



Subsea autonomous systems: next generation technologies

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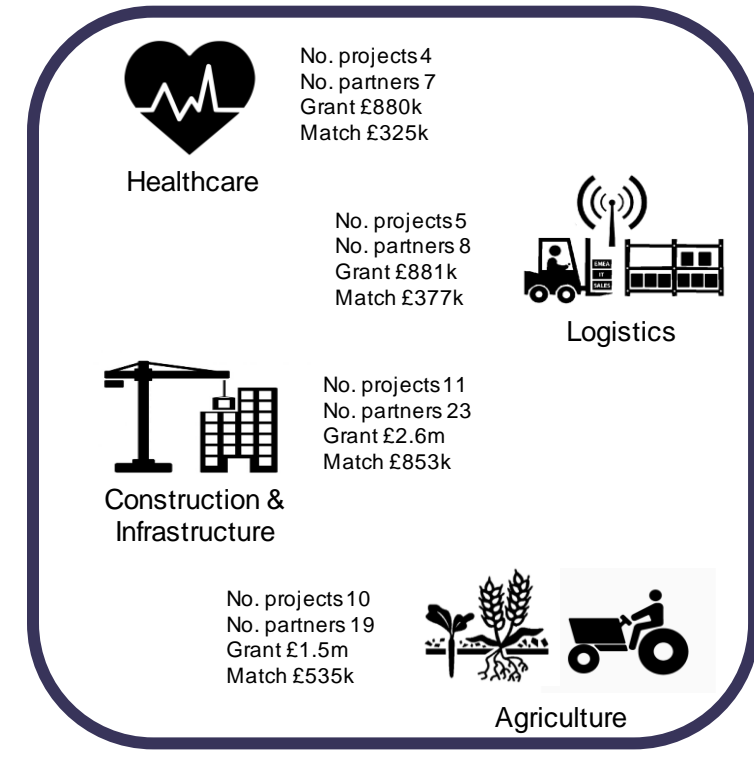
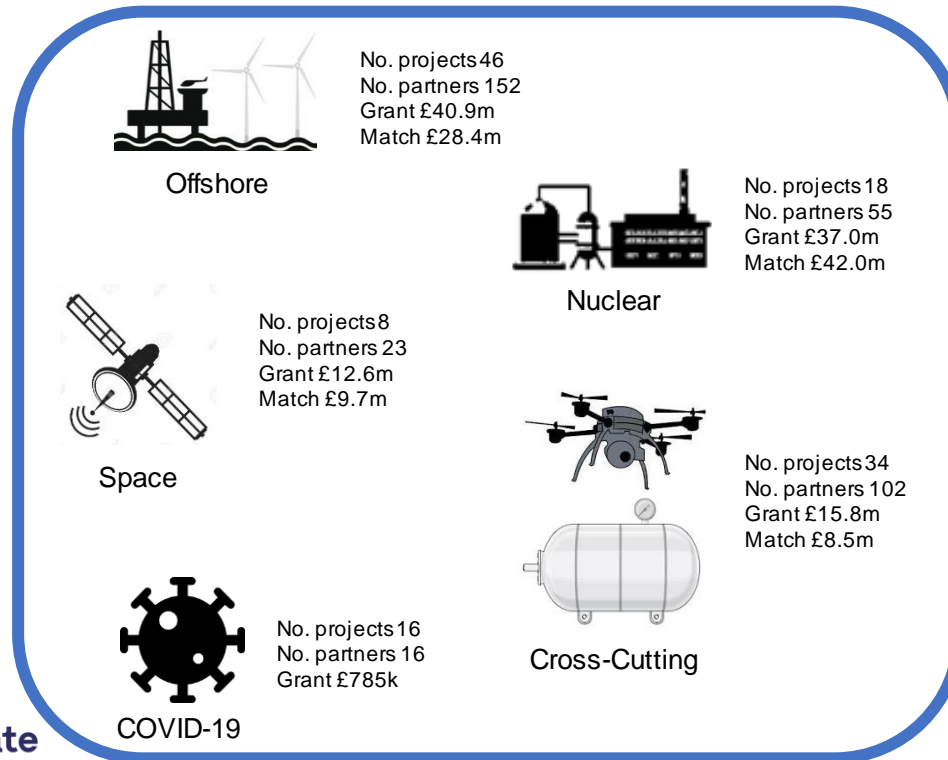


