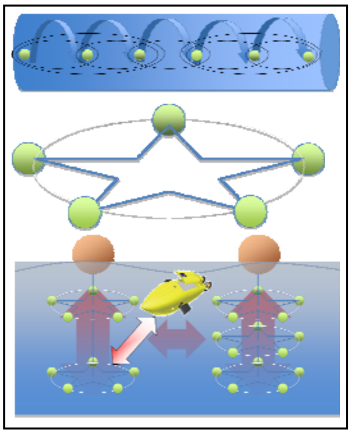
COLLABORATIVE EMBEDDED NETWORKS FOR SUBMARINE SURVEILANCE

CLAM

Key Innovation

Imagine a world where we could just spread a number of sensor nodes in the water, some on the sea floor, others floating at different depths, and these devices were able to talk to each other, autonomously organize themselves into a network, exchange data, identify regions or resources that are experiencing some phenomenon of particular concern to the user, and eventually deliver this information to one or more collection points where it can be easily and cheaply accessed or transmitted. Where if, for any reason, a component failed the other network components could understand it and just reorganize into a different topology with no critical consequences.

Imagine a scenario where autonomous underwater vehicles (AUVs) can travel through such systems, and by dialogue with the various sensors download the data and bring it back ashore for the scientists to examine. Where data is continuously processed and disseminated in real time, thereby providing a live view of what's happening. Imagine swarms of these AUVs traveling around in a coordinated way to accomplish a common mission, while exchanging data and being guided together from a remote location.



Although it may sound like science fiction, today's technology is in fact very close to making all these possible by opening up new ways in which we learn and understand the complexity of submarine life, and we can monitor waters and coasts. The key missing ingredient for turning this vision into reality is the availability of an effective and cooperative underwater sensing, reasoning, and communication platform, which makes possible for sensing and actuating devices to exchange data, network together, and collaboratively and locally asses their observation environment and act upon. This is the role that CLAM will play.

Technical approach

Unlike other projects offering sensor network solutions for underwater that address either communication or networking, CLAM deals with the entire system design by developing low power acoustic sensors as well as sensor platform and by encompassing all layers of the protocol stack. In particular, CLAM project will focus on physical layer design and processing techniques but also to their cross-layer integration with MAC, topology control, beam forming and clustering, data handling, distributed processing and reasoning.

Contract number

258359

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Project website

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Community contribution to the project

2 Million Euro

Project start date

1 June 2010

Duration

38 months

This will result in a complete solution for collaborative embedded monitoring and control platform for submarine life.

The ultimate goal of the CLAM project is to develop a collaborative embedded monitoring and control platform for submarine surveillance by combining cutting edge acoustic vector sensor technology and 1D, 2D, and 3D sensor arrays, underwater wireless sensor networks protocol design, advanced techniques for acoustic communication, new solutions for collaborative situation-aware reasoning and distributed data and signal processing and control for horizontal and vertical linear sensor arrays.

Demonstration and Use

The CLAM platform will be based on underwater wireless sensor networks made of low-cost acoustic particle velocity sensors measuring acoustic quantities, which cooperate with each other to sense the environment, and which communicate real-time information to the users about risks, hazards and events of interest. Sensor measurements will be combined both horizontally and vertically and collaboratively processed through distributed situation-aware algorithms and reasoning mechanisms.

Communication of information under water is performed via a hybrid network combining multi-hop underwater acoustic communications with cabled communications (whenever available). Collaborative beam forming will also be considered as an option to improve link reliability or bridge otherwise disconnected network portions. The resulting underwater monitoring platform is then interconnected with centers where the information is stored and processed.

CLAM benefits from a mixture of modelling, simulation, prototyping, lab experiments, and real-world small scale experiments in a diving center and in the Norwegian sea.

Scientific, Economic and societal Impact

- developing a generic platform for **development of miniaturized, low-cost and robust underwater sensors platforms**
- developing and evaluating a **robust and compact underwater wireless sensor network**
- **communication protocol stack** for submarine surveillance
- laying down a robust and scalable platform for **collaborative networking and distributed data and signal processing, situation assessment, reasoning, and event detection** for online submarine surveillance enabling learning, adaptation, and self-organization of 3D sensor arrays
- giving Europe and the European Industry the **capability to play a leading role** in an emerging market which is still in its infancy
- **enforcing the position of Europe in underwater monitoring** that currently is behind the US
- **creating economic opportunities** by opening up new possibilities in the underwater monitoring applications and creating new opportunities for the market
- **addressing underwater societal concerns** such as security, productivity, and quality of life

First achievements

- First design of a small and relatively cheap underwater sensing and communication platform
- Advancing development of particle velocity sensors for underwater deployment
- First design of networking protocols for underwater sensor networks
- First design of a unified simulation framework

Project partners	Country
University of Twente	The Netherlands
Kongsberg Maritime	Norway
SINTEF ICT	Norway
Microflown Technologies	The Netherlands
University of Rome	Italy
University of Padova	Italy
CINI	Italy