New operational steps towards an alliance of European research fleets

Executive Summary:
Marine research infrastructures are key elements of the European Strategy for Marine Research and their quality contributes to Europe research performance. As a research arena, oceans and seas are costly to access, highly variable and very unpredictable. This, together with increasing societal demands and present financial constraints, explains that European research fleets should move towards a coherent pan-European approach with enhanced partnership in investment, development and usage of Research Vessels (RVs) and associated equipment, in order to better meet the diverse needs of European Marine Research.

Launched in 2013, the EUROFLEETS2 project (full name: New operational steps towards an alliance of European research fleets) aimed at further consolidating the alliance of marine research centres, universities and industrialists initiated in EUROFLEETS(1), with enlargement to the Polar research fleet community. Through a wide range of actions, EUROFLEETS2 supported research services for progress of scientific knowledge on marine environment and the sustainable management of regional seas and oceans. In particular, it organized a common access to modern and well equipped research vessels to European and international scientists on sole condition of scientific excellence, thereby contributing to the EU ambitious goals for maintaining the ocean biodiversity or understanding climate change.

Funded by the EU 7th Framework Programme for Research and Technological Development, EUROFLEETS2 (GA n°312762) gathered 31 beneficiaries from 20 countries: 16 EU member states including five "recent" ones, three countries associated to the EU and one "Overseas Country and Territory" (OCT). The EC contributed to the Project by 8.4 M€ on a final budget close to 10 M€.

For its 52-month duration, the EUROFLEETS2 project succeeded at:
- Participating to the European efforts to stay at first rank in the international scientific competition;
- Further consolidating the links between European RV operators and owners, in coordination with existing groups such as OFEG and ERVO, and paving the way towards an increased and cost-effective Regional RV integration through keystone initiatives;
- Developing a comprehensive and up-to-date overview of the European research fleets, with a detailed “forecast” of their future capabilities and capacities in Europe within Global, Ocean and Regional RV classes. As part of the objectives towards the development of a shared strategic vision, EUROFLEETS2 evaluated different models for optimization of the polar research fleets: they will be further developed during the H2020 ARICE project to implement an international network of research icebreakers for joint operations in the ice-covered Arctic Ocean;
- Implementing innovative calls for ship-time and providing 498 European researchers and their partners (33 countries in all, 33% as remote users) with access to 24 cruises on board 17 RVs wearing 13 flags, available in European seas as in Arctic and Antarctic polar and sub-polar areas. The flagship “Super-integration” cruises have shown how multi-platform experiment generate and develop synergies with other initiatives or projects at European and national levels;
- Contributing to the training of the next generation of European marine researchers, through 51 students (from 14 countries) trained during three ship-based courses and one pilot floating university on board four research vessels owned by Project’s beneficiaries, and broaden the access to EUROFLEETS2 funded cruises through i) the recruitment of numerous students or young researchers (representing 45%, e.g. 148 persons, of the embarked personnel on funded cruises), ii) the training of junior co-chief scientists together with well-experienced researchers, and iii) the cooperation with the EGU “Teachers at Sea” programme;
- Developing two generic designs for Regional RVs and producing guidelines and recommendations on key design aspects, which will be used as an advanced backbone to build the necessary next generation of efficient, multipurpose and interoperable European Regional RVs;
- Improving interoperability between European fleets through collaborative work on common software tools;
- Fostering joint R&D between European marine research institutions in a range of innovative methods and technologies applicable to underwater systems, aiming to improve performances and productivity of operations at sea and offer perspectives of future services;
- Further developing the e-platform EVIOR providing up-to-date information about RVs and their operations, cruise schedules, completed cruises and embarked equipment;
- Establishing communication and strengthening the link with industry on innovative activities related to RV designs and technologies for software development.

The overall situation of the European research fleets appears still vulnerable and EUROFLEETS2 conclusions are still in line with EUROFLEETS(1) ones. Despite recent introduction of new RVs, European research fleets are still ageing and existing renewal plans are not sufficient to expand or even keep up the capabilities for marine research in Europe. European research fleets perspective for 2027 shows a worrying increase in the over 30 year vessel category: significantly large renewal programmes should consequently occur within the 10 coming years. This confirms that Europe as a whole still needs an effort to renew its national RVs, in particular within their Regional class, and develop an inter-operable set of modern and innovative scientific embarked equipment.

The impacts of EUROFLEETS2 results are diverse and cover various fields involving research fleets owners and operators, as the scientific user community. Taking into account both EUROFLEETS projects, the main significant examples are:

- EUROFLEETS projects have strengthened the scientific excellence of marine research in Europe and multi-national scientific parties of funded cruises (two to eight nationalities per cruise) have contributed to foster scientific exchange at European and international levels. Since more than half of the cruises were carried out during the last eighteen months of the Project, a limited number of peer-reviewed papers has been published (but one article in “Nature/Scientific reports”). However, many peer-reviewed papers are expected in the five coming years, like in EUROFLEETS(1) which totalized 24 peer-reviewed publications/articles, with the majority of them published in 2015 and 2016, using data collected during funded cruises carried out between 2011 and 2013;
- the ship-time proposal evaluation system developed for both EUROFLEETS projects has proven to be efficient and transparent, and its criteria should be used for future evaluation of European ship-time calls: it will be the EUROFLEETS projects’ legacy to the next coming ARICE project for the evaluation of the proposals submitted in its TransNational Access activity;
- the leverage effect of the European funding has been again demonstrated through additional days at sea during EUROFLEETS2 cruises funded by the ship or equipment operators, through training courses run on board research vessels funded or co-funded by Project’s beneficiaries, or through numerous tests run for developed software or underwater payloads with only marginal costs charged to the Project;
- successfull on-board courses and pilot floating University demonstrate how offshore training programmes should be integrated into existing national and international postgraduate schools and programmes and that EUROFLEETS2 is now a reference programme at European level for at-sea training.
The numerous results and perspectives resulting from EUROFLEETS projects confirm that the European research fleets infrastructure is moving towards a more coordinated and efficient scientific tool. European funding is essential to further complete this structural evolution, this explains that a follow-up of the EUROFLEETS projects is envisaged thanks to the "EUROFLEETS+" proposal to be submitted in the frame of the INFRAIA-01-2018 – Integrating Activities for Advanced Communities work programme of the European Union.

Project Context and Objectives:
Marine environment represents a huge potential of economic growth with a vast universe of unexplored natural resources. This universe opens a myriad of opportunities that can contribute to the European economic competitiveness. Furthermore marine environment knowledge is crucial for a sustainable exploitation of its natural resources. As a research arena, the ocean is costly to access, highly variable and very unpredictable. This, together with increasing societal demands and present financial constraints, explains that European marine research should open a new integration phase with a long-term approach.

The FP7-funded EUROFLEETS2 project is the enhancement of the EUROFLEETS(1) European project and consolidated the alliance of marine research centres, universities and industrialists from the European Union (EU) and its associated countries initiated in EUROFLEETS(1) and enlarged to the Polar research fleet community under EUROFLEETS2. Such wide partnership and resource sharing contributed to improve the quality of marine research and to further develop Marine Board past initiatives and know-how accumulated through EUROFLEETS(1) and other European projects like BONUS 185, ERICON-AB or SeaDataNet.

Research Vessels (RVs) and their embarked equipment are crucial infrastructures required for marine sciences. They provide sea access to the whole community of researchers, enable all kinds of observations, in-situ measurements, sampling and mapping, and are necessary to maintain deep sea observatories. Over the years, the missions assigned to RVs became more complex and technically sophisticated. This encouraged national marine institutions to increase their coordination and collaboration sharing facilities in order to optimize the cost in operating their marine infrastructures and to meet the scientific ever increasing demands.

Following the perspectives opened by EUROFLEETS(1) for an enhanced coordination of these marine infrastructures at European level, EUROFLEETS2 aimed to contribute to the development of a new pan-European distributed infrastructure with common strategic vision and coordinated access to RVs and their embarked equipment, in order to facilitate the access to these rare floating laboratories and maximize their contribution to the scientific knowledge.

By bringing together research fleet owners and operators, EUROFLEETS2 contributed to enhance operational coordination between RVs and associated equipment. Through operational initiatives such as virtual fleets or the development of common tools or methodologies, it promoted more inter-operable and cost-effective European research fleets for sustainable management of regional seas and oceans. EUROFLEETS2 also developed the impact of research infrastructures on innovation by establishing links with industry and fostering the involvement of the industrial sector on specific activities.

EUROFLEETS2 involved multi-disciplinary expertise shared by thirty-one marine institutes, universities, foundations and SMEs from sixteen member states of the European Union, three associated countries (Norway, Turkey and Faroe Islands) and one Overseas Country and Territory (Greenland), namely AWI (Germany), CNR (Italy), CSIC (Spain), DFKI (Germany), DTU Aqua (Denmark), ESF (France), EuroOcean (Portugal), FAMRI (Faroe Islands), GeoEcoMar (Romania), GINR (Greenland), HCMR (Greece), IEO (Spain), Ifremer (France), IMR (Norway), IO-BAS (Bulgaria), IOF (Croatia), IOPAN (Poland), IPEV (France), Maris (Netherlands), Marum (Germany), MI (Ireland), OGS (Italy), PROLLION (France), RBINS (Belgium), SHIP STUDIO (France), SPRS (Sweden), TUBITAK (Turkey), TUT (Estonia), UdG (Spain), UNIZG-FER (Croatia) and VLIZ (Belgium).

The objectives of the Project were ambitious and covered three activities: Trans National Access (TNA), Networking Activity (NA) and Joint Research Activity (JRA).

TNA as core activity of the Project aimed to open free of charge access to twenty-two European RVs and five pieces of equipment on the basis of scientific excellence. Five pan-European calls were organized to this purpose: three "Regional" calls targeting specific geographic areas, one innovative "Super-Integration" (multi-platforms) call aiming to identify one flagship proposal requesting one or several RVs in combination with other infrastructures, and one original "Embarked Equipment" call aiming to deploy underwater equipment during nationally-funded cruises, so fostering inter-operability within European research fleets.

