit

DOMBAR
900 m height
6 m bar
20 floors
40 m floor interval, lead 100 m
2 sensors / bar
Distributed buoyancy (tot. 10kN)
Weight ~6000 kg in air

DOM
17", 43 cm sphere
31 PMTs
~7 W, 12 V
29 kg in air
-14 kg in sea

KM3NeT

Neutrino telescope in power terms:

- ≤ 100 km from shore, depth ≤ 5000 m
- Total power 160 kW (incl. EMSO)
- 320 detection units (DU) of 320 W
- Inter distance 180 m
- 20 active floors with sensors / DU
- Floor power 15 W
- Floor distance 40 m, DU height 900 m

Time rigid communication
- Up to 10 Gbps bandwidth
- Point to point data transport
- Broadcast of slow control
Quantifying a concept

- 100 km 2 wire 10 kV
- Conversion: 10kV → 380V
- 10 kW / converter η = 90%
- 500-3000 m length
- 4000 m depth
- 2 wire 380 V

Power
- DUs: 100 x 320 W
- CUs: 8 x 320 W
- EMSO: 6000 W
- Total: 40 kW

Reliability, redundancy, maintenance

Environmental
- Subsea Pressure ≤ 60 Mpa (600 Bar, 6000m)
- Temperature 14 °C

Communication ~4000 P2P connections

Communication network

- ~80 λ/fibre ≤ 10 Gbps P2P
- ~60 fibres in main cable

Power flow

- 400 V~
- 3 phase
- 10 kV= 100 km MEOC
- 400V= < 3 km HEOC
- 6 kW
- MVC: 10k / 400V
- PJB
- EMSO
- SJB
- 3.5 kW 400V= 360m IL
- 400V= 900m VEOC

Calculations 1

- P = 3615.6 I = 9.5148 P = 3518 Vmin = 351.5
- L = 850 V = 365 Vmax = 362.2
- P = 3615.6 I = 9.5148 P = 3493 Vmin = 351.5
- L = 1950 V = 365 Vmax = 362.2
- P = 3615.6 I = 9.5148 P = 3581 Vmin = 351.5
- L = 550 V = 365 Vmax = 362.2
- η = 72.67%

SHORE MEOC PJB internal
- 6636.8 I = 17.465 P = 6000
- L = 3000 V = 343.5

PFE Shore

3.5 kW 400V= 360m IL
Calculations 2

AC or DC

\[
P_{AC} = U_{rms} \times I_{rms} \times \cos \phi
\]

\[
P_{DC} = U \times I \times V_{rms} \times L
\]

\[
P_{Loss} = (I_{rms} + I_{c_m})^2 (R + j\omega L) + I_{c_m}^2 \omega C
\]

Calculations 3

Converter 10 kV to 400 V:
- \( V_{fb} = 380 \text{ V} \)
- \( P_{in} = 10 \text{ W} \) to drive switches in HEOC
- \( P_{d} = 1000 \text{ W} \) to drive optical switch yard

**MEOC:**
- \( S_{MEOC} = 16 \text{ mm}^2 \) / wire, 6 wires
- \( R_{MEOC} = 7E-4 \Omega / \text{m} \) cable no sea return
- \( V_{MEOC} = 10 \text{ kV from shore} \)

**Shore main conversion**
- \( V_{main} = 400 \text{ V}, 3 \text{ phase} \)
- \( \eta = 90\% \)

Assumptions:
- DC power type
- No sea return
- Shore - PJB 10 kV
- Floor network 400 V
- Connectors available

Sea return?

Pending issues:
- Influence of magnetic field on sea life?
- Chemical process in environment (hydrogen, chlorine, metal transport)?
- Maintenance / replacement?
No sea return?
Comparison for 80 kW – 100 km

3-phase AC cable, 3x50mm²
Power loss 150 kW
230kW to transmit 80 kW
Voltage drop 3.5 kV
Voltage level 5.5 kV

Bipolar DC cable, 4x35mm²
Power loss 85 kW
165kW to transmit 80 kW
Voltage drop 2.1 kV
Voltage level 4.1 kV


Converter

Concept 1
Single transformer

Concept 2
Multiple transformer

Concept 3
Serial input, parallel and serial output

Converter 2

<table>
<thead>
<tr>
<th></th>
<th>Concept 1</th>
<th>Concept 2</th>
<th>Concept 3</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>C2 is a proven design</td>
</tr>
<tr>
<td>Design</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>C2, C3 modular design</td>
</tr>
<tr>
<td>Testability</td>
<td>+</td>
<td>++</td>
<td>++</td>
<td>C2, C3 more components, less stress one failure don’t reduced the output</td>
</tr>
<tr>
<td>Reliability</td>
<td>+</td>
<td>++</td>
<td>+</td>
<td>C2, C3 heat is more spread out</td>
</tr>
<tr>
<td>Heat</td>
<td>+</td>
<td>+</td>
<td>++</td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td></td>
</tr>
<tr>
<td>Sensitivity for component tolerances</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>C1 high frequency currents in transformer C3 total runaway of the input, need for extra local control</td>
</tr>
<tr>
<td>Price</td>
<td>++</td>
<td>+</td>
<td>+/-</td>
<td>C2, C3 has more components. C3 complex control</td>
</tr>
</tbody>
</table>

10 kV can be ±5 kV -5 kV + - 400V out
Communication over Cu

PJB concept

Cable types

- VEOC, 2xAWG18, \( V_{\text{inlet}} \) 600V, PBOF type, 6.35mmOD
  - Under construction Nikhef
  - 2 cables / DU
- IL (SJB-DU), 2x16mm\(^2\), \( V_{\text{inlet}} \) 600V
  - JDR
- HEOC (PJB-SJB), 6x16mm\(^2\), \( V_{\text{inlet}} \) 600V
  - JDR
- MEOC (Shore-PJB), 6x16mm\(^2\), \( V_{\text{inlet}} \) 14kV
  - JDR

**VEOC construction**

- Bend limiters

**Block diagram of the DU power**

**Oil**

- **Midel 7131**
  - Density \((13.8 \, {^\circ}C)\) 1 Bar 600 Bar
    - Sea water \(1029\) \(1050\) \(\text{kg/m}^3\)
    - Oil \(975\) \(1000\) \(\text{kg/m}^3\)

- 4 Bar over-pressure at top (800m)
**400V to 12V**

**Purpose:**
- Provide galvanic barrier between OM and VEOC
- Convert voltage from VEOC voltage to OM voltage
- Provide over current protection

