

Rise of the U-Bots

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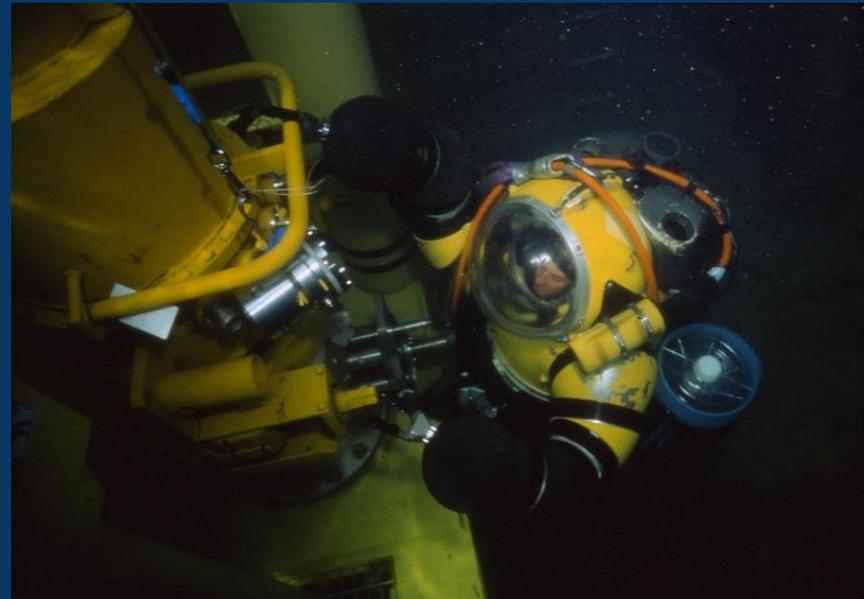
Who are the Society for Underwater Technology?

- International marine Learned Society & education charity, established 1966.
- Interested in diving, offshore energy, submersibles, salvage, policy, insurance, law, leisure, aquaculture, robotics, defence, mining & new 'blue economy'.
- Members in 40 countries, 8 international branches, 2k members, & growing.

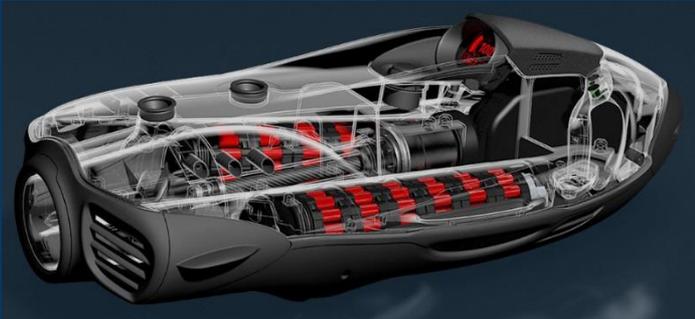


Divers – excellent in shallow water

- Human vision, intelligence & dexterity still the best in clear, shallow, warm water but efficiency & safety fall off quickly with depth, turbidity and cold conditions.
- 1-atmosphere suit avoids some of the shortcomings but requires lots of support services – becoming rarer in civilian use as ROV and AUV technology improves



Swimmer Delivery Vehicles & compact submersibles

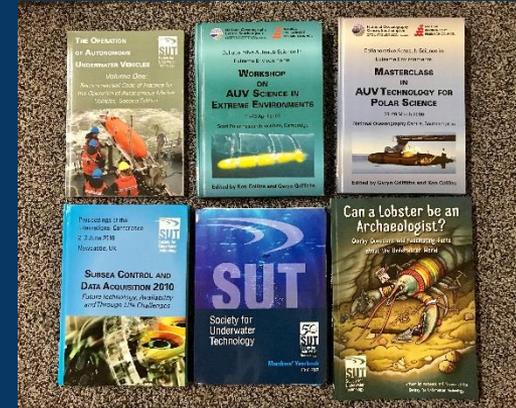


SUT involvement with Marine Autonomous Systems

- Worked with pioneers and early adopters since the 1980s
- Published earliest codes of practice including under ice operations
- Hosts the international Panel on Underwater Robotics
- Advocacy in UN system & with governments

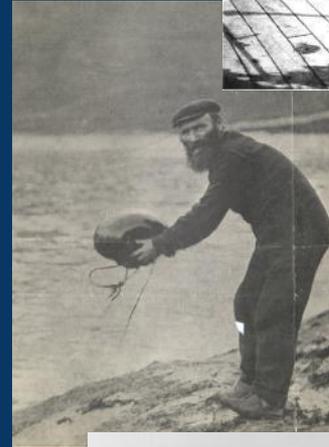


- Prof Neil Bose (Chair)
- Dr R Lewis (Secretary)
- Dr R Mills (Vice Secretary)
- John Allen
- Keith Birch
- Dr Mario Brito
- Prof Gwyn Griffiths
- Dan Hook
- J Jamieson
- C Kaminski
- A Lubbes
- Dr G Meinecke
- Dr J Operderbecke
- Dr A Philips
- Prof A Wahlin
- Dr Jingjing Xu



Autonomy isn't new

- Scientists have used drifting instruments for decades.
- A 'message in a bottle' was an effective means of communication (eg *St Kilda mailboat*)
- Many military uses...



