Sciamano Concept Study

1. Purpose

The presentation of the Sciamano Concept Study is intended to probe the possible interest of Governmental and Commercial organizations, and possibly encourage exchange of ideas and information, leading to eventual cooperation in the development of a new concept of naval assets that make extensive use of unmanned/autonomous vehicles swarms.

2. Introduction

Fincantieri –Naval Vessel Division, Combat System Department– launched the "Sciamano" (Shaman) Concept Study in 2018. It is an in-house endeavor outlining possible technical solutions and estimates of current/future feasibility, and cost-effectiveness of an innovative surface ship solution for Underwater Warfare (primarily) and other maritime warfare areas (secondarily).

The term "swarm" in Italian is "sciame"; verbal pl. form is "sciàmano" ("they swarm"): this led to the nickname "Sciamano".

One of the risk that all naval assets in Underwater Warfare (UWW) is the chance to receive a torpedo hit that in many cases will result in the complete loss of the ship. This is an event that besides the dramatic consequences suffered by the crew, will likely impact on the mission.

Currently, just considering the Antisubmarine Warfare portion of UWW as an example, we can state that there are basically three ways to prevent a torpedo hit:

1 – Have an acoustic signature that is so excellent that the ship can pass on top of a submarine without being detected.

2 – Have a detection system that allows detecting the submarine at a range that is greater than the threat weapon range.

3 – Equip the ship with a Torpedo Defense System (TDS) capable of defeating all torpedo attacks.

Since none of the three ways is achievable with a 100% rate of success, usually a combination of them is pursued.

Similar issues exist also in Mine Warfare and also in other non-UWW areas.

So, what if, instead, we take an approach keeping the main platform as much away as possible from the threat, while still being able to detect and avoid or engage it? And here it is where Sciamano comes into play.

The idea is to de-localize some anti-submarine and mine warfare functions, traditionally held within surface ships on board assets like ASW frigates and Mine Hunters, to swarms of air, surface, and sub-surface unmanned vehicles, carried and operated from a main platform (mother ship, or "Drone Carrier").

The aim, as said before, is to keep personnel and assets away from the threat as much as possible, achieve a wider coverage, a longer operational range, and higher effectiveness, with contained costs and risks.

Furthermore, the concept would also include the full de-localization of the engagement function, which is currently carried out either by the surface ship itself or by air assets such helicopters, and maritime patrol aircraft for antisubmarine warfare, and occasionally by divers for what mine warfare is concerned.

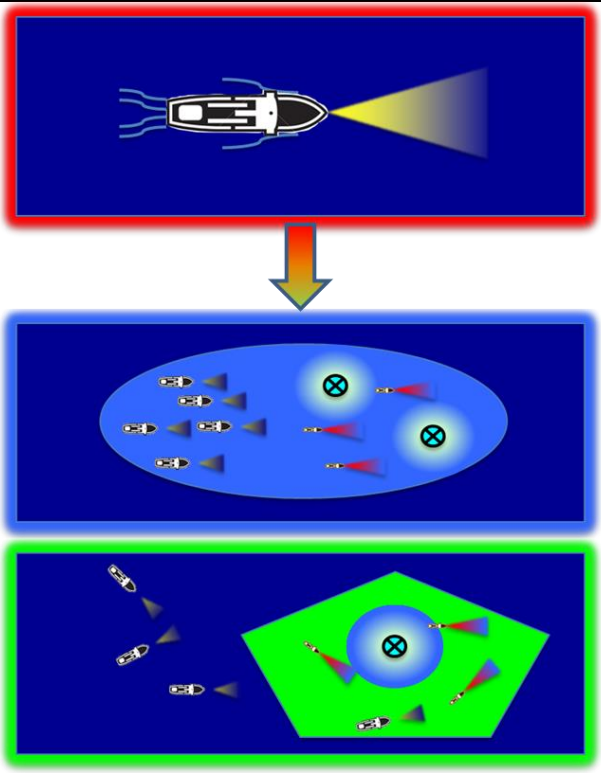

Fig. 1 – From traditional operations to swarm

3. Approach

Two main approaches are being pursued, to evaluate the convenience of this concept:

1. estimate the concept effectiveness, based on performances of unmanned vehicles currently on the market, or being developed;

2. estimate the unmanned vehicles' characteristics required to make the concept worth to be pursued in a medium to long term (indicatively 10 to 15 years ahead).