**Principle:**
- On > 350V off < 315V
- Feedback
- Controller
- Rectifier
- Load

**Node connection**

**Purpose:**
- On/off switching DU
- Over current switching DU
- Communication over power wires

**Simulations on dynamic behavior:**

**Status:**
- Prototype tested
- No part of DU!

**Increasing insight / Choices to made**

Power network feasible
Communication network feasible
SJIB almost passive
Production in blocks preferred
Useful part of telescope for physics
Production in tranches for better control

**400 V / 12 V Realisation v.01**

**Checked specifications @ 60 MPa**

- V_{in} ≥ 350 V switch on
- V_{in} ≤ 315 V switch off
- V_{in} nom. 350 V > V_{in} < 400 V
- Input polarity:
- f_{in} fuse current 500 mA @ 10 ms
- f_{in} nom. 24 mA @ 360 V-8.5 W
- Spike suppres. input 15 nF
- Max. start up load 1000 µF + 26 W
- V_{in} nom. 11 V < V_{out} < 12 V
- V_{ripple} < 100 mV
- t_{on} switch off < 3 A peak reset @ Vin=0
- T_{trafo} switch off 50 °C @ 1.5 A reset @ Vin=0
- V_{nom} In-out 4 kV
- f_{res} @ start 200 kHz
- f_{res} @ nom. values 65 kHz< f_{res} <140 kHz
- P_{nom} 0 W < P_{load} < 18 W
- \eta > 90%
Thank you for the attention

Just a contribution for discussion

Why not a floating windmill farm above the detector?

Main elements:
- Regional operational model (ROMS)
- RV track / CTD
- Weather forecasting buoys (hourly data – ECMWF complete 2004)
- Tide gauge network 18 nodes (6 min.: hourly upload 2003-20?? ~40 nodes)
- Inshore buoy observatories (2008 to present real time – VHF/GSM/GPRS/3G/WiMax)
- Monitoring (various data reporting rates)
- Argo floats
- Wave energy
- Glider (still early days)

Oceanographic services
www.irishtides.ie
www.marine.ie/databuoy

Research vessels
RV Celtic Voyager (31.4m)
RV Celtic Explorer (65.5m)

Numerical Ocean modelling
- ROMS 3.3 - Regional Ocean Model System
- Setup
  - Horizontal resolution ~2.5 km
  - 40 vertical (sigma) levels
  - INSS, Infomar, GEBCO 2008 bathymetry
  - GFS met forcing
  - Mercator (PSY2V3) boundaries
  - TPXO 7.2 tides
  - 39 rivers (climatology)
  - Weekly 7-day Hindcast
  - Daily 3-day forecast
  - Boundaries for downscale models
- Biogeochemical model
  - Currently working on adding a simple nitrogen-based BGC model to operational system
**Numerical Ocean modelling**

Model domain, multiple-nested, hi res., down scaled.

**Oceanography – much activity**

Winter / Summer standard climate sections to 18° West.

- Long term high precision temperature and salinity (data buoys)
- Temperature / water level (tide gauges)
- Fisheries
- Phytoplankton
- Aquaculture / Climate change modelling

**Irish National Data Buoy Network**

- Hourly summary collected and processed locally
- Hourly upload managed by EUMETSAT (moving to Iridium)
- Central base station at Met Eireann
- Stored in operational SQL data bases
- Real time data to web
- Real time unrestricted FTP site

www.marine.ie/databuoy

**Out with the old**

**In with the new**

Massive Challenges
Irish National Tide Gauge Network

- 6-minute log
- 15-minute upload by SMS
- Central base station at HQ
- Stored in operational SQL data bases
- Real time data to web
- Real time unrestricted FTP site
- Feed data to myriad real time research and operational systems

<table>
<thead>
<tr>
<th>Gauge</th>
<th>Latest Reading</th>
<th>Water Level</th>
<th>Temperature</th>
<th>Atm. Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aranmore</td>
<td>19 Oct 10:00</td>
<td>-1.021</td>
<td>12.700</td>
<td>1015.000</td>
</tr>
<tr>
<td>Ballycotton</td>
<td>19 Oct 10:00</td>
<td>-1.406</td>
<td>13.300</td>
<td>n/a</td>
</tr>
<tr>
<td>Ballyglass</td>
<td>19 Oct 10:00</td>
<td>-0.729</td>
<td>12.800</td>
<td>1014.000</td>
</tr>
<tr>
<td>Castletownbere</td>
<td>19 Oct 09:45</td>
<td>-0.960</td>
<td>18.400</td>
<td>1019.000</td>
</tr>
<tr>
<td>Dublin Port</td>
<td>19 Oct 10:25</td>
<td>0.807</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Dundalk</td>
<td>19 Oct 10:00</td>
<td>1.254</td>
<td>10.400</td>
<td>1010.000</td>
</tr>
<tr>
<td>Galway Port</td>
<td>19 Oct 10:00</td>
<td>-0.935</td>
<td>n/a</td>
<td>1017.000</td>
</tr>
<tr>
<td>Howth Harbour</td>
<td>19 Oct 09:54</td>
<td>0.850</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Killybegs Port</td>
<td>19 Oct 09:54</td>
<td>-0.896</td>
<td>11.700</td>
<td>1012.000</td>
</tr>
<tr>
<td>Kish Bank Lighthouse 1</td>
<td>19 Oct 09:54</td>
<td>2.600</td>
<td>n/a</td>
<td>1011.000</td>
</tr>
<tr>
<td>Malin Head</td>
<td>19 Oct 10:00</td>
<td>-0.933</td>
<td>n/a</td>
<td>1011.300</td>
</tr>
<tr>
<td>River Dodder</td>
<td>19 Oct 11:00</td>
<td>1.222</td>
<td>10.300</td>
<td>n/a</td>
</tr>
<tr>
<td>River Liffey</td>
<td>19 Oct 10:45</td>
<td>0.752</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>River Tolka</td>
<td>19 Oct 10:12</td>
<td>0.878</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Skerries Harbour</td>
<td>19 Oct 10:00</td>
<td>1.180</td>
<td>13.490</td>
<td>1013.000</td>
</tr>
<tr>
<td>Sligo</td>
<td>19 Oct 10:00</td>
<td>-0.911</td>
<td>11.500</td>
<td>1014.700</td>
</tr>
<tr>
<td>Wexford</td>
<td>19 Oct 10:00</td>
<td>-0.658</td>
<td>13.200</td>
<td>1017.000</td>
</tr>
</tbody>
</table>