The scientific excellence of submitted proposals was evaluated according to the European and independent evaluation process
successfully developed within EUROFLEETS(1).

NA objectives were wide and diverse: i) the strategic vision to propose future integration steps to volunteering European research fleets, ii) the flagship initiative for polar access aiming to propose coordination schemes for the European Polar RVs, iii) the initiatives (like virtual fleets) towards coordinated and cost-efficient operational activities, iv) the innovation promotion and fostering of industrial partnership, and v) the training of scientists through on-board training courses. NA also included the preparation and evaluation of TNA calls.

JRA included three R&D projects, concerning the developments of i) generic designs for future Regional RVs, ii) embarked software to harmonize and standardize workflows from on-board data acquisition to onshore data storage by marine data centres, and iii) innovative technologies for underwater equipment (3D terrain modelling, terrain following, dynamic positioning algorithms, and qualification of innovative battery products).

In the continuity of EUROFLEETS(1), EUROFLEETS2 was coordinated by Ifremer (France). The Ifremer Coordinating team was helped by three activity coordinators from IMR (Norway) for NA, MI (Ireland) for TNA, and RBINS (Belgium) for JRA. AWI (Germany) was in charge of the preparation, organization and evaluation of the five TNA calls. EurOcean (Portugal) was in charge of the Project communication.

The Project overall budget was nearly 10 million euros, on which the European Union granted a maximum contribution of 9 million euros for 52 months.

Project Results:
EUROFLEETS2 main results and foreground:

In the continuity of EUROFLEETS(1), TransNational Access has been the core activity of the EUROFLEETS2 project with the central aim to provide access to European Research Vessels –RVs- for all European scientists and their partners on basis of scientific excellence.

Building on the successful achievements of EUROFLEETS(1), EUROFLEETS2 implemented five innovative calls for ship-time and equipment-time proposals to access 8 Ocean/Global and 14 Regional European RVs from 15 different flags and five pieces of embarked equipment:
- Three "Regional" calls targeting geographical regions, to foster access to research vessels available within specific maritime regions, together covering a wide geographical area including polar and sub-polar areas;
- One "Super-Integration" (multi-platform experiment) call to demonstrate how access to and synergistic use of a combination of European research vessels and a range of scientific equipment leads to excellent science;
- One "Embarked Equipment" call to facilitate the access to underwater systems and promote larger interoperability between European research fleets.

Ship-time and equipment-time funding was the result of a competitive evaluation coordinated by AWI (Alfred Wegener Institute, Germany). The evaluation of proposals was carried out by independent experts following pre-established evaluation criteria: scientific excellence (more than 50% weight), European cooperation, involvement of non-equipped teams and training of young scientists, which were proven to be appropriate as already used in EUROFLEETS(1).

The proposals evaluation was performed by external experts. Three evaluations were required and afterwards discussed by the Project's Scientific Review Panel (SRP), an external body composed of 12 scientists that ranked the proposals and recommended the excellent ones for funding. The Logistics Review Panel studied the feasibility of those excellent proposals and allocated the right ship/equipment combination. The Principal Investigators (PIs) were informed about the decision and based on their agreement the respective fleet manager implemented the proposal under the conditions set by the SRP.

The evaluation of proposals has been proven to be transparent and fair. Being based on existing procedures of European evaluation systems, it ensures the scientific excellence of the granted proposals. The EUROFLEETS2 ship-time proposals evaluation system has been accepted by the RV operators of 22 European RVs, as members of the EUROFLEETS2 project. This is especially relevant as EUROFLEETS projects are the first projects in which a European evaluation system grants ship-time on national RVs.

The integrated evaluation system developed under the umbrella of both EUROFLEETS projects has been proved efficient and its criteria should be used as a baseline for developing a shared evaluation for future European calls.

Based on the acquired experience, several rules have been considered as imperative when establishing a future European System for
Evaluation to give access to European Research Vessels:

1) Affiliation: As applied in EUROFLEETS2, eligibility criteria must ensure that the affiliation rules promote that EU and associated "EU Framework Programme for Research and Innovation" countries are benefiting from this action, that the access to RV and marine equipment is transnational and that the action works towards improving RV and equipment interoperability.

2) International cooperation: International cooperation must be a requisite for proposals submitted to a European System. After the experience in EUROFLEETS2, where only two different nationalities were requested to compose the scientific team, it is considered that this rule must be strengthened and a requirement of a minimum of three nationalities must be guaranteed to emphasize the spirit of international cooperation and open opportunities to newcomers.

3) Training and education: Proposals must include an advanced training or educational programme. Training of new generations of scientists and technicians must be an essential component of any research proposal.

4) Excellent science: Only scientifically excellent proposals must be considered for funding. In this respect, the two-step evaluation system used by EUROFLEETS2, in which only scientifically excellent-ranked proposals are considered for the logistical evaluation, ensures that only excellent proposals are considered for funding.

5) Early career or newcomers: Promote access to research infrastructure to early career scientists or to PIs from countries with no or limited access to this infrastructure. This criterion is considered within the proposal evaluation. EUROFLEETS2 has proven to be an excellent platform for giving access to marine infrastructure to non-traditional users such as early career scientists and users from non-equipped countries.

6) Dissemination: Only user groups that are entitled to and willing to disseminate the knowledge they will generate under the Project are eligible to benefit from access free of charge to the infrastructures offered.

Altogether, 50 proposals were submitted to the five implemented calls, involving 354 scientists from 40 countries, which confirm the high demand for research vessels in Europe. 24 of the submitted proposals were funded and successfully implemented with PIs representing 10 different EU countries. The 24 cruises sum a total of 211 ship and 24 equipment fully funded days. The scientific disciplines carried out on the cruises covered all fields of marine research, with a main focus in physical oceanography. International cooperation has been fully evident with partnerships of 2 to 8 countries per successful proposal. In total, 498 participants from 33 countries were involved in EUROFLEETS2 funded cruises, with 33% as remote users. Embarked scientific parties include 45% of postdoctoral, PhD and undergraduate students recruited by PIs, and 55% of senior researchers and technicians.

The funding rate (48%) was higher than in the EUROFLEETS(1) project, this is mainly due to the launching of ship-time calls in targeted geographical areas, what allowed a better matching between the working areas requested in the proposals and the availability of the RVs in the regions. Six cruises were carried out in polar and sub-polar areas: four cruises in Arctic and sub-Arctic ("PREPARED" and "POLAR PLASTICS" on board RV G.O. Sars and "BURSTER" on board RV Polarstern in South of Spitsbergen and North-Western Barents Sea, "ORCA" on board RV Sanna in Central West Greenland) and two cruises in Antarctic ("PHARMADEEP" on board RV Hesperides and "ANTSSS" on board RV OGS-Explora). However, like in EUROFLEETS(1), the Mediterranean Sea received the greatest demand from the academic community and in total 10 cruises were carried out in this region. Very high standard proposals were submitted to the Super-Integration call, and the flagship multi-platform experiment selected for funding ("MEDSUVISES" on board RVs Sarmiento de Gamboa and Aegaeo) was also carried out in the Mediterranean Sea. This proposal met all the super-integration requirements and fully delivered the commitments in terms of use of a variety of infrastructure (marine and shore based) utilising a variety of national and international funding sources for the overall project, public outreach and training and accommodation of young scientists. Three of the proposals carried out in the Mediterranean Sea ("TAIPRO-2016" on board RV Angeles Alvarino in the Western Mediterranean, "ESAW" on board RV BIOS DVA in the Adriatic Sea and "CRELEV-2016" on board RV Aegaeo in the Eastern Mediterranean) were also submitted as complementary components of the MedSHIP programme for sustained hydrographic observations in the Mediterranean Sea.

At the end of the EUROFLEETS2 project in June 2017, the number of scientific publications is still limited since more than half of the cruises were carried out during the last eighteen months of the Project (12 cruises in 2016 and two cruises in 2017). Three peer-reviewed articles have been published: 1) one article in "Nature/Scientific reports" by the PI of the POLAR PLASTICS cruise, 2) one article in the "Annals of Geophysics" by the scientific party of the Super-Integration MEDSUVISES cruise and 3) one article in the "Analytical methods" journal by the scientific party of the PROSID2014 cruise carried out on board RV Salme in the Baltic Sea. Many PIs of EUROFLEETS2 cruises have informed that papers are under preparation and should be published in the coming months. Due to the time needed from cruise completion to data analysis, especially when huge amounts of data have been collected, publications will "normally" occur between five to eight years after the data collection. This is confirmed by the analysis of the number of scientific publications following the 17 EUROFLEETS(1) funded cruises carried between 2011 and 2013, which generated 24 peer-reviewed
Joint Research implemented within the Project focused on generic designs of multi-purpose Regional RVs, innovative technologies for underwater systems and software tools aiming to facilitate future transnational access through common tools and procedures.

A modern fleet in terms of concept and design, for multipurpose use and interoperability of sea operations, is required to comply with the need for high performance vessels (maximum operative range, endurance, detection capacity, etc.) and the strong commitments in terms of preservation of the marine environment and protection of the variety of ecosystems. Within this context, a EUROFLEETS2 Joint Research activity was devoted to “Regional RVs guidelines and generic designs” focusing on the definition of guidelines for the design of Regional Research Vessels (RRV), on the definition and development of innovative basic designs of RRV, and on innovative technologies for optimizing existing vessels.

Guidelines and recommendations were developed for the three following design key points of a RV: noise and vibration, bubble sweep-down avoidance and work deck installations.

- Noise and vibration reduction: the sources of underwater radiated noise (URN) and its impact on both the ecosystem (living species, etc.) and on the hydro-acoustic equipment were analysed. An overview of the URN requirements was given, along with the noise reduction technologies and systems. A series of indications was provided, addressing: the definition of the upper limit for acoustic profile for a multipurpose RRV, the design and the realization of the ship in order to meet the URN requirements (vibration, internal and external airborne noise, self-noise, echo-sounder detection capabilities), and some practical considerations on possible operating conditions allowing minimization of the URN.

