SYREDOMY : an underwater wireless pop-up system for deep and remote data recovery

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Two applications: CPIES and CIAM
SYREDOMY Aims

1. Data recovery on shore from ongoing deployments

2. Status of immersed instruments

3. Start data validation as soon as received

4. Extend duration of deployment according to instruments status

5. Partial recovery of data in case of instruments damages
SYREDOMY : Principles

1. Every sensor/instrument collects and stores data which are sent to concentrator

2. At predefined rendezvous, the concentrator transmits data to pop-up messengers over an underwater wireless link

3. Pop-up messengers are released either on a predefined date or acoustic command from a surface (opportunity) ship

4. Once at surface, data are transmitted to shore via a satellite link (Iridium)
### Some numbers and constraints

<table>
<thead>
<tr>
<th>Instrument Type</th>
<th>Storage Capacity (Mb)</th>
<th>Transmission cost (k€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPIES</td>
<td>32</td>
<td>22</td>
</tr>
<tr>
<td>ADCP</td>
<td>1000</td>
<td>700</td>
</tr>
<tr>
<td>CTD (SBE37)</td>
<td>8</td>
<td>6</td>
</tr>
</tbody>
</table>

- **Pop up buoyancy**
- **Limits on embedded weight**
- **Limits on embedded energy**
- **Limits on data flow to shore**

**Compromise and strategy to define**
# Underwater wireless link: some options

<table>
<thead>
<tr>
<th>Method</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
</table>
| **Acoustics**       | • High transfer ranges  
                      • Moderate to high data flow  
                      • 1 emitter – many receivers | • Cumbersome devices  
                      • High energy  
                      • High cost |
| **Optics (IR)**     | • Small devices  
                      • Low consumption  
                      • Low cost | • Small transfer ranges  
                      • Mechanical alignment  
                      • Moderate data rate  
                      • Emitter and receiver at all nodes |
| **Magnetic induction** | • Small devices  
                      • Low consumption  
                      • Low cost | • Small transfer ranges  
                      • Moderate data flow  
                      • Emitter and receiver at all nodes |
| **Microwaves**      | • Small devices  
                      • Low consumption  
                      • Low cost  
                      • Very high data rates  
                      • 1 emitter – many receivers | • Very small transfer ranges |
| *Zigbee, Bluetooth, Wifi* | | |
IFREMER pool tests to evaluate the microwave transfer (Zigbee)

2 spheres immersed at 1,5 m below the surface: evaluate the transfer distance

Transfer character by character

RS 232 link

PC #1

Maximum distance: 3 cm

RS 232 link

PC #2
To increase the range between the spheres, we must push away the water, which due to its conductivity, strongly attenuates the electromagnetic waves.

*Use of a PVC piece diameter 60 mm, length 300 mm*
First prototypes

Concentrator and messengers in Nautilus glass tubes

White support is PEHD:

- Mechanical support for messengers
- «waveguide» for microwave propagation
CPIES Version

- Messengers in Nautilus glass spheres or tubes
- Sphere is cheaper than tube (-1200€)
- 6 messengers distributed as 2 at 45°, 2 at 90°, 2 at 135° relatively to concentrator
Attenuation measured between concentrator and messengers

- XBEE emission: 18 dBm
- XBEE receiver sensitivity: -100 dBm

**ATTENUATION MUST BE <118 dB**
ALEES – SYREDOMY-XBEE boards

**ALEES board** (Advanced Low Energy Electronic System)
- Developed by IFREMER REM/RDT/I2M
- Microcontrôleur Energy Micro EFM32
- Active lowpower mode: <2 µA / 3V
- Active mode at 48 Mhz: 10 mA / 3V
- IDE: Eclipse, GCC compiler, JLINK JTAG debugger
- Size 45x55 mm

**SYREDOMY application board**
- Receive ALEES and XBEE module
- RS232 level adapters
- Voltage regulator
- Power switches

**DIGI XBEE module**
- Range: up to 100 m
- RF emission power: 58 mW (18 dBm) adjustable

18-21/11/2014 -
INMARTECH
Electromagnetic Release in balanced pressure

Ferromagnetic core coated with teflon

Electromagnet in balanced pressure
Integration in 10" Nautilus sphere (1)

IRIDIUM antenna

Reed relay (release detect)

SYREDOMY-ALEES-XBEE

Energy: 6 lithium Saft LSH20 primary batteries
7.2V/39Ah
Integration in 10" Nautilus sphere (2)

- Vacuum port
- Iridium modem 9602
- Hook to hold sphere on the frame
- XBEE antenna

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Transmission IRIDIUM : SSUIT (Simple and Secure Usage of Iridium Transmission)

Library développé by LPO under license CeCILL-B (french free software BSD-like)

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IRIDIUM : results

Iridium data rate : 18 to 70 kb/h
IRIDIUM : résultats

Total SBD transmitted volume : 1825 kb
SYREDOMY: timelines/résultats

2010:
• Start developing on Persistor CF2 board (concentrator+messenger)
• Validate overall feasibility (in laboratory, pool…)

2011:
• 1rst trial at sea for a week (~300 m depth)
• Validate underwater wireless XBEE link

2012:
• Switch to ALEES board
• 2nd trial at sea for 5 months
• Validate concentrator on ALEES board
• Validate Iridium SBD (340 bytes) SSUIT.

2013:
• Global system integration and validation
• 09/2013: 1rst operationnal deployment (SAMOC program)

2014:
• 06/01/2014: 1rst messenger release -> Nominal functioning 100% of data recovered from mid-South-Atlantic coming from 5000 m depth instrument récupération des données
• Since then: no more ?!
  • Hypothesis: trouble with electromagnetic release ➔ corrosion ➔ burnwire
Conclusion

• Wireless microwave link is feasible

• Iridium SBD transmission from small devices barely emerging is working

• Attractive system but…

• need to work on simple and robust release ➞ burnwire is a good candidate
Thanks for your attention