Near shore ocean observatories

- Near shore ocean observatories
  - Cabled nodes for power and communications
  - Satellite communications
  - Data processing, modelling and forecast
  - Wireless data communications
  - Physical, chemical and biological sensing

Glider

Glider

Engineering

Cabled nodes for power and communications
- Climate Change Buoy, Mace Head
- SmartBay/Offshore Aquaculture Buoy, Mid Bay
- Onshore Test Buoy
- Waverider Buoy, Spiddle OE Test Site
- Tide Gauges, Inishmore and Galway Harbour
- Corrib River Flow Gauge, Claddagh Bridge

Near shore ocean observatories

Cetacean Tracking

- IBM System S software
- Stream processing of data sets
- Software algorithms to be developed for identifying species and tracking sounds.
- Analysis and visualisation of data
Near shore ocean observatories

Ocean Energy

- Access to real time Wave Data
- Device developers can analyse real time wave data and apply complex algorithms via the portal interface.
- Wave energy power output can be accurately related to wave conditions over a time period.
- Supporting the development of a new industry

*Research* i.e., research and operational government organizations don’t generally seem to employ mechanical engineers -

A surprising amount of SME’s working in the marine technology sector don’t have a qualified and/or experienced engineer on their books, and if they do seldom in an EO level strategic post as part of their core staff compliment.

I am finding this is a real problem in terms of general fit for purpose and QA issues coming up again and again, often show stopper issues, where more than a tidy up is required and we have to completely re-design, manufacture and implement our own solutions.

Thanks
Guy.Westbrook@marine.ie
They call me Mr PPE

Thanks

Guy.Westbrook@marine.ie
Funding Future Developments

Personnel costs:
- Core personnel Opex – the definition of this core personnel corresponds to the hypothesis of "virtual departments". It not only headache people but a network of skilled personnel working remotely.
- Regional personnel Opex – remaining personnel.

Infrastructure costs:
- Core infrastructure Capex – assumed for onshore facilities, headquarters, data management computers,... The standalone type of observatory is assumed to involve core infrastructure type of expenses linked to the cruise preparation facilities.
- Regional infrastructure Capex – mainly offshore facilities.

Subcontracting (not addressed at this stage)

Consumables
- Core consumables Opex – similar definition as personnel.
- Regional consumables Opex

Ship and ROV
- Ship and ROV CAPEX – means cable ship for cable laying and installation of backbone, refined survey with oceanographic vessel, subsea intervention for the Junction Boxes, instruments, ROV work. Decommissioning is included.
- Ship and ROV OPER – maintenance (mainly yearly), instrument exchange and installation of new experiments. Mainly oceanographic or private ship with ROV operating under Esonet Label. A provision for cable ship intervention in case of damage is included.

Preliminary scope of the infrastructure

<table>
<thead>
<tr>
<th>ESONET Site</th>
<th>Preliminary scenario of planned development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arctic</td>
<td>Two sites monitored with stand alone observatories from 2011 to 2015. 2 nodes cabled observatory construction starting in 2014</td>
</tr>
<tr>
<td>Norwegian Margin</td>
<td>Snhvit offshore field (Statoil) – 5 km extension in 2012. Available for further extensions</td>
</tr>
<tr>
<td>Celtic-Porcupine</td>
<td>Permanent stand alone observatory (EuroSITES) at Porcupine Abyssal Plain site. Two sites (coral reef and slope) monitored with stand alone observatories from 2013. A potential third sub-site is being discussed</td>
</tr>
<tr>
<td>Azores</td>
<td>Two stand alone acoustic observatories will monitor after Esonet Demo Mission : one at the same site, the other at a different location over to 2017. Same sites cabled, construction starting in 2015</td>
</tr>
<tr>
<td>Iberian</td>
<td>Two stand alone acoustic observatories will monitor after Esonet Demo Mission : one at the same site, the other at a different location over to 2015. Same sites cabled, construction starting in 2013</td>
</tr>
</tbody>
</table>

Preliminary scope of the infrastructure

<table>
<thead>
<tr>
<th>Location</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liguria</td>
<td>Stand alone observatory at Nice (Var-Dyfamed) area from 2012 to 2016. Cabled extension of Antares/KM3Net cable from 2010. New cable with two nodes, construction starting in 2013</td>
</tr>
<tr>
<td>Sicily</td>
<td>Off Catania 30-km cabled and it will be extended- Off Capo Passero 100-km cabled, it will be operative from 2010-2011.</td>
</tr>
<tr>
<td>Hellinic</td>
<td>Continuity of stand alone observatory over to 2014. One cabled node extended from the NESTOR/KM3Net site with equipment according to Esonet standard. Construction in 2013</td>
</tr>
<tr>
<td>Marmara</td>
<td>Cabled extension of the underwater observation platforms, foreseen in 2010-2012.</td>
</tr>
<tr>
<td>Black Sea</td>
<td>Two stand alone observatories from 2021 to 2026</td>
</tr>
</tbody>
</table>
### Easier funding anticipation (1)

The time schedule is driven by:
- scientific readiness
- results of first site investigation,
- cable-ship access,
- ship and ROV access and availability,
- funding capacities of involved countries,
- opportunities of partnership with other infrastructure deployments,…

### Easier funding anticipation (2)

European Investment Bank - Risk sharing Finance Facility
30 to 50% of the total eligible costs (salaries, investment, amortisation,…)
for amounts above 10 M€.

Provides:
- Financial flexibility
- Improve notation (becomes AAA)
- Better access to other financing sources
- Risk sharing (from one contributing nation, from delays in budget, lack of available ship,…)
- Positive advertising effect

Exemples:
- 3 year loan providing an averaging effect during construction/purchase
- 20 year loan gives the time to build the return from the industry (example of ELETTRA large infrastructure).

---

### Continuity

**Budget efficiency of task sharing.**

The Core governance, for instance of an ERIC will diminish the total costs including personnel of the order of:
- 31% during construction phase,
- 60% during the operation phase.