- Bubble sweep-down mitigation: indications on hull shape design have been provided on the basis of a simulation-based design and optimization strategy investigating the local flow at the bow and heave and pitch motions, representing the key mechanisms originating bubbles and its convection through. The study was performed on two hull shapes, representative of two design concepts (with and without bulb), as the bubble sweep-down phenomenon is strongly dependent both on the vessel characteristics and the environmental and operating conditions. Moreover, indications on technical devices that can be used to improve bubble sweep-down performances were addressed.

- Work deck installations: a list and description of instruments and vehicles, which can be deployed from a RRV, was provided. As a contribution of the EUROFLEETS2 project towards standardization of sampling procedures and interoperability of equipment and gears within European research fleets, a guidance on the choice of gears and the sequence of actions required for their safe deployment and recovery on board has been also presented. Hence, general work deck arrangement and facilities are presented, aiming at ensuring flexibility over the work deck despite its limitation in space and to optimise safe multipurpose activity on board.

Taking advantage of the developed guidelines and recommendations, generic basic vessel designs including diverse technological solutions and options were developed, focusing on two vessels sizes: the RRV50 Research Vessel with a 50m length and the BRV35 Research Vessel with a 35m length. Both designs are characterized by flexibility (allowing for various missions), high accommodation/equipment standards for research and life at sea, high level of integration of latest technologies, high sea keeping and manoeuvrability performances and environmental friendliness:

- The RRV50 vessel is designed for an autonomy at sea of 20 days and its mission scenario was defined including offshore and coastal hydrography and oceanographic missions, fishery surveys, geological surveys (including seismics), operating submarine systems, service of buoys and other systems in off-shore areas.
- The BRV35 vessel is designed for an autonomy at sea of 12 days and its intended operation area is the Baltic Sea, including shallow coastal areas. The mission scenario includes offshore and coastal hydrography and oceanographic missions (including environmental monitoring), biological surveys (including bird watching), geological surveys (including seismics), operating submarine systems, service of buoys and other systems in off-shore areas.

The overall design project is enriched with a list of optional technologies to be added to the original design and with some considerations on the hull shape of the RRV50 project, enabling improvements in terms of bubble sweep down, sea keeping and resistance performances.
An additional task identified guidelines for optimizing existing vessels. Several possible interventions were examined including: the reduction of fuel consumption (e.g. power management/storage systems, propellers, hull design and coating), the optimization of the crew and the staff onboard (e.g. automation of machinery, navigation and bridge equipment, scientific equipment acquisition), the optimisation of the scientific equipment performances (reducing underwater radiated noises, reducing bubble sweep down, integration of new equipment), the upgrade of the vessel's infrastructures for scientific equipment.

In its second Work Package (WP), the EUROFLEETS2 Joint Research Activity focused on innovative technologies applicable to Underwater Systems. The productivity of operations at sea, and the perspective of novel innovative services and performances are key criteria that rely on the autonomy of underwater vehicles and sensing technology. New techniques allow production of high performance data sets and new, derived information on a site of interest. Active sensing implies observation driven vehicle control, especially in the field of optical 3D modelling where huge data sets according to specific vehicle trajectories are processed. The increasing integration of sensor technology, data processing and vehicle control requires a strong commitment to technological R&D within ocean research institutions. In this area, EUROFLEETS2 beneficiaries focused on several axes, with i) the development of 3D reconstruction methods adapted to different vehicle hardware configurations (stereo camera rigs, single camera rigs etc.) in off line processing tools, ii) the development of on-board mapping integration for reactive and task-driven mission execution and iii) the evaluation and qualification for new battery technology, common approaches for procedures and safety management. The work achieved in EUROFLEETS2 in this area contributed to 11 articles published in peer-reviewed journals:

- In the 3D terrain modelling for underwater vehicles, two complementary approaches were considered for the design and development of mapping algorithms of 3D natural scenes: 1) the acoustic micro-bathymetry technique, fusing data coming from multi-beam sonar systems and navigation sensors on-board the embedded vehicle controller, allowing to build 3D micro-bathymetry maps available for on-line path planning and terrain referenced navigation, and 2) the optical dense reconstruction based on large image sets from single cameras generating varying view angles from a moving vehicle to produce an accurate 3D cloud point model of the natural scene.

1) Textured Micro-bathymetry algorithms were designed and developed to provide in real-time a 3D micro-bathymetry map textured from geo-referenced optic images in areas of significant relief. Real-time on-board processing software modules for the creation of on-the-fly bathymetric models, equally relevant for environment reconnaissance and advanced autonomous piloting (terrain following, obstacle avoidance), have been implemented to fit in a large vehicle controller framework. Based on the ROS (Robot Operating System) middleware used on numerous autonomous underwater vehicles, these modules can be integrated in various systems.

2) To complement the development of the 3D high resolution camera developed in EUROFLEETS(1), EUROFLEETS2 focused on an alternative technique based on single cameras exploiting varying view points from a moving vehicle. Algorithms and techniques for optical dense reconstruction have been brought to an operational status through integration in the software tool of one Project's beneficiary. These techniques use sequences from standard single video or cameras and can provide geo-referencing when navigation data synchronized with the image sequence is available.

- For the development of terrain following and dynamic positioning algorithms, EUROFLEETS2 focused first on the identification of the parameters of the marine vehicle mathematical model, which were identified by self-oscillation manoeuvres. The method is simple, reliable and proven by experiments at sea, can be executed on site in a test tank, and gives parameters of the linear mathematical model as well as parameters for the nonlinear mathematical model of the vehicle/vessel. There is no need for cumbersome and sometimes lengthy test voyages in order to obtain parameters of the mathematical model of the vehicle/vessel. Self-oscillation identification was extensively tested in laboratory (hydrodynamics tank) and then at sea for various vehicles (AUVs and USVs). If end-users are changing sensor suite on their marine vehicles, dynamics of the marine vehicle will inevitably change, and the guidance and control algorithm will no longer be appropriate if autopilots with fixed parameters are used. In this situation auto-tuning of the autopilot parameters can be explored with self-tuning identification being the main component of this control structure. The end-user then ends up with appropriately tuned system and with needed system performances which is very important in critical situations such as obstacle avoidance, terrain following (under-ice sailing) etc.

The terrain following and dynamic positioning algorithms were then developed and uploaded to various vehicles (AUVs and USVs). Numerous experiments (Croatia, Spain, Israel, Germany, Italy, Portugal and France) were performed during the project duration and many improvements were included in the algorithm. The end-product is reliable, robust and complies with the desired performance specifications that were defined at the beginning of the Project. It can be easily used on various unmanned vehicles that are using ROS middleware.
In the field of Lithium-Ion and Lithium Polymer batteries for underwater vehicles, EUROFLEETS2 has also produced broad knowledge on the feasibility of pressure balanced integration for underwater battery systems, as the electro-chemical technologies of batteries show fast progress in the fields of automobiles, consumer electronics etc. The supervising electronics "Battery Management Systems (BMS)" have been demonstrated to be functional in an oil-filled pressure balanced housing. Innovative battery products from specialized SME have been successfully qualified for use on underwater vehicles.

The third WP of the Joint Research Activity, focused on the development of four different software: i) EARS V2 (the development of the EUROFLEETS Automatic Reporting System) for recording events occurring during a cruise, adding an ontology to decentralize vocabulary of events and standardize storage and management, ii) the Data Acquisition System, to standardize the data obtained by the acquisition process, iii) an En-route Ship Summary Report (SSR) for the en-route data transmission from vessel to shore, and iv) WebServices to link EARS with the Data Acquisition System and En-route SSR. Efforts were also put in to the possibility to have a remote access to the acquired data, in real time or almost in real time.

Furthermore, following the EUROFLEETS(1) project, the standardization was considered as a key cross-cutting issue. To promote data transmission to marine data centres, the Project made special efforts to continue producing guidelines to developers and to highlight that standards do not only deal with common data formats and structures but also with nomenclatures, data dictionaries and communication protocols as part of the strategy of interoperability and data sharing, as well as to develop a new ontology. The standardization effort created synergies and allowed to establish links with other European initiatives such as SeaDataNet (for common vocabularies, Cruise Summary Report –CSR- and Common Data Index –CDI- formats), and also with international programmes such as the Ocean Data Interoperability Platform (ODIP 2) and the Rolling Deck to Repository (R2R) program (for common vocabularies and metadata).

- The EARS V2 software is an on-board tool which aims to record any possible event, information of navigation, cruise info and underway data. It is the present version of the software and a product of EUROFLEETS2. This prototype made use of the EARS V1 user interface and was adapted to make use of the new Entity classes of EARS V2 (Process, Action, Tool Category, Event Definition); it operated on a SPARQL query result, illustrating the use of the underlying ontology as a resource. This prototype uses a web service infrastructure developed by CSIC, disassociating the implementation of the GUI (Graphical User Interface) and the database. Events could be used in data quality control processes, or in a more general approach, they provide contextual information useful to scientists during data processing. Three subsets have been identified: i) the Automatic event entry (automatic acquisition of data from selected sensors), ii) the Manual event entry (for additional information, comments or actions set by an operator) and iii) the Reporting component.

The EARS ontology is a set of terms that can be combined to form meaningful oceanographically events that can be logged by a software application such as the EARS2 front-end application. The ontology is valid in different settings: base (official, ontology hosted at http://ontologies.ef-ears.eu/ears2/1) , vessel or program scope are possible. The integration into the EARS application has been achieved in all these settings.

EARS V2 is using the ontology based GUI and it uses the vocabulary infrastructure to incorporate new terms needed to define new events. The Web Service implementation (Event, Cruise, Navigation) facilitates the connections with the data repositories to extract or insert information and also the integration of all systems that can produce or consume Event, Cruise info and Navigation data.

- The first purpose of the Data Acquisition System is to organize the real-time flow of data coming from the sensors to every client that needs to process that flow. Modularity and consistency should be applied. Modularity will be designed for each package regarding acquisition tasks (typically for each sensor: GPS(s), motion sensors, ADCP, trawling operations sensors, winches, weather sensors ...). Consistency is integrated to merge sensors by categories in order to facilitate maintenance and evolution for the whole system. Based on CSIC and Ifremer experiences and knowledge, the Data flow diagram provides an integrated system keeping options for extensions and evolutions especially to extend front-end users applications such as GIS viewers (2D, 3D), WPS services, etc...