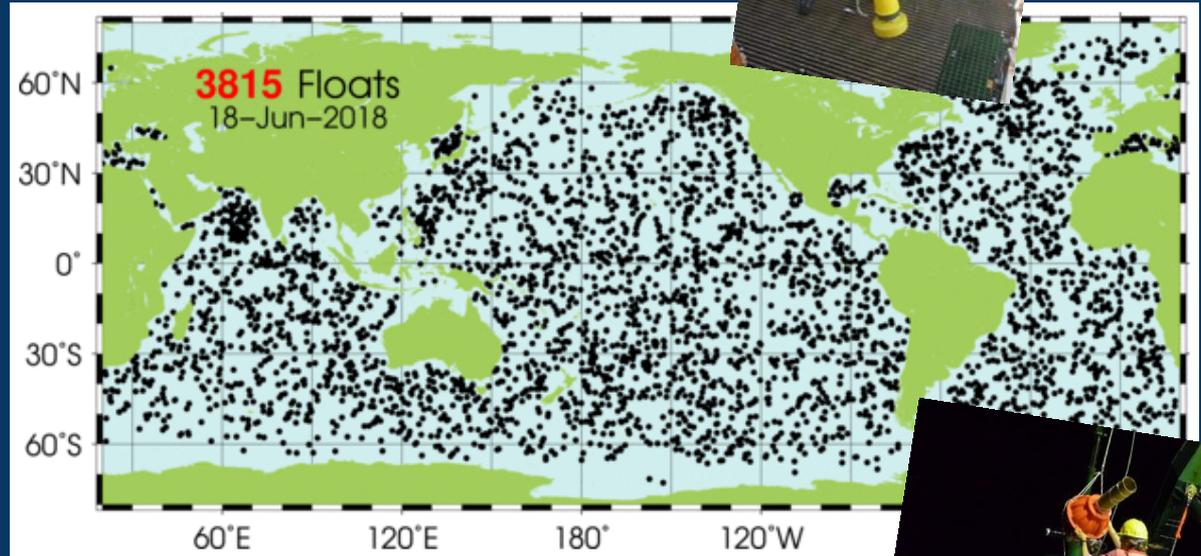
Going places humans prefer to avoid

- Under Ice operations
- Specialist hazardous tasks
e.g. nuclear reactor
inspection, mine clearance
- Winter weather & storms
- Contested waters

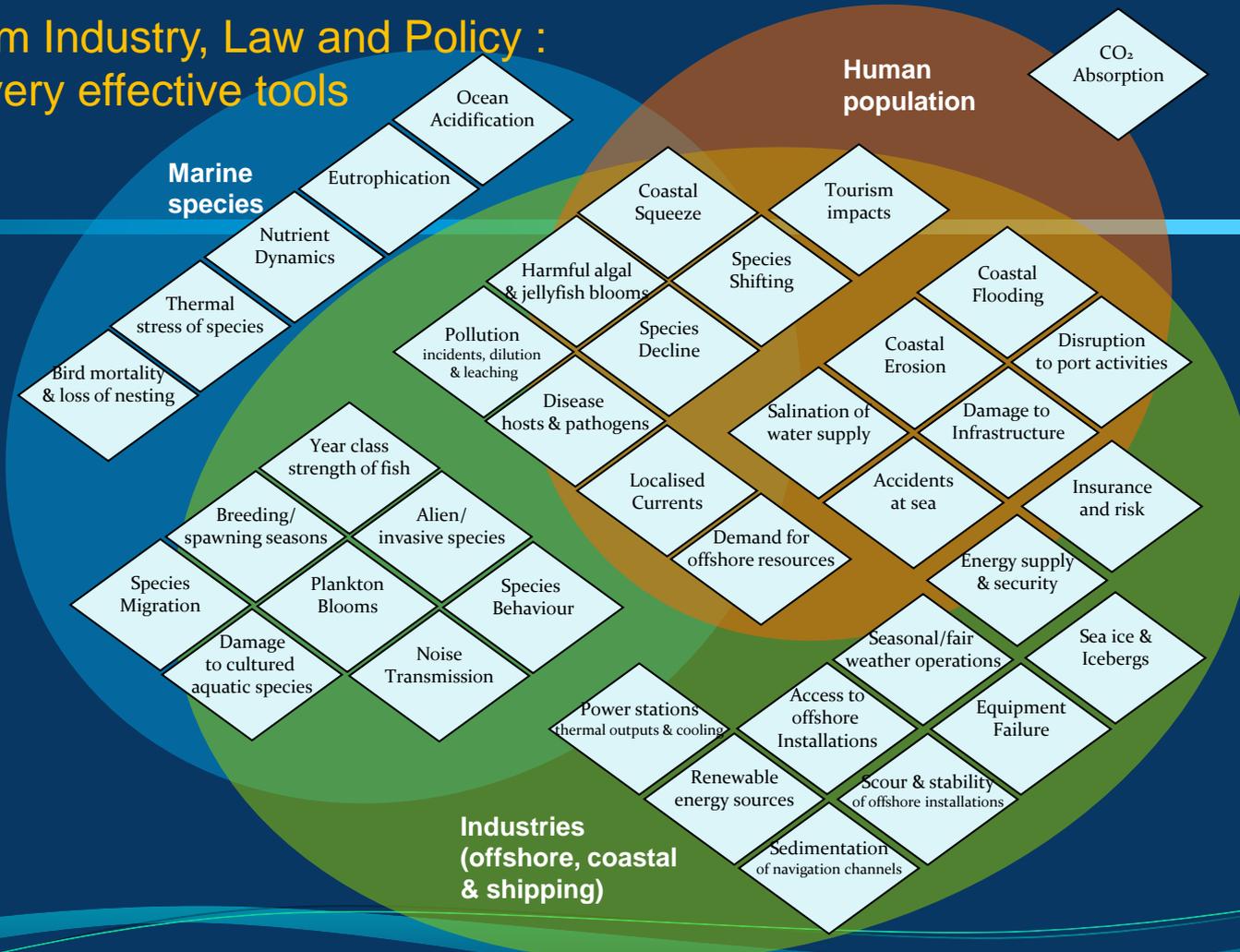


Repetitive survey & surveillance

- Climate monitoring
- ‘Mowing the lawn’
- Pipeline inspections
- CCS Reservoirs
- Statutory survey