---

### Table: 5 year costing 2011-2015

<table>
<thead>
<tr>
<th></th>
<th>2011-2015 Cost (M€)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CORE</strong></td>
<td>14.3 M€</td>
</tr>
<tr>
<td><strong>CAPEX</strong></td>
<td>24.9 M€</td>
</tr>
<tr>
<td><strong>OPEX Personnel</strong></td>
<td>2.1 M€</td>
</tr>
<tr>
<td><strong>OPEX Consumable</strong></td>
<td>2.2 M€</td>
</tr>
<tr>
<td><strong>REGIONAL</strong></td>
<td>61.8 M€</td>
</tr>
<tr>
<td><strong>CAPEX</strong></td>
<td>53.3 M€</td>
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<tr>
<td><strong>OPEX Personnel</strong></td>
<td>2.1 M€</td>
</tr>
<tr>
<td><strong>OPEX Consumable</strong></td>
<td>6.4 M€</td>
</tr>
<tr>
<td><strong>SHIP&amp; ROV</strong></td>
<td>62.3 M€</td>
</tr>
<tr>
<td><strong>CAPEX</strong></td>
<td>37.4 M€</td>
</tr>
<tr>
<td><strong>OPEX Personnel</strong></td>
<td>2.2 M€</td>
</tr>
<tr>
<td><strong>OPEX Consumable</strong></td>
<td>2.1 M€</td>
</tr>
<tr>
<td><strong>EU seed money</strong></td>
<td>14.3 M€</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>138.6 M€</td>
</tr>
</tbody>
</table>
MODOO demo mission May 2010

Johannes Karstensen - Leibniz Institute for Marine Sciences IFM-GEOMAR, Kiel, Germany
Jens Greinert - Royal Netherlands Institute for Sea Research NIOZ, Texel, Netherlands
Richard Lampitt - National Oceanography Centre NERC-NOC, Southampton, UK
Monty Priede - Oceanlab, University of Aberdeen, Newburgh, UK
Fiona Grant - Marine Institute, Galway, Ireland
Michael Klages - Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany

Outline

- MODOO concept
- MODOO application to PAP
- BOBO lander
- MODOO demo mission May 2010

MODOO concept

- MODOO – Modular and mobile Deep Ocean Observatory
- Provide a concept to integrate multiple stand-alone observatories into “one” coherent network
- Demonstrate a joint EuroSITES and ESONET NoE observatory – applying principle of both projects to a real observatory
- Up to 1 year deployments
- Open ocean

MODOO application to PAP

- Connects PAP mooring with BOBO lander
- Observatory from atmosphere to sub-seafloor (4500m water depth)
- Synchronized and central logging of multiple sources of data
- Real time data access
- “Event control” of sensors by 2-way communication
MODOO application to PAP

Science Missions:

- Follow propagation of signals from surface to the deep ocean
- Detect deep sea marine life
- Record seismic activity and bottom pressure variations

BOBO (BOttom BOundary) lander

- 120-kg weight
- 3.5m
- Aluminium frame
- 1200 kHz ADCP
- OBS
- Sediment trap
- Argos beacon

- Since 1997 >40 deployments in N Atlantic
- Maximum duration 12 months
- Maximum depth 4975 m
BOBO lander

Nazare Canyon, Portuguese margin

Image: NOCS

4975 m

BOBO lander

500

1000

1500

Depth (m)

• Lisbon Canyon, Portuguese margin

BOBO lander instrumentation

“Heart” of MODOO:
- Data collection & dissemination node (DCD node)
- Records 8+ instruments/sensor data
- Serial & inductive connection
- Adds time stamp to all data (drift <3sec/yr)
- Acoustic underwater telemetry

Lander DCD

Mooring DCD

BOBO lander instrumentation

Photo of researchers working on BOBO lander instrumentation.
BOBO lander instrumentation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Connect to DCD node</th>
<th>2-way communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature, conductivity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current velocity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acoust. backscatter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Optical backscatter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passive acoustics</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Sediment trap</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxygen</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Seismometer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Camera</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Dropcamera</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

MODOO demo mission May 2010

Dropcamera
MODOO demo mission May 2010

1st deployment

2nd deployment
Non cabled observatories (NCOs) are worth considering:

- Modest cost, re-usable / re-locatable
- Complementary to heavy cabled infrastructures
- Particularly suited to the European situation: geographical dispersion of sites / limited funding sources

They meet an actual need, but ... / ...

NCOs suffer from a serious handicap: the limited amount of transmitted data, due to the existing limitations of acoustic modems.

- Until now in Europe, a number of separate experiences came up against the same problem
- Meanwhile, significant progresses are displayed by most manufacturers
Motivation

- Since technological R&D is outside the scope of ESONET, the least we could do was using ESONET weight and network to make sure we use the best existing technology in the world.

- For this, COMMODAC proposed to carry out a comparison of the worldwide offer of acoustic modems, from the angle of their capability of serving subsea observatories.

Methodology / Paper selection

- 13 manufacturers approached worldwide (2007)

<table>
<thead>
<tr>
<th>Name</th>
<th>Address</th>
<th>Name</th>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applied Acoustic Engineering</td>
<td>Marine House, Irvine Park, Irvine, CA 92614 USA</td>
<td>LinkQuest Inc.</td>
<td>3744 Top Gun Street Las Vegas, CA 89121 USA</td>
</tr>
<tr>
<td>Apexim Group Ltd</td>
<td>High Street, Irvine Park, Irvine, CA 92614 USA</td>
<td>Neptune ASI</td>
<td>22 Peregrine Road Westhill Business Park, Westhill, AB32 6JL, UK</td>
</tr>
<tr>
<td>Echosens GmbH</td>
<td>525 route des Dolines 06560 Sophia Antipolis, France</td>
<td>Techno Solutions</td>
<td>12 rue de la Vallonneraye, ZI de la Rangotière, 95500 Roissy</td>
</tr>
<tr>
<td>DOPPLER</td>
<td>Strandpromenaden 50, NO-3183 Horten, Norway</td>
<td>Tecifun Bremen</td>
<td>G28- N2-12-50 Silver Fields, WA 99392 USA</td>
</tr>
<tr>
<td>iXWaves</td>
<td>220 rue Albert Capell 06560 Sophia Antipolis, France</td>
<td>Thales Safare</td>
<td>8 rue de la Rivière des Blins, 92800 Nanterre</td>
</tr>
<tr>
<td>Thalès F&amp;E Labor</td>
<td>Ackerstrasse 76, D-13355 Berlin, Germany</td>
<td>Teledyne Benthos</td>
<td>50 Nether Green, Cockermuir, AB10 7QL, UK</td>
</tr>
<tr>
<td>Develogic GmbH</td>
<td>Nautronix House, 220 rue Albert Capell, 06560 Sophia Antipolis, France</td>
<td>Teledyne Benthos</td>
<td>50 Nether Green, Cockermuir, AB10 7QL, UK</td>
</tr>
<tr>
<td>DSPComm</td>
<td>12 rue de la Villeneuve 29200 Brest, France</td>
<td>Teledyne Benthos</td>
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<tr>
<td>Sercel</td>
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<td>50 Nether Green, Cockermuir, AB10 7QL, UK</td>
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<tr>
<td>EvoLogics GmbH</td>
<td>49 Edgerton Drive North, Falmouth, MA 02556 USA</td>
<td>Teledyne Benthos</td>
<td>50 Nether Green, Cockermuir, AB10 7QL, UK</td>
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</table>