The main objective was to define the data formats and metadata bodies included in data sets and to develop an acquisition software prototype. The main Deliverable was a "Data Acquisition Software" prototype with the definition of data formats and metadata bodies included in acquired data sets. The Acquisition data model on-board is focused on the underway data and more precisely position and thermo-salinograph data. The prototype is also used as a test tool for produce the Ship Summary Report (SSR) data. A link between this prototype and the EARS system was established. The Data Acquisition Software prototype is also responsible to detect and
produces data quality events while the EARS system includes them in the event registry and produces at the end the corresponding reports.

The Data acquisition prototype will undergo new sea trials in September 2017, with the goal of using it operationally on a RV by the end of 2017.

- Two new reporting approaches had been introduced in EUROFLEETS(1) and have been followed in EUROFLEETS2: i) the Full Reporting that exports from the database all occurred events and ii) the 24-hour Ship Summary Report (SSR). The latter provides the snap-shot of the RV situation (ship ID, cruise ID, position, heading ...) extended with a set of latest 24-hour events from EARS, and also with the last 24-hour navigation track. It is implemented in a set of Web Services that independently modifies the different parts of the SSR. Hence, different updating rates can be adopted to refresh each element of the SSR, or to work with different sources of information facilitating its deployment in different RVs. The SSR represents the information about the real state of the ship (position and activity) whether it is on a cruise or not. An SSR data model is proposed for en-route information following two different schemes: i) A « core » expression to reflect the minimum necessary information, and ii) an « extended » expression to contain complementary information. This daily report is intended to be transmitted from vessel to shore to the ship operator's data center, or to information portals such as the European Virtual Infrastructure in Ocean Research (EVIOR) developed within EUROFLEETS and available at http://www.eurofleets.eu.

On top of the two reporting approaches introduced here above, EARS is able to create automatically the Cruise Summary Report (CSR) required by data centers at the end of the cruise. For this purpose, the SeaDataNet “MIKADO” software has been plugged to EARS.

- A specific interface between the on-board Data Logging System and the different software agents acting as data consumers and producers was developed. This intermediate layer, implemented as a Web service called the EUROFLEETS2 Web Service Layer (EWSL), is a way to standardize the process of storage, modification and retrieval of Events, Cruise, Program and Navigation from and to the on-board Data Logging System through the different data consumers and producers that can be implemented on-board.

The EWSL has been fully tested using a developed test client, and working properly for Events, Cruise, Program and Navigation. The EUROFLEETS2 client, a user friendly graphical interface, is working through web services, and also uses a Web Service to get the Vocabulary from the EUROFLEETS2 ontology.

- Developing methodologies for shore-to-ship e-access of data and metadata was another objective of the Joint Research Activity on software and tools. Indeed, data management in the marine sciences needs to consider the various representations that different communities build for overlapping areas of interest. Each of these communities constructs an identity on a specific and personal set of inherited backgrounds, practices, and tacit knowledge that can result in mis-linking observations and usage. This becomes particularly relevant when researchers from different fields collaborate. Metadata can help sorting out these problems if semantically enabling data access. OGC (Open Geospatial Consortium) standards such as Observation and Measurement (O&M) and SensorML have been used to develop a cross domain metadata model that could join high level and domain specific metadata. Results of the activity have been published in an international scientific journal and have been tested in the Project and integrated with other data management initiatives.

The EARS software was based on the vision to move metadata as close as possible to the acquisition, and it was thought that this approach could be extended to data access as well. Means were developed to access the vessel acquisition system and preview the data. Of course, this would lead to great advantages since researchers would be enabled to revise their planning upon the feedback from the survey. This not only can save time and money, but can also help scientists follow the most interesting features they now will be able to follow in quasi real time. Tools were developed that through links from EARS could access preview facilities resident on the vessel. It was realized that more than the size of the data, which is an issue that can be mitigated within a server side paradigm, the bandwidth and reliability of the network connection could be critical. At the same time, this is constantly improving while the costs are lowering.

During the whole project duration, it has been important to establish and undertake regular communication between EUROFLEETS2 and parties from industry and beyond, in particular those engaged in operating research and survey vessels and associated equipment, those using marine and ocean data for various use applications, and those engaged in design and outfitting of vessels and manufacturing scientific equipment. This dialogue has been undertaken in a dedicated Work Package (WP) “Innovation promotion-Fostering industrial partnership” and aimed at identifying innovation opportunities and receiving feedback and input from industry for refining and completing EUROFLEETS2 results, where possible, in its three Joint Research Activity WPs. Considering that the activity on
A list of 102 European RVs has been established in the survey, with the following distribution by class: 15 Global, 15 Ocean, 37 Turkey and United Kingdom. A total of 24 countries have been surveyed in this study, namely Belgium, Bulgaria, Croatia, Denmark, Estonia, Faroe Islands, Finland, France, Germany, Greece, Greenland, Iceland, Italy, Ireland, Lithuania, Norway, Netherlands, Poland, Portugal, Romania, Spain, Sweden, Turkey and United Kingdom.

Concerning the Regional RVs guidelines and generic designs, it was concluded that outcomes of this activity could be interesting for shipyards and ship design companies involved in oceanographic RVs. This is a relatively specialized and limited market. Therefore in cooperation with RV operators and managers within the EUROFLEETS2 consortium, an inventory of 31 ship designers and 35 shipyards in Europe that have experience with research vessels was compiled. A specific workshop was organized for presenting and discussing the draft RRV guidelines with a selection of industry representatives. This was implemented as a Workshop and Industry Exhibition as pre-meeting to the IRSO meeting (10-13 October 2016, Capri - Italy). IRSO concerns the International Research Ship Operators (IRSO) forum, a group of RV operators representing 49 organisations from 30 countries who manage over 100 of the world's leading RVs. During this IRSO workshop an overview was given of the results, followed by an active dialogue aimed at refining and strengthening results and conclusions as well as at establishing contacts for further exchanges. The workshop attracted 40 participants, consisting of 27 project leaders and RV operators (members of IRSO) and 13 industry representatives of shipyards, ship designers and others with expertise in RVs. It was followed by an Industry Exhibition whereby participants from research and industry highlighted their activities and products for RRVs by means of posters.

Concerning the “Software and Tools”, a very innovative activity that appeared is the standardisation of the data acquisition process by using OGC Sensor Web Enablement (SWE) technologies. There are various projects in Europe, USA and Australia interested in adopting SWE and active in developing SWE standards, because these might be applied by operators of operational marine observation systems. Therefore at an early stage “Software and Tools” activity was encouraged to cooperate with these other projects, in particular within the framework of the EU ODIP project. SWE developments should be interesting for companies manufacturing and delivering oceanographic instruments and therefore a list of relevant companies and their contacts was compiled. Later in the project a SWE workshop was organised by EUROFLEETS2 on 15th March 2016 at the Oceanology International 2016 event in London (UK). The workshop presented the EUROFLEETS2 SWE and EARS developments, also featured contributions of other EU projects such as SeaDataNet II, BRIDGES, FixO3, JericoNext, NeXOS, SenseOcean, Schema, ODIP II and USA projects (IOOS, X-DOMES) giving the present state of SWE developments and a panel discussion. This workshop brought together circa 60 persons: developers and managers of operational oceanography observing systems on board RVs and on networks of observation platforms; manufacturers of observation instruments and of observation platforms; marine and ocean data managers. It was concluded that the cooperation and tuning should be continued and increased as it appeared there was not yet convergence to one stable set of SWE standards.

As a necessary complement to TransNational Access and Joint Research, Networking Activities contributed to an impressive sharing of knowledge, best practices and expertise. A wide range of actions was implemented, representing a further step forward towards an enhanced coordination of European research fleets owners and cost-effective use of their facilities.

Recognized as the appropriate forum for information sharing on strategic views of European fleets operators, the EUROFLEETS Fleet Evolution Group (FEG) created in EUROFLEETS(1) was maintained and extended in EUROFLEETS2 in the frame of the "Strategic vision of European research fleets and international coordination” work package activity. The FEG gathered all ship operators involved in the Project and allowed to follow-up the status of European research and their foreseeable evolution, in collaboration with OFEG (Ocean Facilities Exchange Group) and ERVO (European Research Vessel Operators) groups which were invited as permanent invitees to the EUROFLEETS2 General Assemblies.

Following the inventory of European Research Vessels and renewal plans established in EUROFLEETS(1) EUROFLEETS2 launched in 2016 a new and more complete survey, aiming to update the list of European RVs established in 2013 and also to identify their geographical areas of operation, their types of activities (notably to distinguish between RVs involved in academic research, in monitoring missions or in logistics missions) and to give an overview of technical capacities available on board. While the EUROFLEETS(1) survey focused on Global, Ocean and Regional class RVs, the EUROFLEETS2 survey was extended to RVs of the Coastal classes, with the aim to determine which of the Coastal RVs, classified in an intermediate class “Coastal/Regional (CR) RVs”, have the ability to sail within their basin of operation to possibly be involved in cooperation programmes.

A total of 24 countries have been surveyed in this study, namely Belgium, Bulgaria, Croatia, Denmark, Estonia, Faroe Islands, Finland, France, Germany, Greece, Greenland, Iceland, Italy, Ireland, Lithuania, Norway, Netherlands, Poland, Portugal, Romania, Spain, Sweden, Turkey and United Kingdom.

A list of 102 European RVs has been established in the survey, with the following distribution by class: 15 Global, 15 Ocean, 37
Regional, 11 Coastal/Regional and 24 Coastal RVs. The breakdown of RVs by class highlights that Global and Ocean RVs represent a total of 30 vessels, and that Regional RVs are the largest group with 37 RVs in total. The 30 RVs of Global or Ocean class are operated by 11 European countries (Denmark, Finland, France, Germany, Italy, Ireland, Norway, Netherlands, Spain, Sweden and UK). Among the 7 countries operating Global RVs (France, Germany, Italy, Netherlands, Spain, Sweden and UK), RVs’ operators from 5 countries (France, Germany, Netherlands, Spain and UK) are members of the OFEG (Ocean Facilities Exchange Group). The other country involved in the OFEG is Norway which operates Ocean RVs.