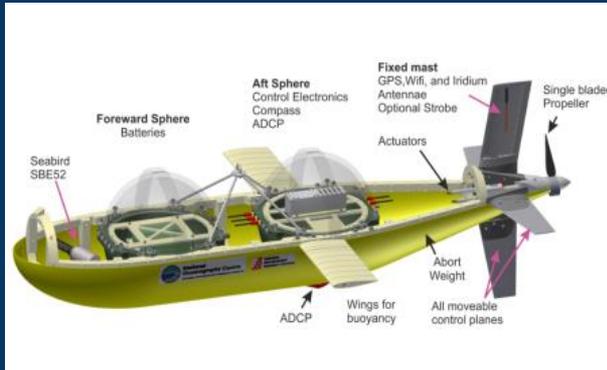
Data to inform Industry, Law and Policy : Robots are very effective tools





Autosub Long Range (ALR)

Mass	600 kg
Maximum Depth	6000 m
Maximum Range	6000 km and/or 6 months
Speed range	0.35 to 0.8 ms⁻¹
On-board energy (lithium)	29 kWhrs (primary)
Communications	Iridium & WiFi at surface
Standard Payload ADCP	CTD (SBE 52), 300 kHz



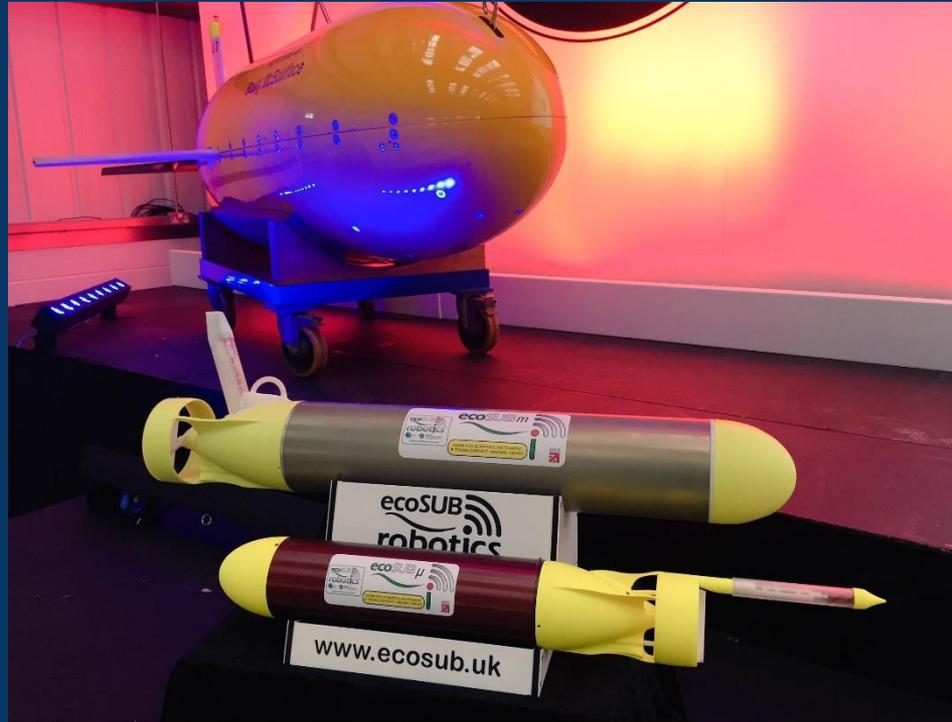


Stealth

- AUVs can be very hard to detect, and even harder to neutralise.
- They can be disguised to look like marine wildlife or driftwood.
- One company is using them for offshore diamond mining survey.



AUVs are getting smaller & less expensive



Emerging Technologies & Concepts

- Seabed data storage
- Carbon Capture & Storage
- High level nuclear waste storage*
- Seabed Hyperloop
- Offshore aquaculture
- Floating Wind & Solar power
- Offshore hydrogen production
- Seasteading & China-style artificial islands
- Novel sensors – eDNA a game changer
- Everything is getting smaller, cheaper & smarter...