Agenda

- Robots for a Safer World Programme
- Subsea autonomous systems competition
- Subsea autonomous systems projects
- AutoNaut for extreme environments
- UK in Horizon Europe
- Q&A

Robots for a Safer World

- A £112m, 5-year programme (2017-2022) developing robots to take people out of dangerous work environments, increasing productivity and going beyond human limits.
- In the final year the scope was extended to include other sectors focussing on Robots for a Resilient Future in a post COVID environment.



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Robots for a Safer World (2017-2022)

Robots for a More Resilient Future (2021-2022)



Subsea autonomous systems: next generation technologies

A Collaborative Approach to Innovation

Defence Innovation Unit



Net Zero Technology Centre



Royal Navy



Competition Overview: Challenge & Scope

- The challenge was to develop next generation subsea autonomous system technologies, which are modular in design with common interfaces and open architectures.
- The approaches/solutions proposed should make trusted unmanned operations the standard approach for off-shore operations.
- The competition included the “*Innovation Lab*” with the aim to generate innovative and commercially viable new ideas which improve: levels of autonomy; sensor miniaturisation; mission planning; monitoring; communications; navigation; data management and operations; with improved endurance in the water column up to 3,000 metres deep.
- The project(s) must focus on one or more of the following:
 1. off-shore energy
 2. aquafarming
 3. deep sea mineral exploration
 4. maritime defensive security operations

Competition Overview: Process

- The Competition was launched in 2019 and comprised three stages:
 1. An Expression of Interest to enter the Innovation Lab
 - Individuals apply to participate, on behalf of their organisation
 - Applicants were chosen and invited to attend in March 2020
 2. The initial plans were for a ~~5-day~~ collaborative, ~~residential~~ Innovation Lab in ~~May 2020~~
 - Project proposals were developed during a *7-day virtual* Innovation Lab in May 2021
 - Proposals were assessed at the end of Innovation Lab to see if they can go forward to final submission
 3. Final proposals are submitted on behalf of collaborations formed
 - The proposals were subjected in independent assessment for potential funding in July 2021
- Three projects were approved and started in October 2021