RVs of the Global, Ocean, Regional or Coastal/Regional classes are identified as the platforms that can play a key role in enhancing cooperation and coordination at a regional level. This sub-group of RVs represents a total of 78 RVs. 10 countries (Belgium, Bulgaria, Croatia, Denmark, Estonia, Faroe Islands, Finland, Greece, Lithuania and Romania) operate one of these vessels each, while Italy, Sweden and Turkey operate four such RVs, and the countries operating the higher number of RVs each are France, Germany, Norway, Spain and the UK (all OFEG members).

The analysis of the main activities carried out by this sub-group of 78 Global, Ocean, Regional, Coastal/Regional RVs surveyed in the study shows that there is a limited number of RVs strictly used for monitoring missions only (15 RVs, 11 of them are logically classified as Regional RVs due to the regional nature of their activities) or for logistic missions only (two RVs which ensure logistic support in the Southern Ocean). In total, 62 RVs are involved in research activities: 20 of them are used for research purposes only, but the wide majority (42 RVs) are involved in combined activities, i.e. in research plus other activities such as monitoring and logistics. For operators undertaking the twofold mission of research and public service, the difficulty is therefore to reconcile scheduling and geographic allocation of cruise requests for the different types of missions. This can result in a higher complexity in the ship scheduling and in less flexibility when it comes to accommodating cruises for partner countries.

Focusing on the group of 62 RVs involved in (academic) research allows an update of the average age of the fleets as described in the 2007 Marine Board-ESF Position Paper 10 on European Ocean Research Fleets. Despite the renewal of some RVs across the European fleets, it appears that the average age of the fleets has increased to 25-35 years compared to the situation described in 2007. The comparison between the situations in 2017 and 2007 shows that, despite recent introduction of new vessels, the general trend is towards aging fleets with a large majority of RVs over 20 years old and with the larger age class being the “over 30 years” class. This is a significant change since the 2007 survey, reflecting the lack of investment and lack of removal of old tonnage in the last 10 year period. The growth in the number of older (over 30 years old) RRVs further highlights the need for investment in this area as recent investment (in terms of number of RVs and in terms of budget) has focused largely on the Global/Ocean RV classes.

As regards the distribution of RVs across the European regional seas, the study shows that they are quite uniformly distributed, with 1) 30 to 40 RVs operating in the Arctic Ocean (including Norwegian Sea), the Channel, Skagerrak and North Sea, and in the North East Atlantic, 2) circa 30 RVs operated in the Mediterranean Sea (including the Black Sea), and 3) less than 25 RVs in the Baltic Sea. Most of them are involved in research activities. However, the Mediterranean Sea appears as a case point: it is a large, enclosed sea with depths in excess of 4000 m in some places, where the need is not only for Coastal or Regional RVs, but also Ocean and even Global class RVs. The study shows that the number of Global and Ocean RVs operated in the Mediterranean Sea is much lower than in the Arctic Ocean (including Norwegian Sea), the Channel, Skagerrak and North Sea, and in the North East Atlantic.

The scientific demand versus RV availability in the Mediterranean Sea was also studied using the proposals submitted to the EUROFLEETS2 TNA calls. Taking into account the nationalities of the PIs for the third Regional call (focusing on the Mediterranean Sea and the Black Sea) as well as the nationalities of the proposal partners, it appears that the applicants and users are generally of two types: i) local regional applicants with a lack of availability of vessel capacity to meet demand (e.g. Italy), or with a lack of funding for ship-time in their own region (e.g. Greece), ii) North Western European applicants with an interest in the research region without available national RVs in the region of concern (e.g. Germany, Ireland and UK). The Mediterranean Sea is also a region of high academic interest particularly from a geological perspective, which explains the high number of applicants in this discipline (mostly focused on Central–Eastern Med.).

Furthermore, the RV fleets in the Mediterranean are aging and less developed than in other regions, often with less technical capabilities. Access process to RVs for academic researchers seems not very well developed, and many of the RVs have rather low activity levels due to financial restrictions. Complex diplomatic clearance processes and issues are also a negative factor affecting utilization and co-operation, mostly in the Eastern Mediterranean Sea. Finally, it is apparent that there is a great imbalance between the Eastern and Western sectors of the Mediterranean Sea with the Western side using the more recent RVs with higher utilization and the Eastern region suffering from aging fleets with lower utilization (with some exceptions to this like the new Turkish RV Tubitak Marmara).
The number of fleet operators is quite high with, in average, 20 to 25 operators from 10 countries per European maritime basin. This rather high number of involved countries means that further development of cooperation at regional level should not be limited to riparian countries, but should also include other countries operating Global or Ocean class RVs in these areas. This comment is of particular importance since although it is observed that RVs are quite uniformly distributed across these sea basins, countries are not evenly represented across them and some countries with a number of regional seas do not have adequate resources, or the specific resources required.

Concerning the national roadmaps and renewal plans for RVs and equipment, the survey shows that less than half of the countries which responded have a national roadmap or strategy. From the responses, it is possible that about 20 new RVs will come into service over the next 10 years, less than half of these RVs have been built or are under construction, whilst the remainder is awaiting a green light in terms of funding. The Arctic and Norwegian Sea areas will see the greatest number of RV renewals (in particular Ocean and Global class RVs, with two renewals for Germany, two new RVs and two major refits for Norway, one new RV for the UK), followed by the Baltic which will see a significant renewal of the regional fleets in particular (one renewal for Estonia, one renewal and one new RV for Poland, one renewal and one new RV for Sweden, and one major refit for Finland). The North-East Atlantic will see fleet renewal through two major refits (Portugal and France) and renewal of two Regional RVs (Faroe Islands and Ireland), whilst the Mediterranean and Black Seas may see renewal of two Regional RVs, however these are contingent to funding. The Channel, Skagerrak and North Sea region will see the replacement of one Regional RV with an Ocean Class vessel (Belgium).

Taking into consideration the plans for new RVs identified so far, the study includes a projected state of the European fleets by 2027 which shows an increase in 6-10 and 11-15 years old vessels, but also a large increase in the over 30 year old vessel category. The projected average age of the fleet in 2027 is estimated to 29 years, but it is most likely that a reasonably large amount of renewal programmes will occur between 2022 and 2027, depending on economic progress, and it is highly probable that a large amount of the older vessels (over 35 years) will be taken out of service.

As part of the objectives of the Project towards the development of a strategic vision of European research fleets, EUROFLEETS2 focused on the Polar component in a dedicated WP entitled “Flagship initiative for polar access” aiming to find appropriate ways to optimize the usage of the European Polar RVs (PRV) by: i) determining the available capacities of PRVs, ii) comparing that with the scientific demand, in accordance with IASC (International Arctic Science Committee) and SCAR (Scientific Committee on Antarctic Research), for research in the Polar Oceans and iii) establishing models for optimization of this fleet by better coordination of the vessels’ scheduling and by harmonizing the deployment of ice-strengthened research vessels with the heavy icebreakers.

The determination of available capacities of PRVs has shown that there are 14 worldwide heavy icebreakers that are empowered to accomplish research in all Polar oceans. However, these RVs show great variability with reference to capacities, equipment, schedules and access, and while most of these vessels to some extent have capacities to support polar stations and a capacity to support research, only a few of them are fully equipped for multidisciplinary science. Only two of the heavy icebreakers are based within the European Union (the German PRV Polarstern and the Swedish IB Oden). Russia operates a large PRV fleet mainly in the Arctic Ocean, but most of the vessels are not used for research and are very difficult to access for European researchers.

18 Ice Class RVs are available at a global scale, 12 of them are European vessels. These vessels are able to work at the ice-margins, but are not capable to enter ice-covered areas in the Arctic Ocean or the heavily ice-covered waters around Antarctica. In comparison to the heavy icebreakers, these vessels are mostly designed solely for science purpose.

The WP evidenced the difficulties to study the Polar Regions in winter with the current European PRV capacity. Not all the PRVs are able to operate in the Arctic or Antarctic all year round. Only those classified according to the new PRV classification between PC1 and PC5 (Category A) are able to operate at least in first year sea ice while those classified as polar categories B and C can only operate with an ice thickness of less than 70cm. These vessels are therefore confined to marginal ice areas, and only operative during the Arctic and Antarctic respective summer seasons.

The WP also analysed the most relevant international polar plans and identified five major scientific core topics which have been selected based on their occurrence within the different documents. The study showed that the European polar fleet is not able to cover the key geographic areas highlighted by the international scientific community.

The current scientific demand was inferred by analysing the data collected from the 473 Cruise Summary Reports from cruises that took place in the Polar Regions in the time frame 2008-2015. Despite of the increasing interest in polar marine research, the big impact
of the European scientific community at international level and the growing demand of polar research infrastructures, the capacity of
the European polar fleet and the infrastructures does not meet the requirements of the scientific demand, even when considering the
ongoing newbuilding projects of new icebreakers like Kronprins Haakon (Norway), Sir David Attenborough (UK) and Polarstern II
(Germany).
It is therefore imperative to increase the international cooperation and improve the coordination of the current polar fleet (both
icebreakers and ice-classified RVs) at European and international levels, in order to maximize the availability of ship-time in the Polar
Regions.

Different models for optimization of the polar research fleet were evaluated, from a Barter exchange system for polar research to the
implementation of a European/international consortium that runs and operates the two existing European icebreakers. The analysis
focused in particular on the “Arctic Research Icebreaker Consortium (ARICE): a strategy for meeting the needs for marine based
research in the ice-covered Arctic Ocean” as it is a new scientific proposal submitted in 2016 to the H2020 call for TransNational Access
to infrastructures as a starting community. ARICE aims at developing an International network for joint research icebreaker operations
in the ice covered Arctic Ocean with the available European and international RVs. The International Arctic Research Icebreaker
Consortium would be the legacy of ARICE. The organizational framework of such a European/international consortium could be based
on the model established for the Integrated Ocean Drilling Program (IODP) and the European Consortium for Ocean Research Drilling
(ECORD), through the signature of a Memorandum of Understanding (MoU) between the stakeholders which is binding enough to allow
the agreement of membership fees to be able to operate PRV Polarstern in full, and operate IB Oden on a charter basis.