Selection criteria for subsea observatories

- **Energy efficiency** (bits / J) = quantity of correctly transmitted information (to the surface) / spent energy (on the sea bottom)

**Autonomous long term behaviour and reliability**

- Typical representative application specified:
  - Range = 3500 m
  - Max depth = 2500 m
  - Vertical communications (max angle = +/- 45°)
  - Bi-directional comms, mainly from bottom to surface
  - Working duration without human intervention = 2 years
  - Max sleep mode power * = 30 mW
  - Max transmit power = 70 W
  - 12 V < Power supply voltage < 30 V
  - Maximum energy efficiency (bits / J) sought

* In which the modem can wake up upon detection of a carrier
Methodology / Short term comparison cruise

**Bottom modems installation**
- Common energy pack
- Ref. modem used to control power supply of modems under test.
- Common application electronics (Costof), answering surface requests by sending calibrated known files (300, 3000 and 36000 bytes)
- Measurement of energy and time consumed for the transmission of each file

**Trials geometry**

```
2200 m < 1650 m
```

- Transducers under test @ 14 m wd
- Propeller shafts released & stopped
- Recording of noise conditions and waveforms, from a large band hydrophone near the surface
Methodology / Long term trials

June 2009, R/V Poseidon – Feb 2010, R/V Europe
2200 mwd - 16 NM offshore Nice – Zonex free

Surface transducers installation

RESULTS
Manufacturers consultation (13 manufacturers)

- Aquatec Group Ltd,
- Develogic GmbH,
- Evologics GmbH,
- Sercel,
- Teledyne Benthos,
- Thalès Safare,
- Tritech International Ltd.

August 2007

5 manufacturers

- Aquatec Group Ltd,
- Develogic GmbH,
- Evologics GmbH,
- Sercel,
- Tritech International Ltd.

Test stages

Short term cruise (3 manufacturers)

2 manufacturers

June 2008 – February 2010

Integration tests in Brest (June 2008):
- wiring, software adaptation, bassin tests
- Evologics GmbH, Sercel, Tritech International Ltd.
- Withdrawal of Aquatec just before the cruise,
- Late delivery from Develogic GmbH.

Long term deployment (2 manufacturers)

1 manufacturer

August 2008

5 manufacturers

Integration tests

Short term cruise configuration
8 days of test:
Different parameters:
- File size (3kB, 10kB, 36kB),
- Sea states,
- Geometrical configuration,
- Emitting power,

Measurements:
- Transmission time $\rightarrow$ bitrate,
- Energy consumed $\rightarrow$ energy/bit ratio,
- Number of errors

+ Acoustic noise (surface large band hydrophone)

Short term cruise configuration

RV L'EUROPE

The bottom station before the deployment
Short term cruise

Long term tests configuration – bottom station

Long term tests configuration – buoy
Long term tests configuration – buoy

- Deployment on June 22nd 2009,
  -- Good functioning for Evologics until recovery of MAP2 (Feb 2010)
  -- Hardware problem with Sercel modem (no data), fixed in November 2009
### Volume of received data from Evologics (Mbytes)

![Graph showing volume of received data from Evologics.](image1)

**Long term tests– results**

**Evologics mean data rate (bits/sec)**

![Graph showing Evologics mean data rate.](image2)

**Evologics mean energy / received bit (mJ/bit)**

![Graph showing Evologics mean energy.](image3)

**Wind influence**

![Graph showing wind influence.](image4)
Long term tests - results

First application: MoMAR-D

Seamon West: the geophysical node
First application: MoMAR-D

Seamon East: the ecology node

First application: MoMAR-D

The Smoove camera in the Tempo module

First application: MoMAR-D

The Borel relay buoy, 1700 m above Lucky Strike

First application: MoMAR-D

Snapshot from the Smoove camera, transmitted through acoustics / Borel / Iridium
Other features of MoMAR-D

1. Underwater electrical connection devices

2. Connecting the OBS

3. Switching the main power on

4. Underwater Wi-Fi and CLSI devices
Other features of MoMAR-D

Underwater Wi-Fi and CLSI devices
Boundary conditions (2)

- Singles rates are due to $^{40}$K and are about \textbf{300 kHz} per floor. (6 MHz per DU, ~2 GHz total)
- Somewhere between 32 and 64 bits per hit means data transfer of 0.1 Tb/s
- This can increase due to bioluminescence by factor of 10.
- System has to be capable of total \textbf{1 Tb/s} and \textbf{3 Mb/s} at the floor level.

Boundary conditions (3)

- For reconstruction of the neutrino (muon) signal – need to know the position of the OM to ~40 cm (17”) and the arrival time of the photons to ~\textbf{2 ns}.
- Muon takes ~10 $\mu$s to traverse the detector
- Signals in wires/fibres take 15 $\mu$s
- The detector is 100 km from shore this adds a further delay of \textbf{300 $\mu$s}.
- Need to measure/keep-track of this delay to better than \textbf{1 ns}.
Solution
• Have a single fibre optic channel run from shore to each DOM or electronics container
• Have a Continuous Wave laser on shore
• Have a reflecting modulator at the deep-sea side

Timing
• We can do time stamping of signals on shore or in the deep-sea
  – Off-shore we need to transmit a clock (add modulator) and we need to know the delay between shore clock and OM
  – On-shore we need to know the delay from OM to shore.