Demeter objectives

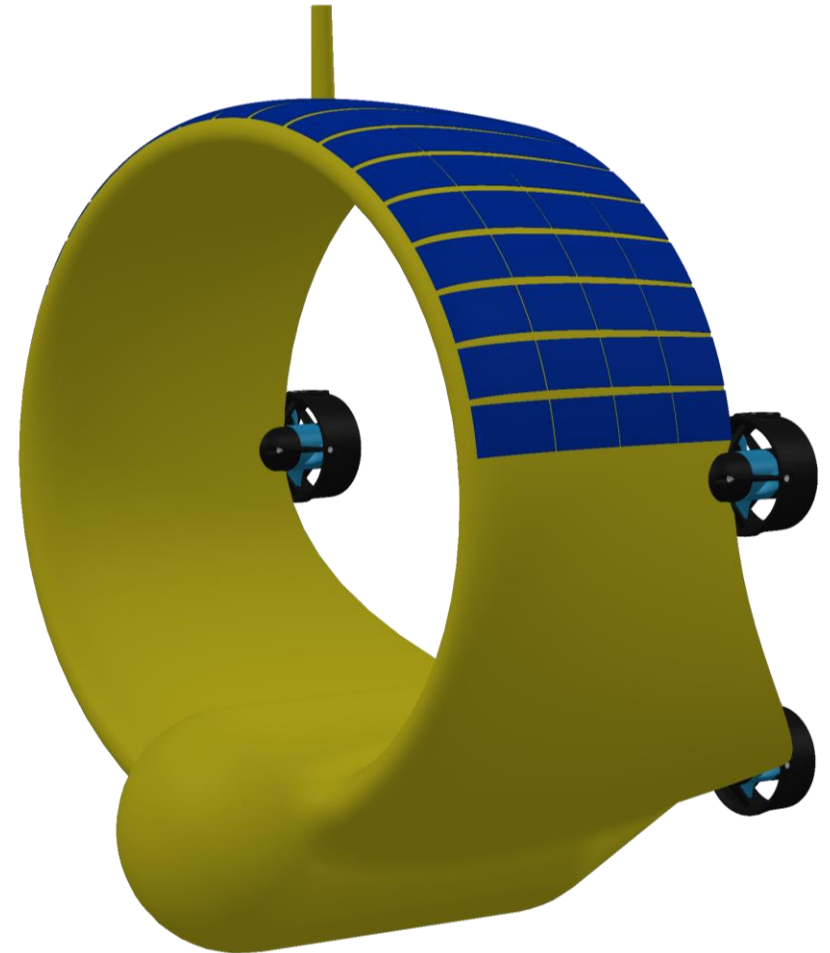
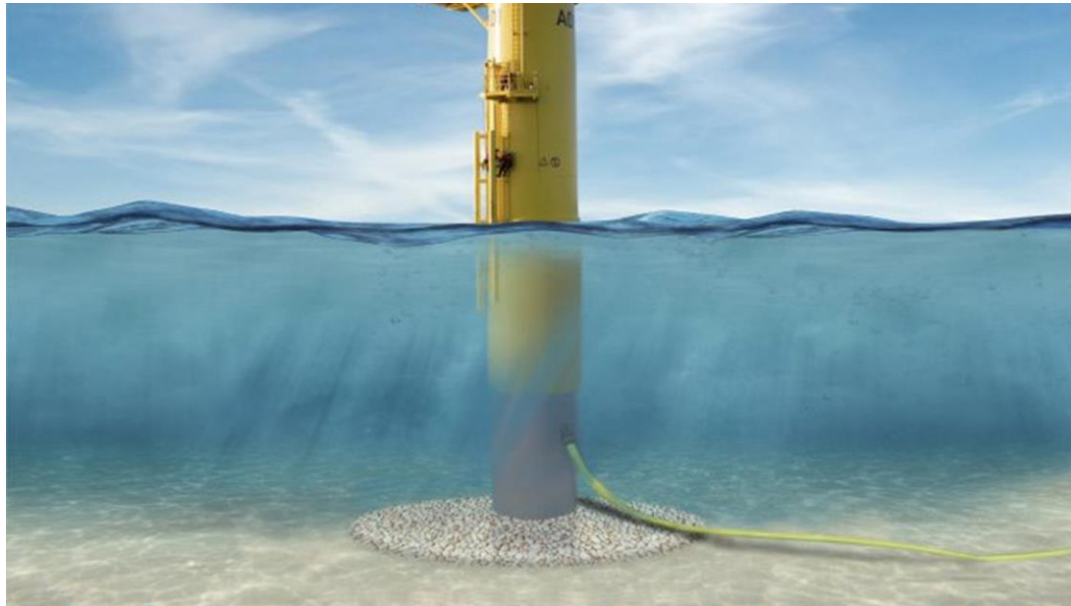
To develop an integrated system comprising:

1. A long-endurance, energy-harvesting, hybrid underwater and surface autonomous vehicle
2. An onboard edge-processing module based on a novel computer architecture, capable of performing intensive statistical analysis of harvested sensor data at a fraction of the power of current technologies
3. A technology stack for high-integrity long-term autonomous navigation and decision making
4. An embedded subsea sensors adapted for data retrieval by the autonomous vehicles.

