Communication constraints and requirements for operating Multiple Unmanned Marine Vehicles (MUMVs)

M. Perrier, L. Brignone, M. Drogou
Underwater Systems Department, Ifremer Mediterranean Centre
La Seyne sur mer, France

ABSTRACT
This paper presents the different communication constraints and requirements identified for operating several Unmanned Marine Vehicles (UMVs) as a fleet or a swarm. The possibility to operate several vehicles in a collaborative way strongly relies on the capability of communication of each vehicle. Indeed, in order for a fleet of vehicles to execute co-ordinated manoeuvres in a well concerted manner, navigation, control and mission data must be exchanged among the team members through a communication network. In the marine environment, different means of communication exist due to the heterogeneous nature of the environment itself and of the operated vehicles (surface and underwater vehicles). The communication network must handle aerial (radio) communication link between surface vehicles, and underwater (acoustics) communication between underwater vehicles and between underwater and surface vehicles. The study presented in this paper results in a collection of functional and technical requirements and constraints for Multiple UMVs (MUMVs) communication.

KEY WORDS
Marine vehicles; heterogeneous systems; acoustic communication; underwater robotics; co-ordinated control.

INTRODUCTION
Dynamic system theory provides a rich methodology and a supporting set of mathematical principles and tools for analysis and design of navigation, guidance and control for “single” autonomous vehicles (J.Bellingham, T.Consi, 1990) (Byrnes, 1993). Today, considerably effort is being placed on the deployment of groups of networked vehicles in a number of challenging environments, and in particular in the marine environment (A.Pascoal, C.Silvestre, and P.Oliveira, 2006).


The European project GREX (“Co-ordination and control of co-operating heterogeneous systems in uncertain environments”) aims to study and implement methods for co-ordinated mission control of heterogeneous marine vehicles, enabling end-users to effectively program and follow the state of progress of multi-vehicle missions. The project also aims to exploit perception and communication techniques to enable ad hoc formation of information and sensor networks among a swarm of vehicles (GREX, 2006) (T.Glotzbach, J.Wernstedt, 2006).

Communication is one of the key elements to enable successful execution of complex mission scenarios involving the use of multiple vehicles. In fact, in order for a group or a swarm of vehicles to execute co-ordinated manoeuvres in a well concerted manner, navigation, control and mission data must be exchanged and shared among the team members via a (possibly complex) communication network. A general communication strategy must be defined and applied to the co-ordination of different types of vehicles, including aerial drones, Autonomous Surface Vehicles, and Autonomous Underwater Vehicles. As such, the strategy will explicitly address the heterogeneous nature of the robots used to fulfil the requirements of a pre-programmed mission plan.

In the marine environment, different means of communication exist due to the heterogeneous nature of the environment itself and of the operated vehicles (surface and underwater vehicles). The communication network defined for MUMVs must handle aerial radio communication link between surface vehicles, and underwater acoustics communication between underwater vehicles and between underwater and surface vehicles. To these links, it should also be added the inter-process communication link existing either on-board each vehicle or on a common Supervision Station (SS) from which the fleet is programmed,