In a WP entitled “Initiatives towards integrated and cost-efficient operational activities”, EUROFLEETS2 has paved the road towards an
increased and cost-effective Regional RV integration through keystone initiatives that has resulted in: i) a progressive Regional “Virtual
Fleet” scheme for trans-national cooperation, ii) a case-based sustainable concept for trans-national exploitation of embarded heavy
duty equipment, and iii) the upgrade of the EVIOR platform aiming to provide up-to-date information on planned, ongoing and
completed cruises, on the research fleets and associated large equipment, and to promote interoperability by deploying the EARS
software for logging data and metadata.

- A main objective at the European level is to improve Regional RV efficiency and cost effectiveness through increased cooperation,
coordination and an actual pooling of trans-national resources. This WP has therefore analysed schemes for future collaboration that
progressively evolves with respect to complexity and involvement, with proposed schemes ranging from a) implementing annual
meetings dedicated to mutual information on national cruise schedules among countries operating RVs and equipment within the
same geographical area (resulting in e.g. charter and/or barter agreements), to b) a more formalized establishment of dedicated
regional fleets.

It is first suggested that the regional annual meetings might in a long-term perspective be organized within the auspices of ERVO, as
initiated through the first pilot-meeting (Eastern Mediterranean Sea) organized in 2016 (Rhodes, Greece) and followed by a second
meeting (Baltic Sea) in June 2017 (Helsinki, Finland).

The WP has also analysed a concrete French-Belgian future infrastructure cooperation scheme, and a specific case of possible future
optimization of the use of vessels engaged in DCF (Data Collection Framework) activities scheduled across European regional waters
under the auspices of ICES. It is suggested that ICES might – to the benefit of the EU system at large, regional and national authorities,
the research community, and marine stakeholders - play an active role in a future optimization of these primarily fishery data collection
activities, to encompass also additional community requested data collection initiatives, as well as basic research field work
components. The WP also suggested to further develop the “Virtual Fleet” concept and to build on the EUROFLEETS TransNational
Access experience which has proven to be an efficient mechanism to strengthen collaboration through multidisciplinary groups of
users with complementary skills and expertise and to allow access to maritime resources for countries that do not have appropriate
infrastructures or marine equipment, such as deep-water systems, long coring equipment etc... In this context, a “Virtual Fleet” is defined
as a group of RVs and/or embarded equipment, to which a funding scheme and shared assessment organization of research projects
gives access.

A European distributed research infrastructure, as recognised by ESFRI and comprising several Regional RVs, is a concept that has also
been evaluated by EUROFLEETS2 with limited success chances.

- Exploration seismology is a branch of geophysics that studies the earth interiors analyzing the propagation, reflection and refraction
of acoustic waves using a streamer, an array of very costly receivers towed by a vessel. The instrumentation currently available in the European scientific research community is very limited, when it comes to equipment with longer offsets. Long offset signals contain crucial additional information since useful reflections can be deviated by steeply dipping geologic features such as salt flanks or fault planes, and are also important for rock fluid content analysis. To overcome this lack of research capacity a new strategy has been devised where multiple streamers from different institutions are integrated to obtain a single streamer with longer offsets. A mapping of available European equipment and a characterization of brands and technologies has been carried out as a keystone approach. Further work has targeted resource management at large, e.g. survey planning and optimization of streamer design, using geologic models of wave propagation of areas under consideration for future surveys. A multi-ship approach deploying a series of shorter streamers has also been analyzed.

The EUROFLEETS(1) project has developed the European Virtual Infrastructure in Ocean Research (EVIOR/ http://eurofleet.maris2.nl/startpage.html ), an integrated information portal, providing up-to-date information about RVs, cruise programmes, completed cruises and embarked equipment. This portal is operational and maintained since March 2010, and also provides a Dynamic Vessel Tracking & Events System (linked to the EARS software developed in the Joint Research Activity). The portal development did not start from scratch, but integrates and upgrades a number of existing database modules from the SeaDataNet pan-European marine and ocean data management infrastructure, EurOcean and POGO - Partnership for Observation of the Global Oceans. The number of Cruise Programmes and Cruise Summary Reports (CSR) has reached 3169 and 11906 entries respectively (January 2017). The number of connected RVs is now 4, i.e. three Spanish and one French vessel, which provide dynamic cruise tracks and upload their current activities on a web map with position, speed and bearing, as well as give overview of their events and access to underway data. Gradual implementation of the EARS system and SWE standards on board RVs stays a challenge. Workshops have been organized targeting ship operators and technicians with the purpose of informing about the status of the EARS development to get more RVs equipped.

The EVIOR platform also provides information on the “Scheduling tool” prototype that has been developed in EUROFLEETS2. The developed prototype offers a single scheduling architecture which can be shared by all users. The demonstration software is an on-line tool built on an existing graphical tool based on Java language. To allow a possible use by several operators from the same country, but also from different nations, the scheduling tool has been developed in a flexible approach so that several groups of schedulers could be constituted. Through interactive schedules, the tool provides direct access to information on scheduled cruises, RVs and embarked equipment.

In a dedicated WP entitled “Training through Marine Research and floating universities”, EUROFLEETS2 continued the actions launched in EUROFLEETS(1) to contribute to the training of the next generation of European marine scientists and to broaden the access to world-class marine infrastructures by promoting excellent science.

In this view, several actions were carried out to make a further step towards a higher level of marine researcher training. The proposed actions range from i) the organization of specific workshops to help young scientists to write successful applications, in particular to the EUROFLEETS2 ship-time calls, ii) the organisation of ship-based practical training courses and iii) a pilot experiment of a Floating University, to iv) several actions fostering the recruitment of students, young marine researchers and high-school teachers for the embarked teams of TNA funded cruises.

i) The organisation of a preparatory workshop to foster scientists, in particular from less-equipped countries, to collaborate worldwide and write competitive proposals for ship-time. The workshop aimed to support emerging researchers and postgraduate students (especially those from Accession States or States with limited funding for access to vessels) in writing competitive proposals for EUROFLEETS2 ship-time, providing a significant training/familiarization with the infrastructures and their facilities, defining scientific priorities in the study area, preparing the cruise strategy, gathering the optimal international scientific team. Eight young researchers from seven countries participated to the workshop from 18th - 20th February 2014 in Tallinn, Estonia. From the eight young researchers who attended the workshop, 1 PhD succeeded, got her proposal funded and carried out a EUROFLEETS2 funded cruise, five PhD participated to five different EUROFLEETS2 funded cruises as partners of successful proposals and another PhD student wrote a not successful proposal.

ii) The second way to foster widespread TNA to world-class marine infrastructures was to perform on board Training-Through-Research specifically designed for young researchers, postgraduate students and technicians. Effective on board training of PhD students and
young emerging researchers contributes to consolidate their careers, to develop a network of colleagues that may transfer the knowledge to a large number of mentored students in a downflow cascading process. In this context, three practical courses have been organised on-board three RVs: 1) RV Urania: 4th - 9th July 2014, Messina (Italy) - Multidisciplinary Ship-based training for European Postgraduates and Graduate Students of Marine Sciences (11 students from 9 countries), 2) RV Salme: 17th – 22nd August 2015, Tallinn (Estonia) - Using New Technologies for Multidisciplinary Oceanographic Research (10 students from 7 countries) and 3) RV BIOS DVA: 16th to 27th June 2015, Split (Croatia) - Oceanographic Ship-based Training Course for Postgraduate and Graduate Students of Marine Sciences (12 students from 11 countries).

iii) The organisation of a pilot floating university experiment. The course, 21st May-2nd June 2015, offered an introduction to multidisciplinary oceanographic research techniques, with part of the course on board the Danish RV Dana during a transit from Tromso (Norway) to Hirtschals (Denmark). It was designed to give students sea-going experience and a practical introduction to ocean sampling. It was open for both MSc and PhD students enrolled at European universities. 18 students for 198 received applications have been selected from 9 different European countries, 8 as MSc and 10 as PhD. For many of the participants this cruise was their maiden experience at sea, despite studying marine sciences. As such this long course of more than 10 days offered a unique hands-on experience where theory and techniques learnt in the classroom were put into practice.

iv) The development of a four-fold access programme embedded in the TNA activity to facilitate the access to EUROFLEETS2 cruises and participating RVs, and to broaden this incredible access to world-class marine research infrastructures for a range of potential vessel users, through 1) a "Student Access Programme" based on the recruitment by the PIs of the TNA funded cruises of students or technicians as members of their on-board teams, 2) a pilot initiative of co-chief scientist, 3) the recruitment of additional students when berths were available on board, and 4) the invitation of teachers in cooperation with the EGU teacher@sea programme:

1) The Student Access Programme: Thanks to chosen criteria in the EUROFLEETS ship-time proposal evaluation, PIs were encouraged to include a training component in their research programme and to incorporate students as members of their embarked teams. Over the 17 cruises funded in the EUROFLEETS(1) project representing 221 embarked scientists, the number of students represented 30% (or 65 persons) of the embarked scientific parties. This already promising outcome was further improved in EUROFLEETS2 as the number of students and young researchers embarked during the 24 funded cruises was brought to 148, representing 45% of the on-board teams (over a total of 329 embarked personnel), with 8% (or 26) as post-doctoral researchers, 31% (or 101) as post-graduates and 6% (or 21) as under-graduates. Experienced researchers represented 44% (or 147) of the embarked teams and the remaining embarked personnel were technicians (11% or 34).