Operational Objectives

- Using energy-harvesting, intelligent, uncrewed vehicles to provide a persistent, infrastructure-independent subsea sensor data retrieval and analysis
- Enable more cost-effective predictive maintenance of subsea assets, greatly reducing OPEX and downtime, and ultimately lower the cost and environmental impact of exploiting renewable and non-renewable offshore resources alike.
- To shift the subsea monitoring paradigm from one of manual, expensive, and low frequency data retrieval to that of automated, inexpensive, high frequency and on-demand intelligence retrieval.
- To open up entirely new concepts of operation for maritime security that are not currently feasible.
- Further downstream to explore further applications in maritime security operations, including maritime surveillance.

Preliminary vessel concept & usage



Partner roles



- Systems engineering & energy harvesting

Autonomous Devices



Signaloid

- low-power uncertainty-tracking computation module



- technology stack for the implementation of high integrity autonomous behaviours



- subsea infrastructure for monitoring & underwater vessel support



- autonomous navigation



- autonomous mission planning



- novel marine vehicle design & energy harvesting

SEAMless objectives

To develop a gold standard in composite 3D mapping to deliver the 'Google Maps' of subsea with positioning better than GPS. Towards this end the project will:

- Employ an Autonomous Underwater Vehicle (AUV) and an ultimate sensor suit to obtain highly accurate large-scale maps of the seabed
- Develop an advanced perception and intelligent decision-making systems will run on-board an autonomous underwater vehicle through a modular architecture.
- Provide dense millimetric mapping and drift tolerant positioning, thus reinforcing the autonomous navigation and control and improving system performance and safety.
- Employ the latest in serious gaming technologies to provide advanced visualisation, situational awareness and pre-mission planning and post-mission analysis.

SEAMless: Concept of Operation Outline

- SEAMless will operate in open water and near infrastructure, for offshore renewables, oil and gas decommissioning and environmental assessments to provide targeted surveys and inspections.
- Subsea inspection and surveys require highly accurate mapping to support activities such as site assessment, detailed inspection, and asset maintenance. By improving the data accuracy and their utility, operational costs and campaign durations can be reduced, eliminating the need for repeat surveys.
- The envisaged system could feasibly map an entire offshore windfarm creating a digital model through multiple sessions, with increased autonomous awareness enabling underwater robots to position themselves and navigate along safe collision free path.

SEAMless: Partner roles



- Underwater Visual SLAM sub-system



- Underwater navigation sub-system



- Sensing sub-system



- Industrial operations



- technology stack for the implementation of high integrity autonomous behaviours



- AH-1 platform/AUV



- 3D visualization

SoAR objectives

- Step change in the use of role specific, multi-platform robotic swarms
- Develop an easily accessible solution supporting the operation of multi-robot system(s)
 - An “open” system – any robot can join
- A fleet level autonomy engine to provide:
 - Squad mission planning
 - Continuous monitoring of networked vehicles
 - Decision making capability for responsive re-tasking of the fleet to ensure mission objectives are completed efficiently
 - Continuous adaptation to information gathering plans based on what is observed and learned, and what remains unanswered
- Develop a dynamic and scalable communications system/protocol
- Demonstrate Hybrid REAV-60 USV, Hover capable AutoSub Hover AH-1 AUV and a fleet of 5 ecoSUBm5-Scout AUVs collaborating dynamically in mission

The Squad



HydroSurv: Hybrid REAV-60 USV



NOC: AutoSub Hover 1 (AH-1)



5 x ecoSUBm5-Scout AUV

SoAR Concept of Operation Outline

- USV to supervise and coordinate AUV squad, hosting link to Fleet Autonomy Engine and providing USBL
- 5 x ecoSUBm5-Scout AUVs to provide rapid survey of area using side scan sonar to identify targets
- AutoSub Hover AH-1 AUV to provide close inspection of identified targets
- Fleet autonomy engine to design and distribute missions to all robots, continuously monitor robots and re-task as required to ensure efficient and effective conclusion of mission
- Initial application focused on surveys for offshore wind, but use cases likely to be broad and cross-sector