Timing (2)
Round trip timing is “easy”:
• Modulate a signal at a certain time on shore
• Allow it to reflect with w/o modulation
• Time stamp the arrival time on shore (T1)

Return trip:
• Move modulator temporarily to output
• Measure there and back for return path (T2)
• Keep two circulators very close (5 cm (2”) – accuracy fraction of nanosecond

Practicalities
• Limit in length of bidirectional part 2 km (1¼ mi) due to Rayleigh backscattering.
• 80 wavelengths on a single fibre
  – DWDM wavelength multiplexing and demultiplexing
• CW laser 80 \( \lambda \) – down on one fibre
• Split into ~100 – amplification
• 80 \( \lambda \) can feed 80 DOMs or 80 electronics modules
• 80 \( \lambda \) for 2/1 tower(s).
Real design (slow control)

- Need to send signals to OM
  - Turn on HV
  - Turn on light flashers
  - Start-up synchronisation
  - Clock signal

1. Add command signal on top of CW
2. Add an extra wavelength to all OM

Protocols

- Basically anything you want
- TCP/IP – OK but maybe overkill on 1-1 connection
- UDP – OK
- USB3 – ??
- User defined – also possible (video streaming? about 30 HDTV channels)
- Mixed – TCP/IP for slow control & UDP for data
**Sensors:**
- Temperature
- Voltage
- Water

**Optical Network Sensors:**
- Temperature
- Voltage
- Water

**3" PMT's and 8" PMT's**

**Acoustic Sensor**

**Optical Network**

**3D COMPAS S**

**LEDM**

**PMT control**

**PMT LVDS signals**

**Optical Network**

**POWER Board**

**R-EAM**

**MEM:**

**FPGA**

**Virtex**

**Spartan 6**

**R-EAM driver**

**I2C/LVDS**

**I2C Bus**

**SPI**

**512 Mbit Flash Mem.**

**10Gbps TI SerDes 10021**

**100GHz R-EAM**

**pin/TI A**

**ZPU Mem**

**FPGA**

**Spartan 6**

**1,25 Gb/s**

**512 Mbit Flash Mem.**

**1 V8, 2 V5, 3 V3, 5 V**

**Client Voltages Control**

**Octopus Board**

**3D G-sensor ADXL345**

**CPLD for FPGA Config.**

**PMU**

**R-EAM**

**3D COMPAS S**

**31 LVDS signals for 3" PMT's**

**31 LVDS signals for 8" PMT's**

**2 connectors for 2 x SCOTT**

**ADC AD7688**

**Rx Tx pins**

**Calibration Data**

**Output from one 8" PMT**

**Input example 3" PMT's from octopus**

**Input from 8" PMT's from Scott discriminators only**

**D latch**

**CDL Calibration Data**

**OD**

**Heartbeat 311 MHz**

**Parts of the Interlaken Protocol can contribute to a final solution**
Conclusion

- A high bandwidth fibre optic system is possible
- Timing at the sub nanosecond level achieved
- System provides a transparent network for up to 10 GHz transfer rate
DELOS Update

Technology Workshop

Phil Bagley

DELOS

- A DELOS steering committee was established:
  - To oversee all aspects of the project
  - Approve original Oceanlab experimental design
  - Oversee data distribution and analysis
  - Ensure scientific quality

DELOS Origins

- BP operations are gradually extending into deep water areas (e.g. off Angola)
- BP wanted to gain a better understanding of the deep water environment
- Requested assistance from:

DELOS Concept

Block 18 off Angola

- NEAR FIELD: 50 metres from Well (1400m contour)
- FAR FIELD: 16 km from Offshore Infrastructure (1400m contour)
DELOS Design

- DELOS consists of two parts (part A)
  - Two sea floor docking station;
  - Glassfibre construction
  - Remains on sea floor for 25 years;
  - Geometry defined by the scientific requirements:
    - Near sea bed;
    - Minimise sea floor impacts;
    - Minimise sediment re-suspension by ROV intervention;
  - Sensor geometry requirements:
    - Camera field of view;
    - Acoustic field of view;
    - Minimise sampling error due to structure.

DELOS Design

- DELOS consists of two parts (part B)
  - Five observatory modules, slotted into docking station by ROV
  - Recovered to surface by ROV for service every 6 (12) months for service and data offload
  - Returned to the docking station for a further 6 months
  - Repeated for 25 years

Camera module

- Close and wide view camera systems
  - Wide view
    - Visualise seasonal sea floor sedimentation, passing animals, and disturbance events over a 20m² area
  - Close view
    - Identification of invertebrates and fishes:

Camera module

- Abyssocucumis abyssorum
Oceanographic module

- A suite of oceanographic instruments is essential for any long term monitoring station. They provide background measurements to characterise the environment for other observation modules in the docking station.

- Current, temp., salinity, $O_2$, pressure, turbidity, etc.

Acoustic module

- Passive and active acoustics
- Passive acoustics will monitor natural sounds generated by animals in range, as well as background noise levels
- High frequency active sonar enable fish movements to be observed at a lower resolution but at much greater range than photographic systems
- Together these systems could monitor fish reaction to acoustic disturbance

Sediment trap module

- Phytodetritus from plankton in the surface layers falls to the sea floor in seasonal pulses. This input of material is the major source of energy for the deep-sea community. A sediment trap collecting and periodically storing this fallout enables the composition and quantity of this energy input to be measured.
Guest modules

- Empty module for future experiments

DELOS operational

- Installed February
  - Service August 2009
  - Service February 2010
  - Service August 2010
  - Service May 2011
  - Service May 2012
  - etc

Delos close view camera data
Delos wide view camera data

Oceanographic data

Acoustic data

Sediment trap data
DELOS Materials

Technology Workshop

Phil Bagley

Mechanical structure

- Glass fibre Construction with Super Duplex bolted joints
- Solid works
- 2H Offshore Ltd

Mechanical structure

- GRP with bolted joints
  - "I" 200x200x10
  - 8mm Duplex Plates
  - M16 bolts
  - Nylon Sleeves on legs
  - ROV lock down
  - Split on CL for shipping
Material testing

- Modelling of steel structures routine in oil industry
- Glassfibre properties unknown
  - Glassfibre has varying properties in different directions
  - Bolted joints may cause load bearing relative slip between joint members resulting in non linear behaviour
  - Local stress may result in failure

Material testing

- Testing required to prove glass fibre is a suitable material
- Two materials from different manufacturers tested
- Flextural
- Tensile
- Sheer (double notch as a Proxy for interlaminar sheer)

Material testing

- Aging
  - Each 10°C rise in temperature over normal ambient is equivalent to factor of 2 in time (1)
- Pressure
  - Samples tested at 300 Bar
  - Samples cycled 40 times

Reference 1

Material testing

- Micrographs of GRP pre & post Aging
  - Material 1 before aging
  - Material 1 after 24 weeks at 64°C, 300 bar showing water intake and degradation in Material properties
Material testing

- Test show a degradation of material properties
- Still within specification after simulated aging

![Graph showing average shear and tensile results](image)

Technology workshop 2nd & 3rd Nov 2010

Structural analysis

- Two modelling approaches adopted
  - Global wire frame model analysis to determine stability of frame (Structural Analysis Computing Software)
  - Localised Finite Element Analysis (FEA) of important joints (ANSYS)
  - All testing was guided by EUROCOMP design code handbook for composite materials.