2) The Co-chief scientist Initiative, to train junior co-chief researchers together with well-experienced researchers within EUROFLEETS2 TNA cruises, thereby providing the infrastructure, experience and confidence to progress to less experienced researchers. A PhD Student applied under the EUROFLEETS2 Polar and Sub-polar TNA Call to study micro-plastics in Arctic waters. The "POLAR PLASTICS" proposal was subsequently evaluated along with all TNA proposals. The multinational requirement for partners was not taken into consideration, as the proposal scientific team would be embedded in an already multinational team. Due to the excellence of the project highlighted from the SRP, it was decided to fund this proposal and to provide the requested ship-time through two additional days to the "PREPARED" cruise on RV G.O. Sars, also funded by the Project and planned in the North-West Barents Sea. The valuable data which were collected, the enthusiasm shown by this PhD researcher who recognized that this was a great experience, enabling her to learn a lot about how large scale research cruises are carried out, to meet senior scientists and to form plans for future collaborations, all these aspects show that such an experience as co-chief scientist on an international cruise is a valuable opportunity for young PhD students to run their own research. This is a relevant example and a model to further promote and develop in the future, so encouraging young researchers to join international and multidisciplinary cruises.

3) The training through research cruise schemes: The placement of junior researchers and students on cruises where spare berths were available, in addition to the "Student Access Programme". Dedicated calls were organized for the selection of interested students, volunteer PIs were involved in the evaluation and selection process. In total, four berths (for 76 received applications) on two funded cruises were secured to accommodate students from other countries. Both placements took place in 2016.

4) The cooperation with the "Teachers at Sea" programme: EUROFLEETS2 focused on facilitating the participation of High School teachers on board TNA funded cruises, to further develop the "Teachers at Sea" programme already initiated by the European Geosciences Union (EGU) in cooperation with Project’s beneficiary IPEV (France) on board RV Marion Dufresne in 2007, 2008 and 2012. The engaged teachers immersed themselves in life at sea and research under guidance of a scientist. Their students participated to the cruise by sending e-mails, participating in blogs, and journaling about the daily activities of their colleagues on-board. The
EUROFLEETS2 contribution to the “Teachers at Sea” programme was organized in collaboration with the Committee on Education of EGU, which managed the selection of teachers to be hosted on board EUROFLEETS2 cruises. Two teachers were hosted on two cruises (PREPARED cruise on board the RV G.O. Sars in June 2014, and BURSTER cruise on board the RV Polarstern in June 2016).

Potential Impact:
EUROFLEETS2 potential impacts:

As a continuation of EUROFLEETS(1), EUROFLEETS2 aims at bringing together existing European research fleet owners and operators, including the Polar Research Vessels (PRV) community, to enhance their coordination and promote the cost effective use of their facilities. The impacts of EUROFLEETS2 results are consequently diverse and cover various fields involving research fleets owners and operators, as well as the scientific user community.

EUROFLEETS2 serves the economic challenges linked to the maritime and marine sectors by providing access to cost efficient RVs and equipment able to accelerate the access to new knowledge and innovation. EUROFLEETS2 impact on European competitiveness could be significant, especially on a long-term scale as other infrastructure projects.

Through an enlargement of its Consortium gathering 22 European RVs operators from 15 flags, EUROFLEETS2 has significantly consolidated the links between European RV operators and owners. Although the integration impact remains limited, EUROFLEETS2 contributes to reduce the fragmentation within the European research fleets and has implemented a range of activities towards a strengthened collaboration at pan-European level:

- In collaboration with the European Research Vessel Operators (ERVO) group and Ocean Facilities Exchange Group (OFEG) members, the EUROFLEETS2 Fleet Evolution Group (FEG) has stimulated a further step towards the consolidation of a coordinated strategic vision of European RVs. The Project has continued the EUROFLEETS(1) action to follow-up the status of European research fleets: EUROFLEETS2 has developed a comprehensive and up-to-date unique vision of the European research fleets, with a “forecast” of their future capabilities and capacities in Europe regarding Global, Ocean, and Regional class RVs that gives insight and perspectives to European RV owners and operators in their internal planning and deliberations regarding their plans for acquiring new RVs and embarked equipment, refits of existing RVs and/or potential cooperation schemes.

- The work achieved shows that, despite recent introduction of new vessels, the European research fleets are still ageing and present renewal plans are not sufficient to expand or even keep up the capabilities for marine research in Europe, in particular for the Regional class RVs. EUROFLEETS and EUROFLEETS2 projects are timely initiatives that have contributed to share a better understanding within European decision makers of the current situation and its prognosis if no further investments are made.

- In its analysis of the status of European research fleets, EUROFLEETS2 has also identified the main activities of European RVs, their level of activity, technical capacities and maritime basins of operation. The developed picture contributes to a better knowledge of the real usage of European research fleets and could help to determine where and how cooperation and coordination could be more developed at various levels.

- EUROFLEETS2 has paved the road towards an increased and cost-effective Regional RV integration through keystone initiatives. The idea of stimulating regional cooperation, through an increased level of communication (e.g. structured annual meetings among ship operators), is a basic but pragmatic approach allowing to foster future bi-national or multinational collaborations, including a Virtual Fleet concept yet to formalize. The EUROFLEETS2 reporting on these issues also points out possible difficulties met if moving further on to a genuine distributed research infrastructure. This is mainly due to e.g. the highly-varied ownership, organization and funding schemes of the current research fleets across European countries. The EUROFLEETS2 consortium concludes by promoting the set-up of a formal “European Fleet Infrastructure Coordination System” which will on time-scales that extend those of the EUROFLEETS projects accommodate and nurture long term coordination activities, encourage knowledge sharing, catalyze the emergence of joint projects, and overall promote the European oceanographic fleets on the international scene.

- The EUROFLEETS2 activities specifically devoted to the European Polar Research Fleet have been crucial at evaluating the status of the European Polar Research Vessel (PRV) fleet and at establishing models for implementing a joint coordination of these vessels. EUROFLEETS2 engaged regular communication with PRV operators aiming at identifying current gaps and optimizing the usage of European PRVs. The evaluation of the actual current research fleet and of the scientific demand for PRVs will improve decision-making strategies to follow for the future of the European PRV fleet. The strategic long-term coordination vision of European PRVs will improve ship-time availability for research in Polar Regions, the alignment of European research objectives and European integration.
The integrated evaluation system developed under the umbrella of both EUROFLEETS projects has proven to be efficient and its criteria should be used for future evaluation of European ship-time calls:

- The TransNational Access (TNA) to European RVs and marine equipment developed in EUROFLEETS2 has reinforced the EUROFLEETS(1) model for easier access to RVs, embarked equipment and services at sea on basis of scientific excellence, for all European scientists and their partners, creating a unique opportunity for early career scientists and for scientists from nations with limited or no access to RVs.

- The EUROFLEETS2 ship time proposal evaluation system will be used to evaluate the proposals submitted to the "Arctic Research Icebreaker Consortium (ARICE): A strategy for meeting the needs for marine based research in the ice-covered Arctic Ocean", the scientific proposal submitted in 2016 to the H2020 call for trans-national access to infrastructures as a starting community.

- Thanks to chosen evaluation criteria, EUROFLEETS2 successfully incorporated a high number of students and early career scientists as members of the embarked scientific parties. This strongly contributes to prepare the new generation of marine researchers and technicians, to use modern RVs with sophisticated embarked equipment.

- The coordinated access to European RVs developed under the EUROFLEETS2 TNA has highlighted relevant ways to optimize the use of RVs: i) two scientific proposals were merged and funded on board a single RV and ii) one cruise was jointly carried out with another cruise funded by a US programme, allowing optimal use of ship-time and more efficient operations at sea.

EUROFLEETS2 have strengthened the scientific excellence of marine research in Europe by facilitating access to European RVs. Multi-national scientific parties of funded cruises have contributed to foster scientific exchange at European and international levels:

- The TNA has been the core activity of the EUROFLEETS2 project, opening new perspectives for an efficient and integrated European marine science and technology setting, increasing European collaboration and the number of new end users on board European RVs.

- The Super-Integration cruises have shown an innovative way of integrating European and international infrastructures, demonstrating how multi-platform experiments involving RVs together with other land based infrastructures can develop synergies with other initiatives or projects at European and national levels.

- Thanks to the higher number of remote users (representing 33% of the scientific parties involved in the TNA cruises) than in EUROFLEETS(1), EUROFLEETS2 has optimized the use of funded ship-time and enlarged the Project's audience within the European and international scientific community.

- Through its successful TNA, EUROFLEETS2 helped to collect crucial information and enhanced the scientific knowledge of the oceans by giving the European and international marine scientists access to world-class RVs. In doing so, EUROFLEETS2 contributed to reinforce the EU international leadership in marine, environmental and climate researches.

As EUROFLEETS(1), EUROFLEETS2 was an excellent demonstrator of the EC funding leverage effect, particularly in the TNA, as some PIs received significant national funding to complete the European funding. Four fruitful examples can be cited:

- for the DeepMap cruise carried out on board the RV Celtic Explorer, the scientific party got funding of ROV Holland 1 on Irish funding;
- the TOMO-ETNA experiment carried out during the Super-Integration cruises received a combination of European and national (from Italy and Spain) fundings. Partners included the Italian Navy which supplied a vessel to deploy OBS and ROV and run magnetic surveys as well as logistical support for all cruises. The OBS units were provided under separate Spanish and Italian projects whilst further time on the RV Sarmiento de Gamboa was provided under Spanish national funding;
- for the LGT-AMORGOS-56 cruise carried out on board the RV Aegaeo, 8 days of ship time were provided through EUROFLEETS2, complemented with 2 extra days funded by HCMR;
the ship-time for the successful completion of the EUROFLEETS2 training courses on board RVs Urania, Salme, BIOS DVA and the RV Dana were funded or co-funded by CNR, TUT, IOF and DTU-Aqua as RV operators involved the Project.

By developing dedicated onboard training courses, EUROFLEETS2 also made a significant effort to improve practical training of the next generation of marine researchers that will contribute to both raise interest in scientific careers and promote their development:

- The EUROFLEETS2 mission to make European RVs available to researchers and students across the European community through a well-publicized programme, was very well demonstrated by all the students participating to the training courses organized by the Project. The evaluations of the participants to the training courses cite the experience as an indispensable training, with the message that the EUROFLEETS2 training programme offers offshore training opportunities not otherwise available and utilizes existing and extremely valuable capacity within the European research fleets.