Approach #1 outcome should indicate if the concept is likely mature/effective in the near term, or the current gap with traditional solutions.

Approach #2 could possibly drive unmanned vehicles producers' R&T to the development of future systems.

4. Discussion

The concept development started in September 2018. It was supposed to last approximatively six to nine months, and be focused on autonomous vehicles' weapon systems performances, mainly in the Underwater Warfare domain (Anti-Submarine Warfare, and Mine Warfare).

However, during the concept development, it has been noted that further significant potential exists for the employment in other warfare areas and maritime activities.

In any case, even if the Sciamano concept has a Combat System lead, it heavily involves the Platform Department within a Whole Warship approach.

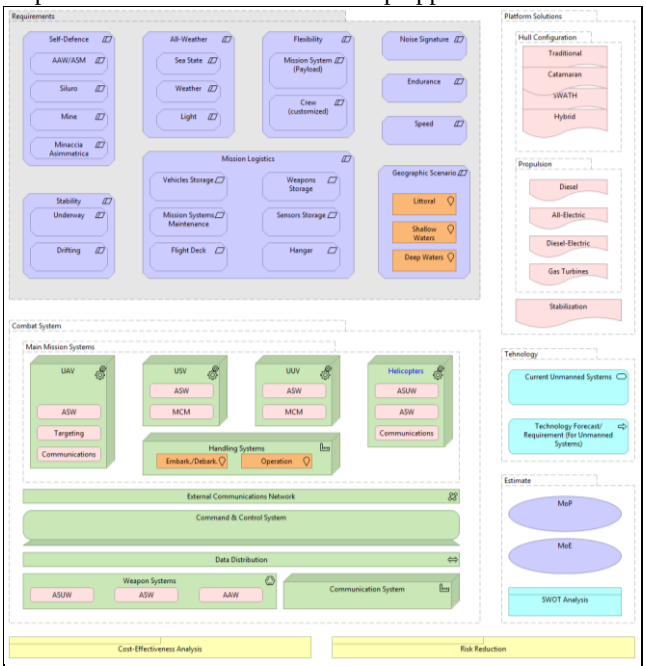

Fig. 2 – Sciamano Concept - Architecture

In the future, the involvement of other bodies, and the marketing of the idea, through organizations/events such as NATO, EU, IQPC, etc. are also being considered.

The activities carried out and in progress consist of:

- Definition of a scenario where the Sciamano concept can be tested. It consists of a synthetic geography and a set of environmental variables against which the possible technical solutions are confronted.
- Definition of a set of missions that could be effectively carried out or supported by the Sciamano. Most of such missions are "sequential", in the scenario, building a sort of storyboard that foresees the deployment of a naval force consisting of a Main Body, composed by an Amphibious Group.
- Selection of a set of high-end autonomous vehicles, based on what is currently (or soon) available on the market, that might form a basic set to be operated by an ad-hoc built or adapted "drone carrier".
- Definition of a standard autonomous vehicles load for the Drone Carrier. Such load is eventually tailored, keeping into account the mission, the operational tempo and the unmanned vehicles capabilities.
- Tailoring possible sets of variable payloads for each unmanned vehicle, in accordance with the set of missions.

The current set of mission the concept is evaluated against is:

A. Escort a Main Body
B. Sanitize an Amphibious Operation Area
C. Protect the Amphibious Operations Area
D. Support a Landing Force
E. Support Land Forces' Operations
F. Protect a Port and/or an Anchorage
G. Carry out Embargo Operations
H. Provide Incident/Disaster Relief
I. Search and Rescue