Technology workshop 2nd & 3rd Nov 2010

Global wire frame model

- 12 different load cases considered to fully characterise frame stability
  - Module weight + current loading: 20yr degraded material properties
  - Ballast in centre slot: New material properties
  - Installation / Retrieval – Docking Station
  - Self-weight in air - Ballast in centre slot: New material properties
  - Soil suction loads (20 kN) distributed on all 3 legs: 20yr Degraded material properties
  - Installation / Retrieval – Modules
  - In air lift with equipment payload: 20yr Degraded material properties
  - Stuck module case
  - Transportation / Deployment
  - Transportation and splash zone loads modelled using assumed Dynamic Amplification Factor (DAF)
  - Separate installation analysis conducted (resonance check)

Technology workshop 2nd & 3rd Nov 2010
Global wire frame model

- Ballast in place, no modules, as new material properties
- Max Vertical Deflection 32.3mm

Technology workshop 2nd & 3rd Nov 2010

Global wire frame model

- Modules In place – Degraded Material Properties
- Max Vertical Deflection 27.5mm

Technology workshop 2nd & 3rd Nov 2010

Localised joint FEA

Technology workshop 2nd & 3rd Nov 2010

Installation Analysis

- Installation analysis conducted to consider deployment of GRP DELOS frame
- Assumed frame deployed from side of vessel using crane

Technology workshop 2nd & 3rd Nov 2010
Installation analysis

50m Installation Depth

BP DELOS Subsea Docking Station
System Installation Analysis
50m Installation Depth

Hydrodynamic modelling

5 cm/s currents, 50mm upstand

Model 5 discrete heights above sediment surface.
From as close to bottom as possible to a height of 500mm above bottom.

Hydrodynamic modelling

- Sediment re suspension unlikely at current velocities of 5cm/s or 10cm/s
- Sediment re suspension may occur at current velocities of 15cm/s and above
Foundation design

Soil conditions
- Sheer strength vs depth

Sheer Strength in vicinity of salt diapir

Shear Strength vs depth

\[ \text{Sudss} = 2.25 + 1.05z \]

Foundation stability

Overturning stability
- 22.6 kN steady state load
- 91.4 kN Peak

Horizontal (Sliding) Mudmat Capacity
- 4.9 kN
- 4.9 kN

Sliding stability
- 35.1 kN ballast

Ultimate Vertical Capacity (kN)
- 4.9 kN

Vertical Mudmat Capacity
- 0.25m skirts
- 0.50m skirts
- 0.75m skirts

Ultimate Horizontal Capacity (kN)
- 4.9 kN
- 4.9 kN

Mudmat Skirt Penetration Resistance - 1.5m diameter
- 0.00
- 0.25
- 0.50
- 0.75
- 1.00

Self-weight
- 11.7 kN per mudmat
- 5.9 kN
- 13.4 kN
- 17.6 kN
JUNCTION BOX RECOMMENDATIONS

Aberdeen Technical workshop 2nd
3rd November 2010

Subsea observatories requirements – Esonet Label

Junction Box (JB) architecture example

- Node or JB
  - 400VDC + Eth 1000LX (fibre)
    - 1 or 2 fibres (fail over, load balancing,..)
    - Or 400VDC + xDSL (few km network extension)

- Switch(es)
  - CoS, QoS
  - IEEE 1588
  - Boundary clock, VLAN, LACP, port Trunk,

- Extension module:
  - RS232/422/485, CAN Bus, VDSL2 modem

- Clock synchronisation
  - Ethernet: PTP/IEEE 1588 clock client
  - Other: GPS Emulation + PPS + NMEA time code

- Controller
  - Optional: Data storage
  - Optional: Embedded instrument driver

- Control/command power supplies – faults detection
Energy needs

10kW junction box – Neptune Canada type (several cameras, winch, crawler, …)

1kW junction box – ESONET-EMSO usual case (camera with low light or short sequences, limited actuator power, seismic monitoring, …)

100 W junction box – Low power consumption for generic sensor package and monitoring (pore pressure, temperature, …)
7 APPENDIX 2 : ESONET Label

Note: This text is a contribution. The conclusions on the Esonet Label are included in the deliverable D68 Esonet Label – Final version. Make choices for the specifications. Mandatory aspects and description of recommended solutions or options. What is mandatory in the point of view we expressed and experienced in ESONET.

The topics addressed are:

1) Define the observatory.
   Definition of words.

2) Infrastructure

3) Generic and scientific modules

4) Maintenance
   Maintenance procedure.
   Exceptional maintenance.
   Spares: provision for spares

5) Data management.

6) Environmental and safety issues

7) Infrastructure

Recommendations:

- AC or DC
  DC power feeding is the most common choice and will gain from previous experiences. AC for short distance may be a good solution. (Exemple of AC for Catania and Antares)

- Power return by sea water
  Magnetic field and by products of the corrosion of the current return devices must be evaluated with respect to their environment disturbance effect. A specific biologic study is recommended over $X$ kW or $Y$ kW. ($X$ and $Y$ to be determined by bibliography and consultation of experts). (see environmental issues)
Connectors – 1 - Establish a European group on **wet mateable** connectors for exchange of experience and sharing of qualification procedures. It should share expertise with deep offshore oil and gas providers and users.

Connectors – 2 - **Dry mateable** should withstand open face pressure and be studied for long term ageing.

Infrastructure - Stand alone observatories

Satellite or direct hertzian link

**Acoustic modem energy efficiency**
- Less than 20mJ per bit is achievable for 2500 m waterdepth (45° angle). For a specific distance, this energy efficiency must be the major criteria towards the manufacturer. 
- the stand-by mode power consumption of the labelled acoustic modems must be less than 20 mW.
- the labelled acoustic modems must support a data integrity checking/correction layer, in order to relieve the upper layers from this highly medium-dependant task.

**Redundancy**
Two parallel independent transmission channels (acoustic modem, electronics and satellite modems) are recommended on a buoy.

**Batteries**
Lithium batteries. Ingress of water is a major difficulty –
Pressure relief devices. Pressure control (house keeping in the pressure vessels). Size of the containers must be limited (reference to the limit for air freight).

**Messengers?**
For failure cases.

**Buoy**
Must be tracked in any conditions (GPS position)
Mooring design and final manufacturing should be controlled.
Intermediate floatations should allow recovery of bottom section.
Double releases are mandatory.