- The experience on design, organization and applicants' evaluation of on-board training courses in the frame of EUROFLEETS(1) was the starting point for the EUROFLEETS2 on-board training courses and the Floating University programme. Compared also to the on-board training courses previously organized in EUROFLEETS(1), EUROFLEETS2 demonstrates that there is an increasing demand for the on-board practical training courses, with a total of 51 selected and trained students from 20 nationalities (EU members States: 14, other European: 1, Africa: 2, Asia: 2 and America: 1), for about 400 received applications.

- The successful activities of on-board courses and the Floating University demonstrate how offshore training programmes should be integrated into existing national and international postgraduate schools and programmes and that EUROFLEETS2 is now a reference programme at European level for offshore training. This alliance of RVs operators and university/research institutions authorities strengthened both reputations within young scientist community.

The design and development of a Regional RV (RRV) is a complex, time consuming and expensive exercise. Several actors, such as qualified ship design companies, experienced shipyards, equipment manufacturers, scientific staff with experience in marine science and in research cruises, and experienced RRV operators have been involved in the entire project loop, in order to integrate “best practices” sought from existing RRVs and the latest developments both in ship design and scientific equipment:

- EUROFLEETS2 produced guidelines and recommendations on key design aspects which can be used as handbooks summarizing both best practices and technological aspects that have to be taken into account as input, when launching the design of a new vessel or when updating an existing vessel. The generic vessel designs assessed within EUROFLEETS2, built on those recommendations, represent an advanced backbone to develop and build next generation of European efficient and multipurpose RRVs.

- Development of this Regional RVs new generation is a key priority due to the age of the existing fleets (with a lot of RVs over 30 years old). Both the guidelines and the generic RV designs have been developed in EUROFLEETS2 to contribute to more innovative, interoperable and cost effective future Regional RVs.

EUROFLEETS2 has reinforced the EUROFLEETS(1) activities to harmonize and standardize the workflow from on-board data acquisition to onshore storage by data centers, seeking synergy with existing international and European initiatives and therefore participating in the implementation of the integrated European Maritime Policy:

- The European Virtual Infrastructure in Ocean Research (EVIOR) portal providing up-to-date information about European RVs, cruise schedules, completed cruises and specialized marine equipment, will enhance awareness of opportunities among users and improve cruise cost-effectiveness. Created in cooperation with existing initiatives such with SeaDataNet and POGO, EVIOR includes the Cruise Summary Report (CSR) service component and provides users and data centres with detailed information about the data acquisition activities engaged during the cruises. This information is crucial for data centres for following up the processing of the data sets and the long term storage and accessibility towards users.

- The EVIOR portal and EARS2 software packages have the potential to become “cornerstones” for the daily operation and management of RVs. The roll-out of identical data handling software and ship operational facilities on European RVs will greatly enhance the possibilities for collaboration at large (e.g. the exchange of personnel and equipment) and contribute to improved data quality. These prototypes systems have still to be further developed and maintained for decades to come.
- The EARS2 software provides to EUROFLEETS community a software tool to manage all cruise data, as well as the events that occur during them. The Ontology, which has been developed specifically for EARS2, should allow making a step on top of the structure that comes from SeaDataNet, being able to extend it according to the particular needs of each cruise, speeding and simplifying the creation of events.

- The Web Services that have been created, are paramount factors for RV interoperability. The information stored in the database has been made accessible, so any developer can create new software and use it without having any knowledge of the operation and structure of the internal storage. This prototype and the integration of Web Services as a practical level, offers an open RV model for the whole European environment.

In the field of Hybrid and Autonomous Underwater Systems, the increasing integration of sensor technology, data processing and vehicle control require a strong commitment to technical R&D:

- Innovative methods developed within EUROFLEETS2 and in particular based on optical 3D dynamic positioning, target tracking and terrain following, will increase the productivity of operations at sea through higher control of vehicle path. 3D reconstruction methods and developed tools capable to process huge data sets offer the perspective of novel innovative services.

- Collaborative work between involved partners allows sharing of R&D risks and costs, and synergy generated through joint integration and experiments opens new collaboration possibilities for the future.

EUROFLEETS2 activities have been important to establish and undertake regular communication with industry, in particular companies engaged in operating research and survey vessels and associated equipment, using marine and ocean data for various applications, engaged in design and outfitting of RVs or manufacturing embarked scientific equipment. These dialogues have aimed at identifying innovation opportunities and giving feedback and input from industry for refining and completing EUROFLEETS2 results, where possible. EUROFLEETS2 focused in particular on i) Sensor Web Enablement (SWE) technologies tuned with a number of other EU projects, and on ii) the innovative RRV designs developed in the Project. Dedicated workshops for selected audiences and more in-depth communication have taken place, allowing EUROFLEETS2 to strengthen interactions between users from research and industry.

Such large and diverse impacts explain that a follow-up of the EUROFLEETS2 project is envisaged through the preparation of the “EUROFLEETS+” proposal to be submitted in the frame of the INFRAIA-01-2018 – Integrating Activities for Advanced Communities work programme, under leadership of the Marine Institute (MI, Ireland).

EUROFLEETS2 main dissemination activities

EUROFLEETS2 has carried out generic dissemination activities and specific dissemination actions. The ultimate objective of them was to increase the awareness, understanding and action of all stakeholders and end users of the EUROFLEETS2 results. This should encourage the results’ exploitation and maximize their positive impact to society.

The Plan for communication and outreach developed at the beginning of the Project life planned to consider different levels of dissemination and to identify which media would be appropriate to disseminate the numerous Project objectives to audiences targeted by the Project. Dissemination activities were so implemented through combined and complementary actions involving the usage of electronics media -in particular the Project internet hub and e-newsletters–, the participation to European and international conferences, the organization of relevant events or workshops, and the development of appropriate dissemination materials.

Dissemination activities implemented within the Project were also the result of a collective effort as many EUROFLEETS2 beneficiaries conducted opportunity dissemination actions through articles published on their own websites or press releases on Project’s results, and promoted the Project’s objectives in European and national events of scientific, political and general natures.

During the preparation of the Plan for communication and outreach, the upgrade of the project’s website was decided since it is considered as the most direct and easy way to communicate with the public, end users and relevant stakeholders. The upgraded
EUROFLEETS2 internet hub was launched on February 2014, it is accessible through three easy identifiable domains (URLs) the main domain: http://www.eurofleets.eu and http://www.eurofleets.org and http://www.eurofleets.net - both redirecting to the main domain. The EUROFLEETS2 internet hub was regularly updated with articles, news, events, press releases, Deliverables, products, etc. which were also disseminated through e-newsletters. The website was further refreshed during the last year of the Project in order to bring the focus to its main results. For this purpose a new and improved EUROFLEETS2 internet hub was launched on March 2016. A Facebook page, accessible from the internet hub, was also set up and regularly updated.

The EUROFLEETS2 graphical identity was kept from the previous EUROFLEETS(1) project to show the continuity between both projects. Several institutional printed materials were developed to assist the Project's dissemination, such as the EUROFLEETS2 factsheet presenting the concept of the Project, the EUROFLEETS2 Institutional and Research Vessels Poster and the "EUROFLEETS2 in Numbers" brochure for the Project Final Conference. Other printed materials were also developed to disseminate on specific Project's results, such as i) the brochure on the EUROFLEETS2 "Ship-time proposal evaluation system", and ii) the brochure "How EUROFLEETS2 succeeded in funding marine research and training through coordinated access to European research vessels" presenting in a synthetical way and easy to understand style the main results from TNA and training activities, including testimonials from some PIs of EUROFLEETS2 funded cruises.

Videos being a medium that efficiently help to disseminate on Project's results, EUROFLEETS2 also produced several videos focusing on the TNA activity: i) two short videos with scientific parties of two funded cruises and two interviews of PIs explaining the importance of the EUROFLEETS2 TNA for the scientific community, and ii) three videos presenting the scientific objectives and works carried out during three funded cruises. A YouTube channel accessible from the EUROFLEETS2 internet hub was created to display all the produced videos.

Stationery (pens and folders) were also developed as they are a longer lasting usable component of the Project graphic identity set, and could be distributed to a range of target audiences such as meetings, conferences, workshops, etc...

The promotion of EUROFLEETS2 objectives together with the dissemination of EUROFLEETS2 results were also ensured through the participation of the Project to relevant European events and thanks to the active participation of the Project's beneficiaries to European and international conferences:

EUROFLEETS2 was represented in various events and conferences in order to further disseminate the Project's concept, objectives and research results. The members of the consortium were eager to prepare various presentations and attendances towards the common objective of reaching a large audience of experts in related organisations. Project's beneficiaries delivered 96 presentations, published 12 papers in peer-reviewed journals, one book chapter and two papers in Proceedings of a conference, presented 7 posters, as well as a range of other outreach tools. The main target audiences were Scientific Community and Ship Operators although some events also targeted civil society, policy makers and industry. The overall estimate is that over 25,000 persons were addressed by these various activities since the beginning of the Project.

Main results of the EUROFLEETS projects have been described in a dedicated legacy report. This document aims to be used by the Project's consortium and also to be transmitted to the ERVO Executive Committee so that it can determine what are the reports that the ERVO group is willing to use, maintain and further expand in the future.

The EUROFLEETS Final Conference, held on January 31st 2017 at the Auditorium of the Royal Belgian Institute of Natural Sciences, Brussels (Belgium) was dedicated to disseminate the main EUROFLEETS2 results and to introduce future perspectives through the ARICE proposal submitted in 2016 and the EUROFLEETS+ proposal to be submitted in 2018 to the H2020 call for trans-national access to infrastructures as advanced community. The conference was attended by more than 70 participants, as representatives of the European Commission, beneficiaries of both EUROFLEETS(1) and EUROFLEETS2 projects, PIs of funded cruises and also representatives of entities, EU projects or initiatives such the European Marine Board, the ERVO group, EuroGOOS, the JPI Ocean, EMSO-ERIC and the BONUS programme.

Exploitation of EUROFLEETS2 results:
Despite the Project's efforts, no commercial exploitation of EUROFLEETS2 results is planned.

List of Websites:
http://www.eurofleets.eu/