* *currently illegal – but could change in future*



Project funding



Promoting innovation



KONGSBERG



LIQUID ROBOTICS



Joint operations



MASSMO3
Autumn 2016

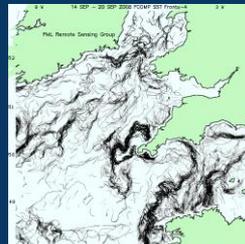
Public engagement



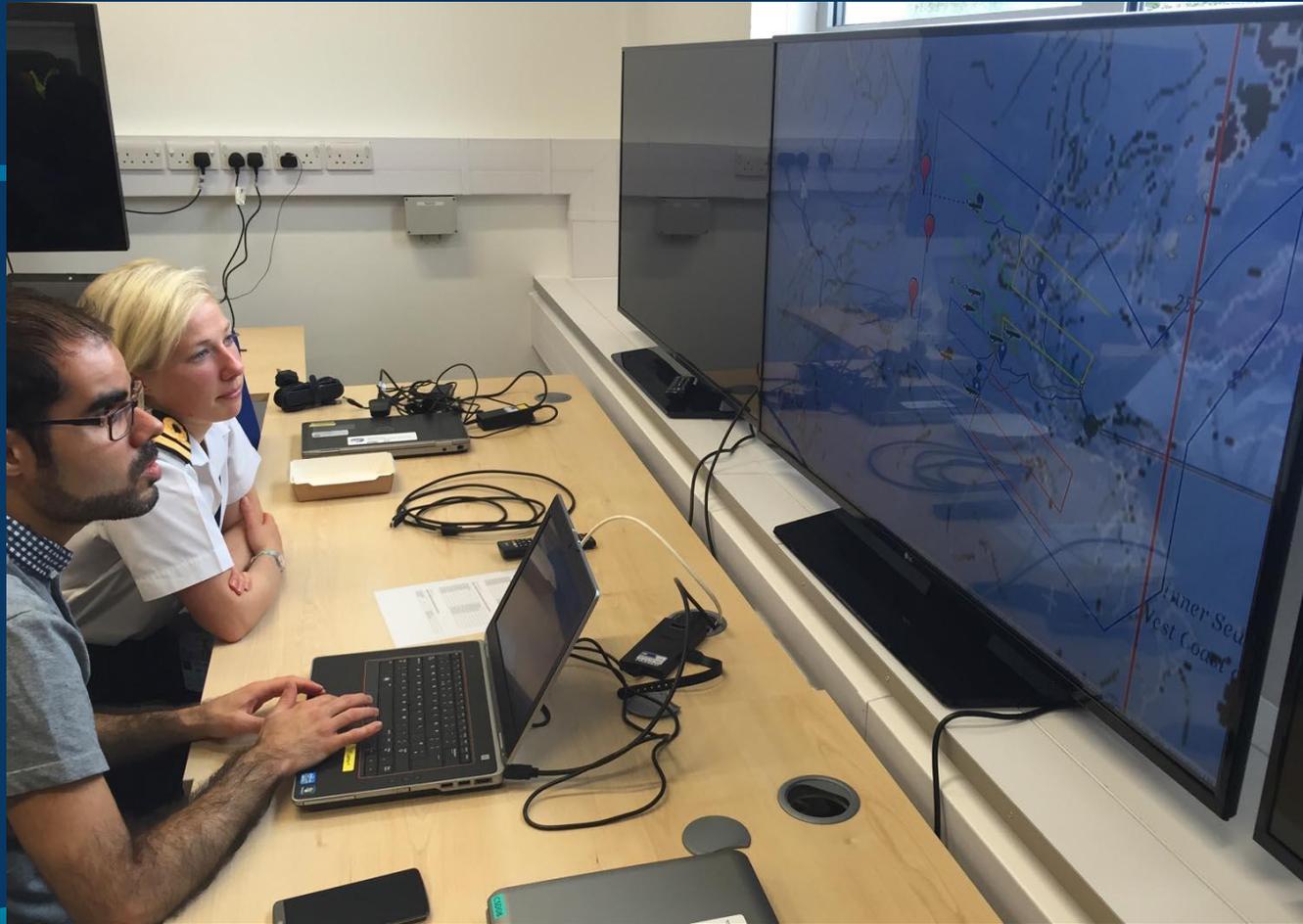
Data management



Operational products

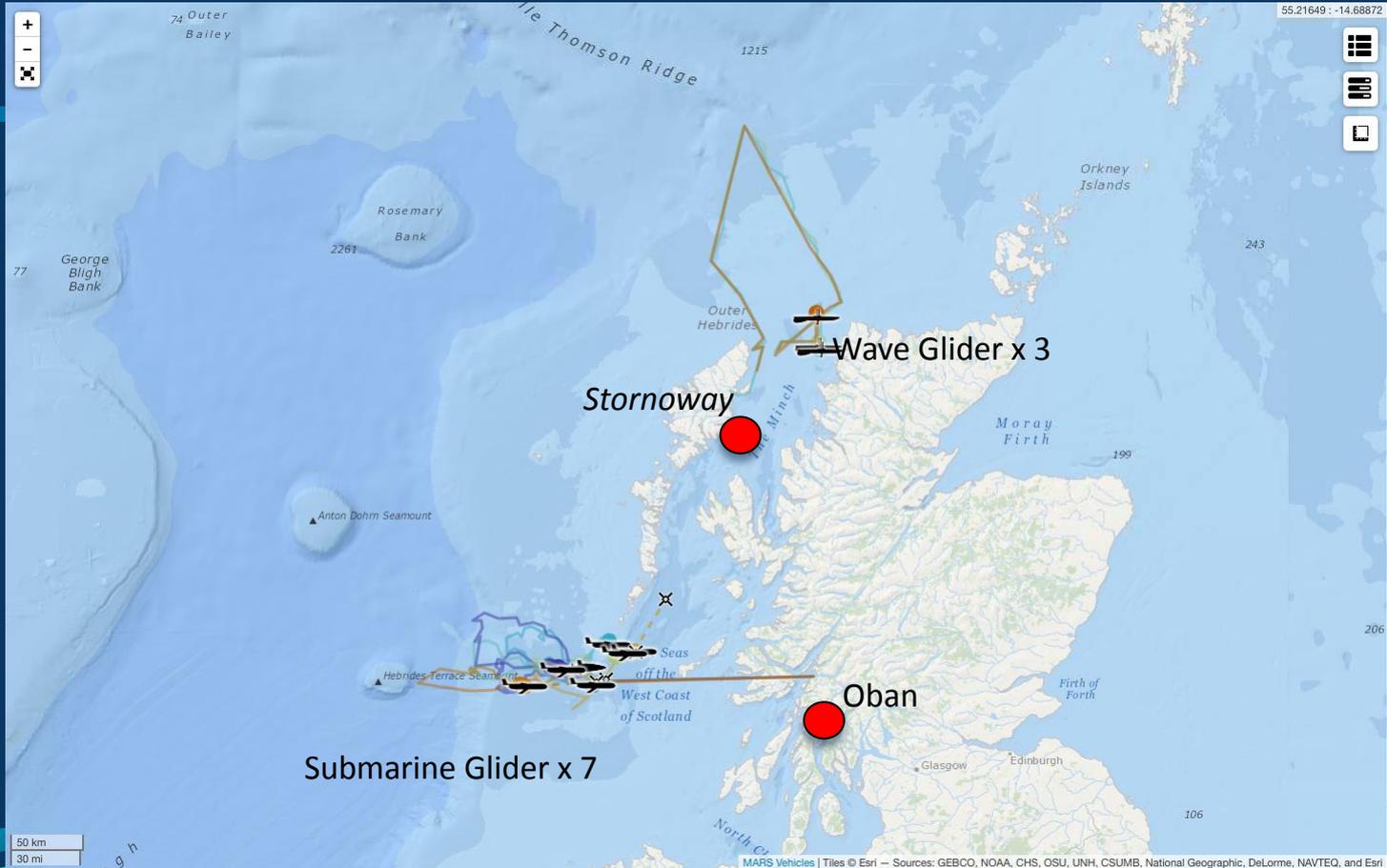


Civilian & Royal Navy MAS pilots practicing joint operation skills



The MASSMO3 fleet at 1220 hrs on 29 Sept 2016

First simultaneous deployment of operational MAS in UK waters



Global Internet cable network



Russia's significant investment in seabed warfare capability

Russian Seabed Warfare submarines.

GUGI, 29sqn, Olenya Guba – 2018

Host Submarines

BS-136 *Orenburg* (Pr.09786 DELTA-III STRETCH)



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PROPRIETARY

BS-64 *Podmoskovye* (Pr.09787 - DELTA-IV STRETCH)



Hosted Deep-Sea Stations

AS-12 *Losharik* (pr.10830)



AS-21 (Pr. 18511 PALTUS)



AS-23 (Pr.1851 X-RAY)



AS-35 (Pr. 18511 PALTUS)