SoAR: Partner roles



- Fleet of 5 ecoSUBm5-Scout AUVs featuring:
 - Increased endurance / power on board
 - New dynamic propulsion system for enhanced performance in harsh conditions
 - Increased navigational capabilities



- Network communications and navigation
 - Integration of AvTrak 6
 - Ultra-Short BaseLine Transceiver



- Provision of USV to host link to fleet autonomy engine & USBL
- Ability to operate as member of squad and complete mission tasks



- AH-1 hover-capable platform
- Lead development of new modular navigation and communications capability



- Lead development of fleet autonomy engine



- Technoeconomic analysis and end-user engagement to support the commercialisation

AutoNaut

- A 5m Wave-propelled uncrewed surface vehicle (USV)
- Capable of completing missions at sea for many months without mother ship support
- Key applications:
 - Passive Acoustic Monitoring:
 - Noise monitoring
 - Baseline monitoring
 - MetOcean / ADCP
 - Communications Gateway
- ADVANTAGES:
 - Removal of personnel from offshore environment
 - No fuel required – NetZero Targets
 - Reduced costs and logistics
 - Mobility and manoeuvrability
 - Low noise



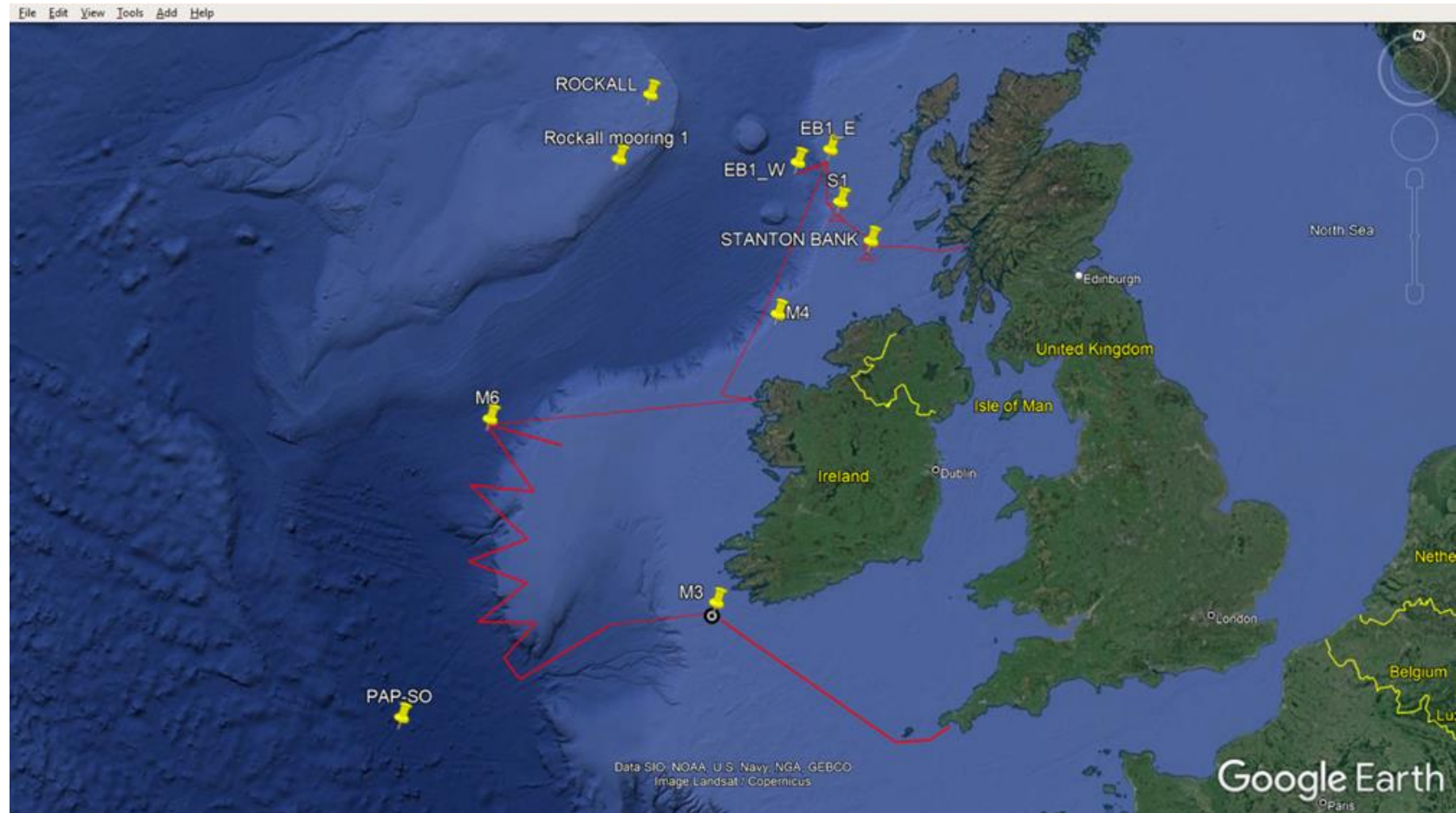
AutoNaut for Extreme Environments

Aim: to create a zero-carbon USV capable of operating in Arctic and Antarctic waters – eventually in winter.

IUK funded 'Extension' trial autumn 2021: *AutoNaut 'Oban' arrives quietly into Penzance after waiting out Storm Arwen off Mount's Bay. The 115 day voyage covered 4,000 nautical miles gathering data on the Atlantic shelf break from the Hebrides to Cornwall.*



AutoNaut for Extreme Environments



- Simplified route map
- Proven endurance (115 days at sea, some 4,000 nautical miles)

Current Status of UK Association to Horizon Europe

- The UK government has stated that its priority remains association to Horizon Europe, as both the UK and the EU agreed under the Trade and Cooperation Agreement, and that it stands ready to formalise UK association