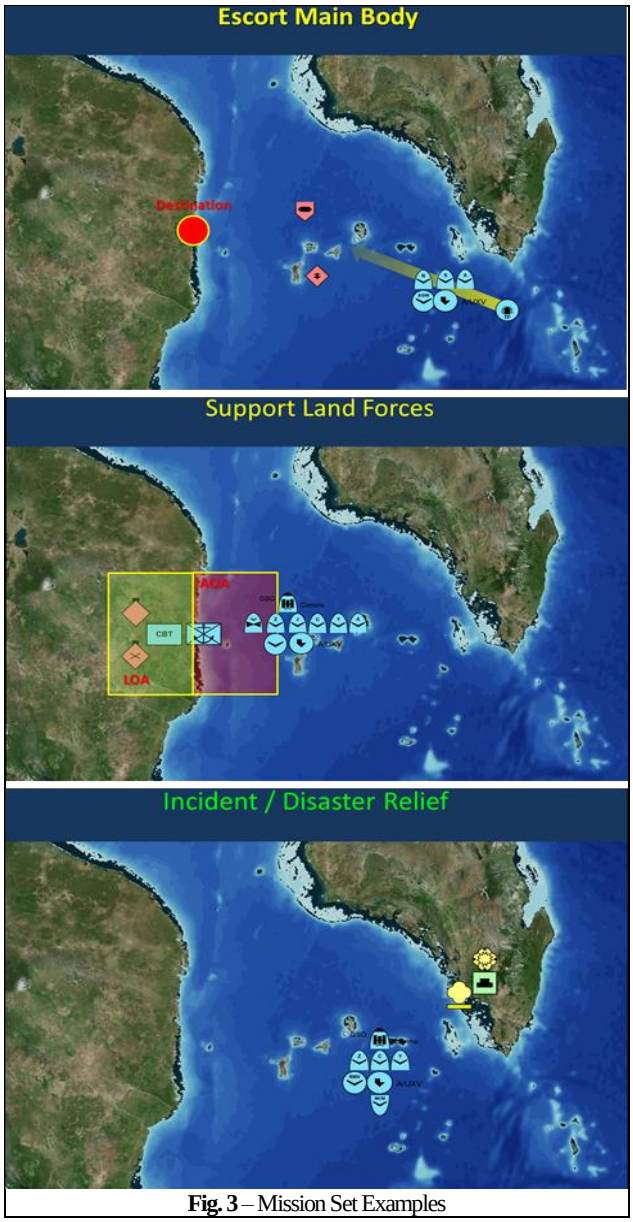

Fig. 3 – Mission Set Examples

A set of vehicles/payloads combination is then defined for each mission and relative domain(s), and every combination will carry its own Measures of Performance (MOP).

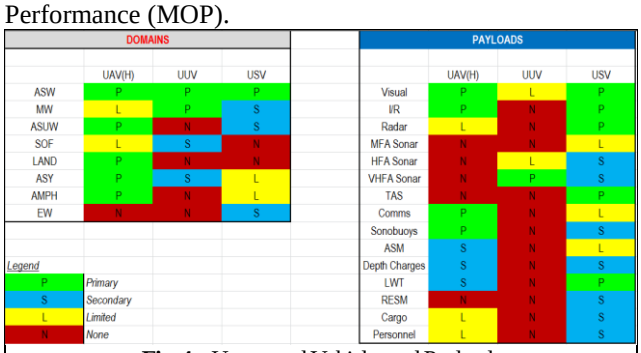

Fig. 4 – Unmanned Vehicles and Payloads

Consequently, Measures of Effectiveness (MOE) can be computed in the scenario, for each mission, and a sound weighted average of each MOE provides the Sciamano overall effectiveness.

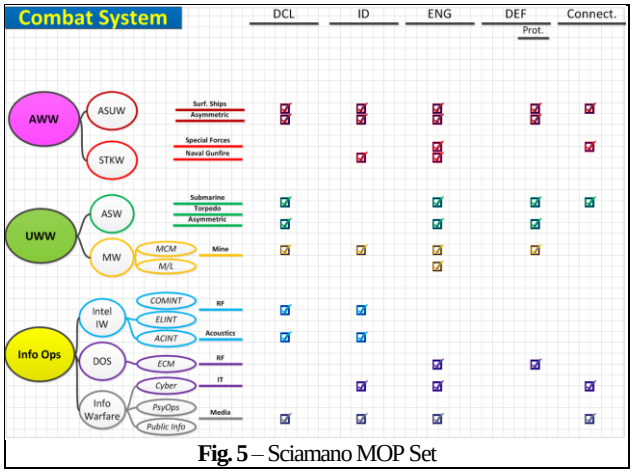

Fig. 5 – Sciamano MOP Set

Then, this can be compared to what is achievable with a traditional platform in the same scenario.

This process falls within the Approach #1 (estimate effectiveness of vehicles currently/soon available) and should tell if the concept is mature in the near term, and the gap with traditional solutions.

The initial set of embarked vehicles that has been considered has been tailored as follows:

- 6 Unmanned Aerial Vehicles (UAV)
- 8 Autonomous Underwater Vehicles (AUV)
- 4 Unmanned Surface Vehicles (USV)

5. Status

At the moment two of the nine-mission set are being examined. The current focus is on detection capabilities of a Sciamano warship, carrying the aforementioned "standard" load of vehicles, considering a full operational availability, and a maximum effort consisting of the employment of 67% to 75% of the vehicles around the clock or for a defined period.