Deep-Sea Stations

AS-15 (Pr. 1910 UNIFORM)



AS-33 (Pr. 1910 UNIFORM)



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BELGOROD

Project 09852 Special Mission Submarine



SHELF (ШЕЛЬФ) АТГУ

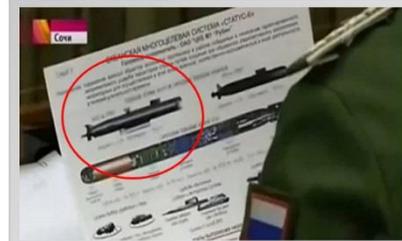
The АТГУ (Automated installation of the nuclear turbine generator) will be used to power underwater sensor network known as HARMONY

The АТГУ has an integral Pressurized Water Reactor, a small-sized turbine generator installation, a simple thermal-hydraulic circuit and the minimum of ancillary equipment. It is enclosed in a cylindrical 'Energoapsule' which is 14m (45ft) long and 8m (25ft) in diameter.

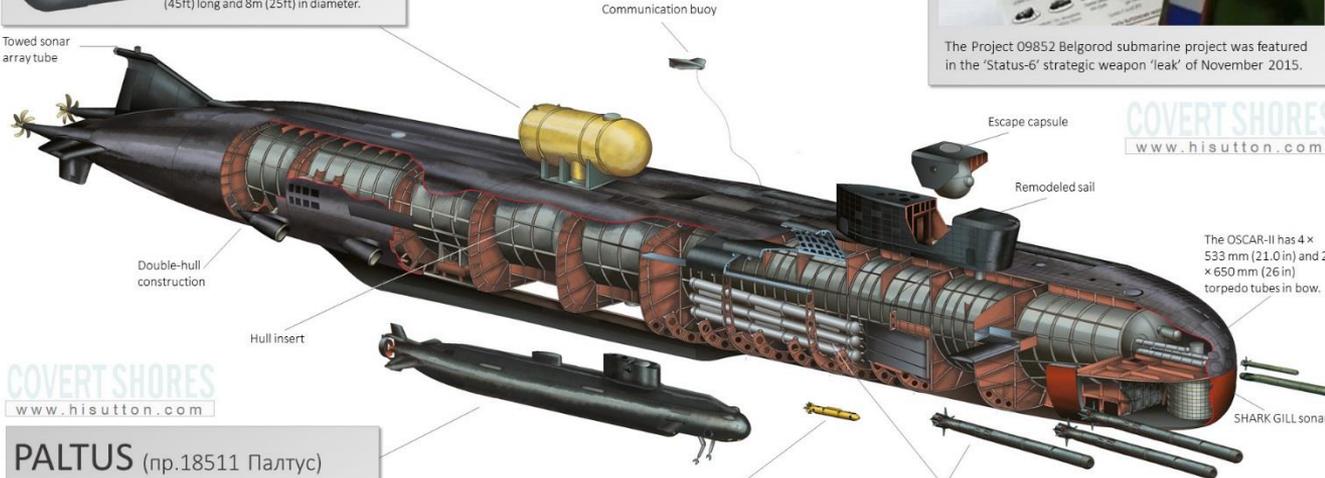


Russia is building the new HARMONY military complex deep under the Arctic, and is bringing the new KANYON strategic nuclear weapon into service. The massive new Project 09852 Belgorod submarine will play a key role in both projects. It will be the world's largest operational submarine when it enters service.