**LONG-TERM DEPLOYMENT: MATERIALS FOR SUBSEA OBSERVATORIES**

*In the definition of subsea observatories, from the scientific vision to cost estimates, long-term sustainable operation is a key issue and probably constitutes a limitation. Any improvement in ageing of materials and components merits further study.*

Based on the experience gained mainly in the offshore industry [1] where materials are exposed in deep sea (up to 2000 m) for long time (up to 25 years), in the framework of ESONET/EMSO program guideline for the choice and selection of materials for long-term, deep-sea exposure was proposed.
These guidelines, based on existing literature [2], feedback from previous experiences and the Best Practices Workshop 2 white paper of this session are under preparation. The following points are addressed:

Description of the deep-sea environment highlighting the influence of parameters behind acting on the degradation process (pressure, oxygen concentration, fouling, etc.)

Review of materials used in service deep sea applications:

Metallic material
Non metallic materials
Associated protection
Cathodic protection, including the choice and design of cathodic protection systems
Paints and coatings
Assembly
Sub-components: moorings, landers, connectors, junction boxes, pressure houses, buoyancy, etc.

Guide for performance evaluation

It must be mentioned that experience feedback is of primary importance for the use of most of the materials. Attention must be paid on the assembly of dissimilar material where galvanic corrosion could be initiated.

Design of structure, choice of material and associated protection method should be performed by skilled people in order to avoid reinventing solutions already evaluated.

In general, the long-term behavior of the material is not or is only weakly affected by pressure. While pressure loading must be taken into account in terms of mechanical loading on hulls for instance, the intrinsic properties of the material are generally not affected by pressure. Materials subject to creep such as some thermoplastics can be easily replaced with materials having more suitable characteristics.

In order to avoid most of the problems of corrosion the use of cathodic protection for metallic structure is strongly recommended and that will limit the use of “exotic” and “expensive” materials, which could be proposed.

The distance needed to avoid biological effect from anodes on the monitored abyssal ecosystem is 50 m.

For polymer and composite materials [3] good knowledge of behavior in water has to be considered in order to limit the risk of long-term detrimental degradation processes (hydrolysis, etc.). However, it must be noted that degradation of such material is generally thermally activated and except in really specific areas (black smokers, etc.), temperature is low enough (around 4°C) to avoid initiation of degradation processes.

An approach based on accelerated test using time-temperature equivalence can be used to predict long-term performance of polymeric materials [4][5] however good knowledge of degradation phenomena is needed in order to guarantee pertinence of the accelerated test.

For specific materials as syntactic foam, synthetic fiber for mooring cable, knowledge of long-term behavior has already been addressed through specific program related to offshore industry [6][7].
Deliverable D61 Workshops on logistical, engineering and technical aspects of observatories


Generic sensor
The minimum generic sensor package has to fulfil following characteristics:

<table>
<thead>
<tr>
<th>Type of sensor</th>
<th>Range</th>
<th>Accuracy</th>
<th>Sampling frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conductivity</td>
<td>0 to 9 S/m</td>
<td>0.001 S/m</td>
<td>4 Hz</td>
</tr>
<tr>
<td>Temperature</td>
<td>-5 to +35°C</td>
<td>0.01 K</td>
<td>4 Hz</td>
</tr>
<tr>
<td>Pressure</td>
<td>0 to 600 bar</td>
<td>0.1 % FSR</td>
<td>4 Hz</td>
</tr>
<tr>
<td>Dissolved oxygen</td>
<td>0 to 500μM</td>
<td>5%</td>
<td>0.01 Hz</td>
</tr>
<tr>
<td>Turbidity</td>
<td>0 to 150 NTU</td>
<td>10%</td>
<td>1 Hz</td>
</tr>
<tr>
<td>Currents</td>
<td>0 to 2 m/s</td>
<td>2%</td>
<td>1 Hz</td>
</tr>
<tr>
<td>Passive acoustics</td>
<td>50 to 180 dB re 1μPa</td>
<td>+3dB</td>
<td>96 KHz</td>
</tr>
</tbody>
</table>

As sensor development continues other parameters can be added. Sensors for pCO2, pH, CH4, H2S, Eh, Chlorophyll-a, and hydrocarbons are likely to become part of the generic scheme as sensors for them become adapted for long-term deployments to abyssal depths. (duration and time between calibration to be addressed) Targeted: reliability figures.

Deployment methods
Deliverable D27 of Esonet presented a review of existing Best Practices and standards in offshore industry and the possible benefits for the scientific community.

Periodic maintenance of the observatory:
Maintenance procedures available for ROVs to replace modules or subsystem. Standard procedures would allow to use any opportunity ROV for these operation and would, so, minimize operational costs;
Planning at European level, would allow to refit and calibrate sensors for redeployment on different nodes
Maintenance cruises are also scientific cruises during a learning phase of a few years.

Exceptional maintenance operation:
Should be budgeted initially
Protocols to be studied for the major components. (extra length of cable for retrieval, additional connectors)
Existing agreements with ROV operators to maintenance operation under a short delay;
Agreement on ships (Ex: MECMA / ACMA interval activity,…)

Deliverable D61
Existing spare component stock related to a failure analysis study (reliability, redundancy, availability).
Could be stored at the manufacturer’s shop.
Data management and dissemination:

Data policy access:
ESONET is recommending following points:
Free and open access according to IOC Data Policy (International oceanographic Commission UNESCO) programmes is applied for basic data, especially the data requested for risk assessment in real time and delayed mode.
Registration of users.....
Experimental data should follow classical scientific confidentiality rules: no more than 2 years restriction.
Data classified for security reason will be stored and be available as soon as they will be declassified.
Access to citizens is facilitated by implementation of specific tools.
Long term archiving more than 20 years) is assumed for all types of data, including classified data, eventually in a specific data center signing convention with EMSO.
( wording to be updated according to VISO document – Tromsoe - 2009)

Environmental impact:
Attention will be paid on the effect of acoustic devices on sea mammals and other organisms and effect of emf’s from power cables on certain species or fish.
Electrical and acoustical noise would be under the levels identified in the OSPAR agreement.
Rules and recommendations of international bodies such as IUCN and ICES are strictly followed.
During fieldwork the disturbance to species and habitats is restricted to the minimum required. For marine protected areas, permission for fieldwork are requested where necessary.
Deliverable D61 Workshops on logistical, engineering and technical aspects of observatories

All deadweight or unused device will be retrieved. *(to be addressed by future projects)*

Limitation in the use of some liquids that could leak. *(to be addressed by future projects)*