- UK organisations are fully eligible to APPLY for Horizon Europe funding as if they are from an Associate Country. Until the UK's association to the programme is complete, however, UK organisations are not yet eligible to RECEIVE Horizon Europe Funding (see [General Annexes](#))
 - UK organisations can Coordinate proposals, they cannot yet Coordinate projects
 - UK organisations do count as one of the minimum three required in collaborative proposals, a consortium of only these three is not eligible to receive a grant to undertake the project
- The UK government has guaranteed funding for successful applicants to Horizon Europe who are unable to sign grant agreements with the EU prior to formalisation of the UK's association to the programme.
 - Details of the calls covered by the UK government guarantee can be [seen here](#) (generally, but there are exceptions, those calls with a submission deadline before end April 2022)

Digital topics: AI, Data and Robotics

Title	Action Type	Action	TRL range	Project budget (€m)	Topic budget (€m)
HORIZON-CL4-2022-DIGITAL-EMERGING-02-05	AI, Data and Robotics for Industry optimisation (including production and services) (27:12 in) new deadline Nov 22	IA	3/5->6/7	3 to 5	19
HORIZON-CL4-2022-DIGITAL-EMERGING-02-06	Pushing the limit of physical intelligence and performance (Robots) (36:56 in) new deadline Nov 22	RIA	2/3->4/5	4	28.5
HORIZON-CL4-2022-DIGITAL-EMERGING-02-07	Increased robotics capabilities demonstrated in key sectors (43:21 in) new deadline Nov 22	IA	3/5->6/7	6	36
HORIZON-CL4-2022-HUMAN-02-01	AI for human empowerment (4:48 in) new deadline Nov 22	RIA	2/3->4/5	4	16
HORIZON-CL4-2022-HUMAN-02-02	European Network of AI Excellence Centres: Expanding the European AI lighthouse (10:07 in) new deadline Nov 22	RIA	2/3->4/5	11.5	34.5

Thank you



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Questions?

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