KC-139 Belgorod (KS-139 "Белгород") is an OSCAR-II cruise missile submarine which is being modified to serve as a Special Missions mother submarine (known as Project 09852). It will be crewed by the Russian Navy but operated under GUGI, the secretive *Main Directorate Deep Sea Research* organization. In order to conduct covert special missions, it will carry a deep diving midget submarine, large payloads and the new KANYON (Status-6) strategic nuclear torpedo weapon.



The Project 09852 Belgorod submarine project was featured in the 'Status-6' strategic weapon 'leak' of November 2015.



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PALTUS (пр.18511 Палтус)

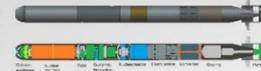
The Belgorod will carry a nuclear powered Deep Submergence midget sub, termed a deep nuclear station (AGS in Russian). These submarines dock with the underside of Belgorod and are used to place the АТГУ and other payloads on to the sea floor down to about 1,000m (3,000ft). The 70m long LOSHARIK can be carried in place of 55m long PALTUS shown.

Harpichord-2P-PM (Клавесин-2P-PM)

Belgorod can carry the Harpichord family of Autonomous Underwater Vehicles (AUV). These probably carry side-scan sonar and other sensors and can operate down to about 2,000m (6,000ft)

KANYON (Status-6)

Belgorod will carry up to six of the massive KANYON strategic weapons. These are nuclear powered and nuclear armed torpedoes which will be used as a second-strike deterrent.

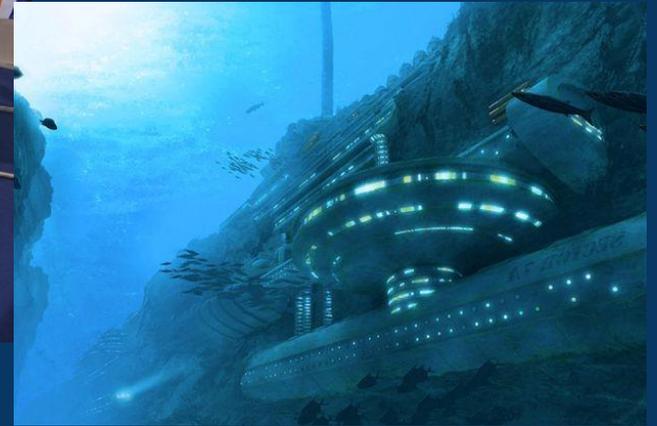


Some new USN Systems & Concepts

- Snakehead Large Displacement UUV
- Orca Long-Range AUV, fish-like AUVs
- Advanced Undersea Warfare System (AUWS) – distributed network of remotely controlled unmanned systems for battlespace shaping and A2/AD – *LaFave, 'Establish a Seabed Command' March 2018*
- Forward Deployed Energy & Communications Outpost (FDECO) – Fixed array of docking stations for recharge, data exchange with UUVs
- Modular Undersea Effectors System (MUSE) – Seabed mounted encapsulated payloads able to deploy weapons, decoys, comms nodes (aka STRIKEPODS) – *Strachan, 'Forward from the Seabed, March 2018'*
- Hydra – DARPA-led initiative for undersea network of payloads and platforms deployed from large UUVs
- Upwards Falling Payloads (UFP) – Similar to MUSE, a DARPA initiative for fixed payloads available for remote activation and deployment.