The two missions currently being examined are:

A. Escort a Main Body, within a 24 hour timeframe, in a roughly open sea space.
B. Sanitize an Amphibious Operation Area, sizing about 1,500 NM^2, within a 6 hour timeframe, in a coastal area.

The weather conditions are assumed to be good enough for the employment of all kinds of autonomous vehicles, and the underwater acoustic environment is set as follows:

- Bottom depth with and without possibility to exploit Convergence Zone (CZ) in the "Escort" case, and no CZ in the "Sanitation" case.
- Bottom type and depth giving a good possibility to exploit Bottom Bounce propagation in the "Sanitation" case.

The considered threat is a conventional submarine, capable to bottom in the coastal area.

About the carried autonomous vehicles:

- Their characteristics are a kind of envelope of what is currently available on the market.
- The payloads set is extrapolated, based on weight market information and rumors,
- Sensors performance estimates are based on (limited) experience, and prediction tools used for naval systems.

The currently computed Measures of Effectiveness (MOE) are related to the set of vehicles/sensors:

- Unmanned Surface Vehicles (USV) streaming a Mid/Low Frequency Active/Passive Variable Depth Sonar (VDS)/Tower Array (TA) not CZ-capable.
- USV fitted with Medium Frequency dipping sonar (MFDS).
- Unmanned Air Vehicles (UAV) capable to operate with up to 6 Active and Passive sonobuoys (SB), typically 1 or 2 Active, and 4 or 5 Passive.
- Autonomous Underwater Vehicles (AUV) fitted with High Frequency sonar (HFS), like a Multi-Beam Echo Sounder, capable to detect and classify bottomed submarines (in shallow/coastal waters).

In the Escort case, the UAV is not considered as a first detection asset, and the AUV is not considered at all, due to its inherent low speed and very limited sonar detection range.

The initial results achieved by comparing the Sciamano asset with a "typical" Frigate fitted with a sonar suite consisting of a (MF) HMS, a (LF) VDS that is CZ-capable, and one helicopter equipped with a MFDS and eight SB, indicate that:

A. In scenarios characterized by difficult acoustic propagation (limited sensor ranges) Sciamano is delivering a better effectiveness.
B. The Frigate provides better results in case the CZ propagation can be exploited.

However, consider that even if some detection MOE are unlike to change significantly across some other scenarios/missions, just two missions out of nine have been considered, so far, and the Engagement MOE are still work in progress.

Furthermore, also Survivability (to the torpedo threat) will need to be considered: it goes without saying that separating the sensors from the platform allows staying

away from the threat area. However, detailed MOE need to be computed and evaluated.

6. Future Work

The aforementioned process (Approach #1: maturity/effectiveness) can be reverse-engineered to estimate the increases of vehicles/payload performances that will be required, in the future, to reach the desired effectiveness level.

This is what has been called Approach #2 (characteristics required to make the concept worth to be pursued, in the future); it may be helpful, especially in case Approach #1 falls (not too much) short of the traditional solutions, or to tailor differently the type number of vehicles that need to be carried.

With at least one of the two Approaches resulting viable, the "operational part" of Sciamano becomes pursuable, and the next step is to detail the Drone Carrier.

Within the initial thinking framework, operationally speaking, the ship should:

- Be stealth enough not to become an easy target while operating the unmanned vehicles.
- Have a robust self-defense system, against all threats (i.e. aircraft, anti-ship missiles, torpedoes, asymmetric)
- Have speed and seakeeping characteristic compatible with the operations carried out by a standard Battle Group she would be eventually part of or providing support to.
- Be appropriately shaped and fitted with the spaces and equipment capable of handling all the foreseen sets of unmanned vehicles, including embarkation and debarkation, preparation for the mission, launch/streaming and recovery, operation, and maintenance.
- Have a stabilization and seakeeping attitude good enough to operate the vehicles also in heavy sea state conditions.

Particularly related to the latter point, the choice of platform configuration is likely to become fundamental. For instance, a "standard" ship (like a Frigate) might incur into difficulties related to the streaming and recovery of surface and subsurface vehicles at low speeds from the sides, and in the fantail area, in case of rough sea.

Currently, the following alternatives are examined (all including a helicopter deck for operating rotary wing AUVs, and eventually helicopters):

- Traditional Amphibious Landing Ship with Dry-dock (LPD), and side davits.
- Catamaran hull.
- SWATH (Small-Waterplane Area, Twin-Hull) hull.
- Hybrid hull configuration (catamaran with traditional bow).

The leading factor is the possibility to have an area at disposal that, in case of rough sea, is sheltered enough from the waves to allow the safe deployment and recovery of surface and subsurface unmanned vehicles.

Fig. 6 – Platform Configurations

However, also other issues can become operationally significant. For instance:

- Ship behavior in a combination of sustained speed and rough sea.
- Crew fatigue and discomfort due to "unconventional" ship roll, in case of Catamaran and SWATH configuration.
- Sensitivity of deck stability/uprightness to unbalanced platform situations (again a possible concern in the Catamaran and SWATH configurations).

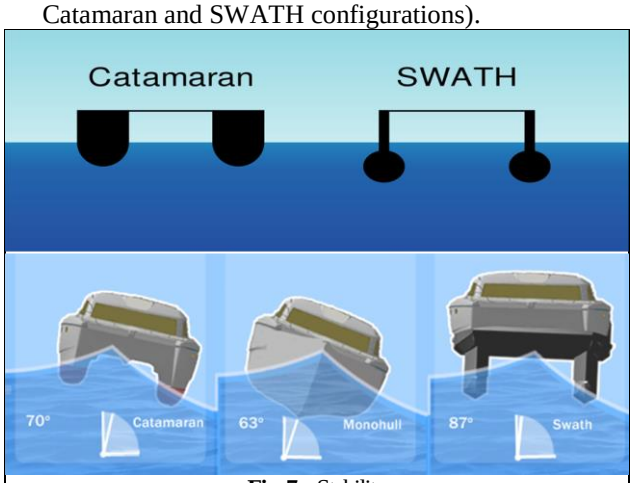

Fig. 7 – Stability

Furthermore there will likely be the need of re-thinking the traditional external connectivity configuration, in relation to the number of unmanned vehicles that could be operated at the same time. Unless it is accepted that all data collected by the swarms of unmanned vehicles is retrieved when they are recovered (this MIGHT be the case of the underwater ones, but is hardly acceptable for the UAV and the USV), there will be a need of having a powerful communication network that allows:

- Controlling the vehicles (air and surface), including feed-back, and engagement.
- Seamlessly receive their navigational data (geographic position, altitude/depth, course and speed, for all kind of vehicles).
- Receive in real time the stream of information collected by the vehicles' sensors, in case of air and surface ones, or download it from the subsurface ones when they come to the surface to communicate and dump the collected data.

- Perform an emergency shot-down, for a vehicle that becomes unresponsive and dangerous.
- Relay information/orders between unmanned vehicles and/or other naval, ground and air assets operating at long ranges.

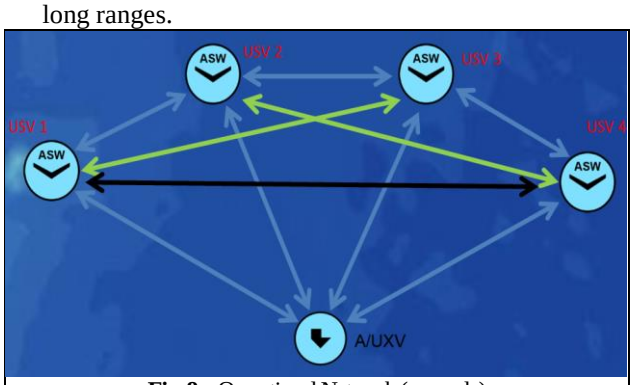

Fig. 8 – Operational Network (example)

7. Conclusions

At this point of the process it is not possible to be 100% sure that the Sciamano Concept will result in the development of an innovative system and way of carrying out some naval operations.

However it is deemed that just the study itself is an excellent opportunity to foster the know-how on the management of unmanned vehicles by surface ships, that will probably result in the development of technical concepts and solutions which can positively impact traditional shipbuilding.

Furthermore it is expected that, as it happens with most innovative ideas, Sciamano may attract Research and Technology investments that will eventually produce effects in fields that are not necessarily limited the military ones.

8. Authors/Speakers Biography

Italian Navy R.Adm.(ret.) Fernando Cerutti.
Consultant at Fincantieri; former ASW specialist. Served as staff officer and Scientific Committee representative at NATO, US Navy, Italian Fleet/General Staff, and STRIKFORNATO (Director of Operations).
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