China making strong progress



Deep-sea Resources

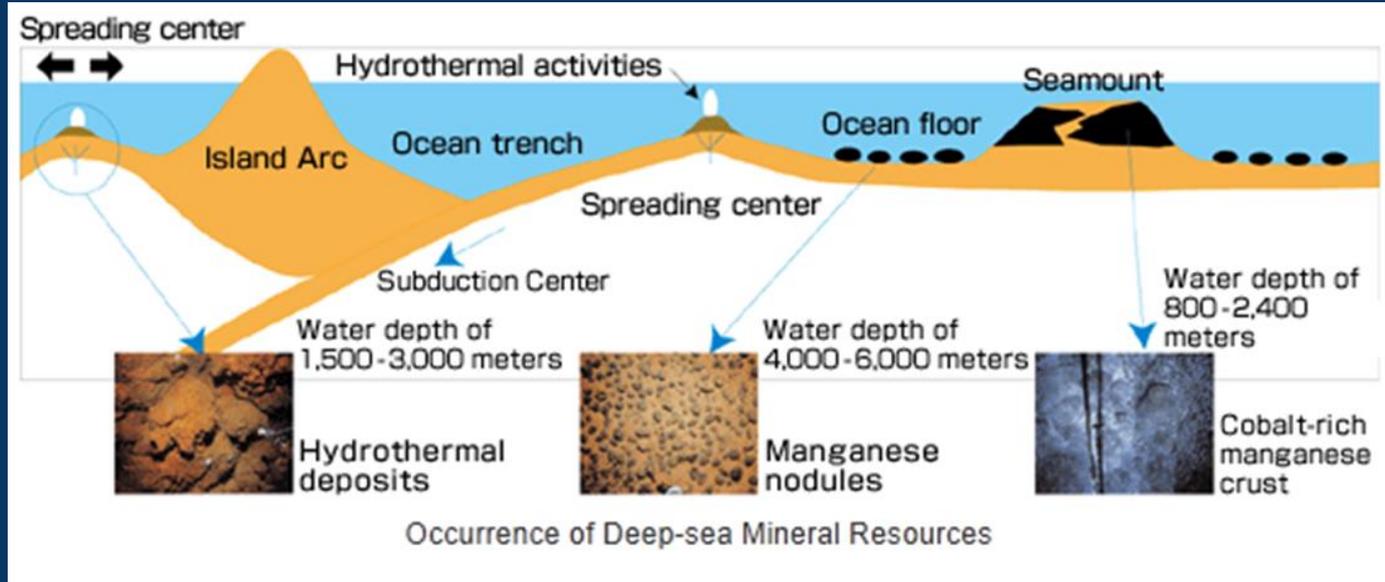
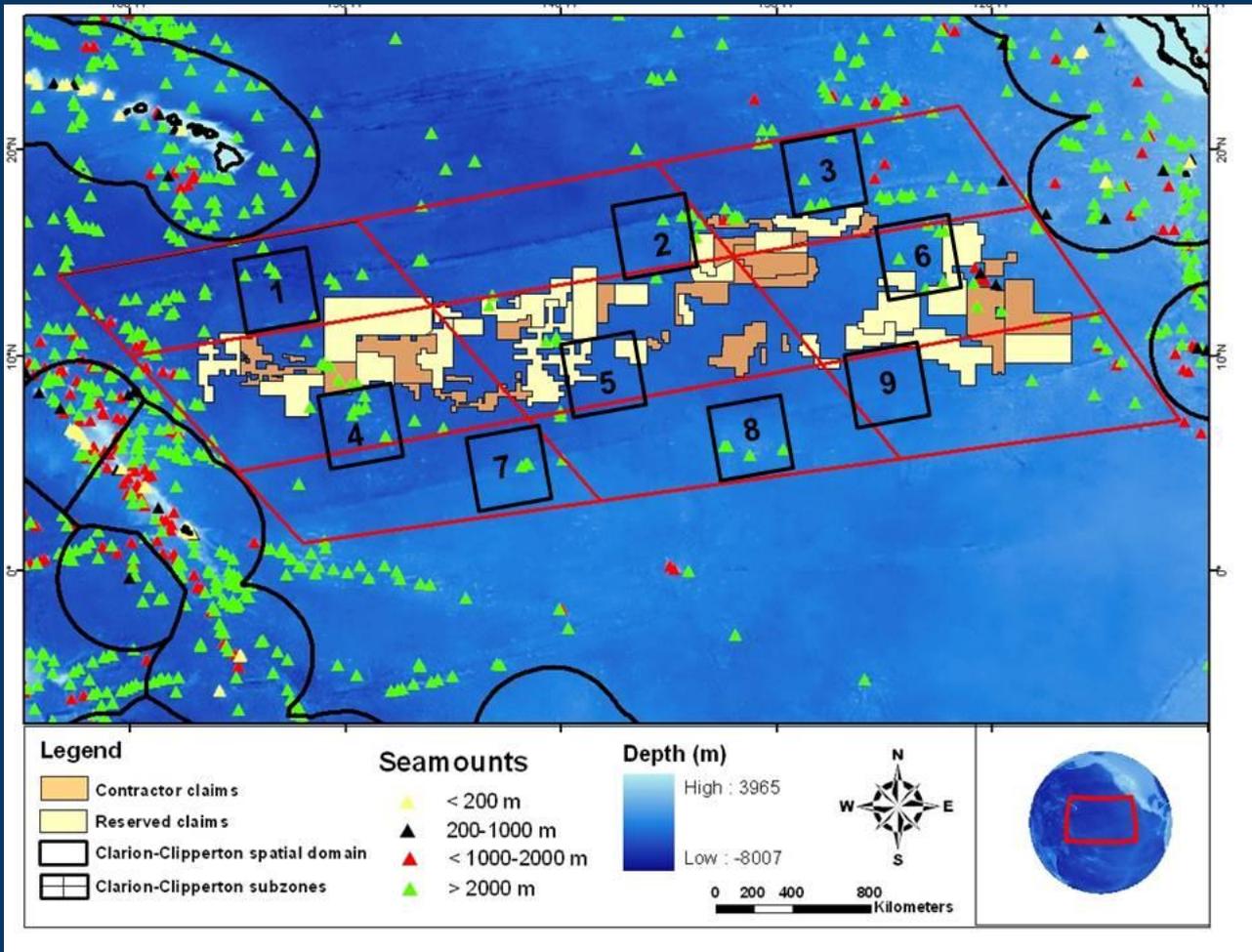


Diagram from JOGMEC



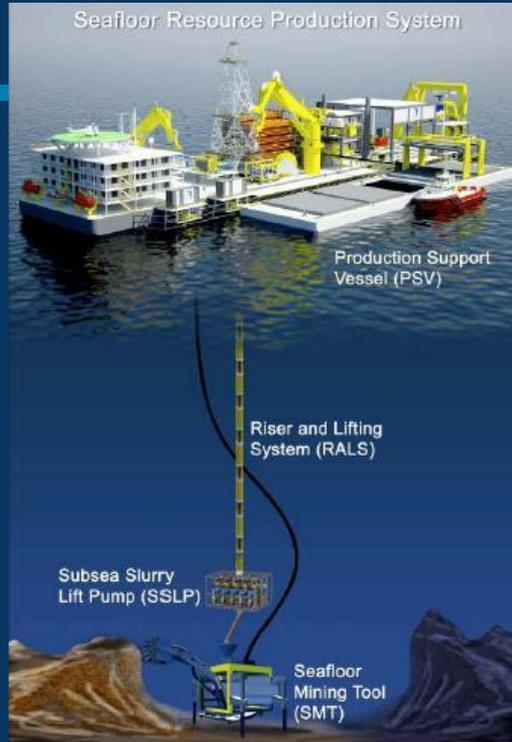
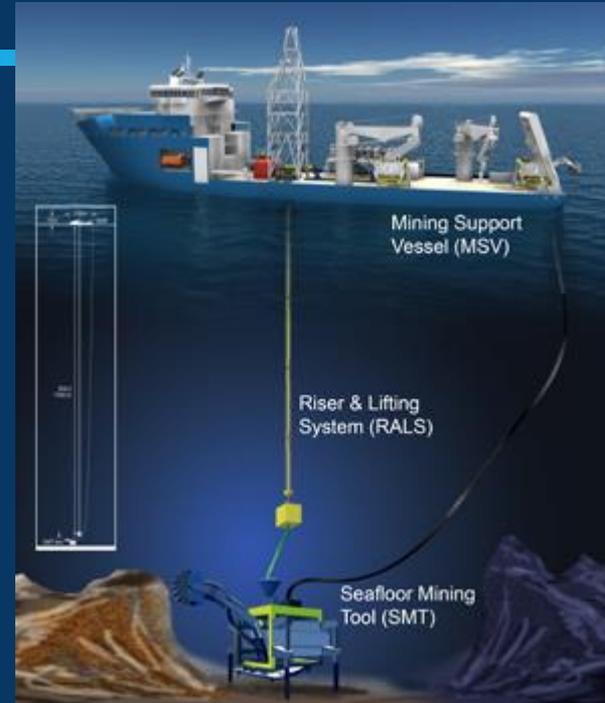


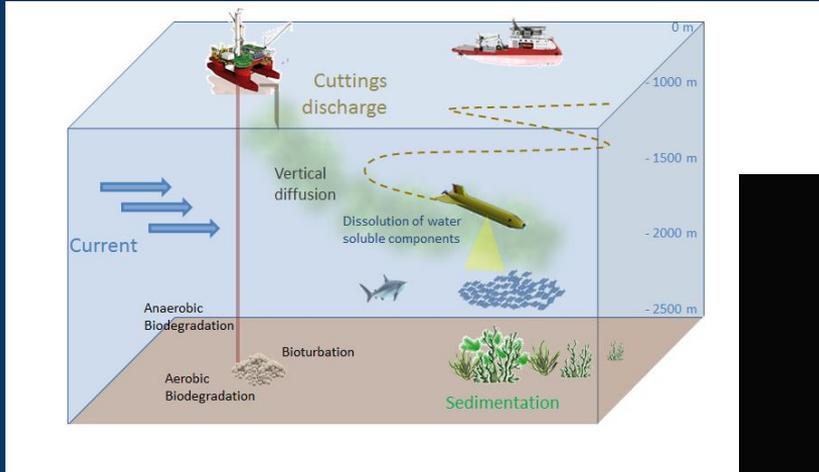
Figure 19-5: Seafloor Resource Production System





BRIDGES

BRINGING TOGETHER RESEARCH AND INDUSTRY FOR
THE DEVELOPMENT OF GLIDER ENVIRONMENTAL SERVICES



Barriers to overcome:

1. Command and Control

- Reliability and bandwidth of datalink, especially when submerged
- Resistance to jamming, satellite navigation ‘spoofing’ and other criminal interference – *how to navigate without GPS?*
- Resistance to hostile boarding and takeover by pirates or foreign agencies
- Ability to respond to calls for help from vessels in distress and render assistance
- ***How will true Artificial Intelligence change everything?***



Barriers to overcome:

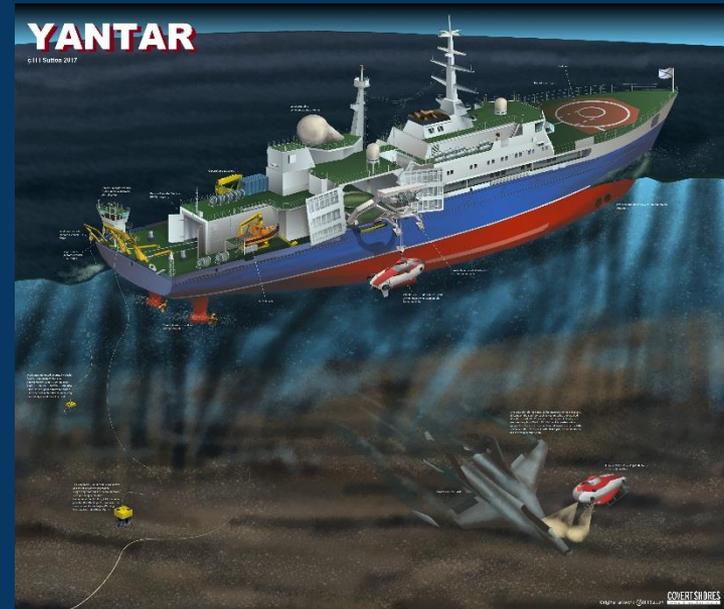
2. Legal and policy

- Insurance?
- Port of Registry
- Ownership
- Diplomatic Clearance
- IMO regulations
- SOLAS regulations
- Agreed training standards
- Liability
- Tracking



Defence Sector Special Interest Group

- Launching Q4 2018
- Membership by invitation.
- Restricted to NATO plus Australia & New Zealand.
- Focus on Marine Autonomous Systems and seabed-placed systems, & OSINT from civilian members.
- Forum for knowledge exchange between industry, research & defence communities.



Thank You

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