

Wargaming to investigate the utility of unmanned systems in a range of underwater tasking.

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- BAE Systems Submarines
- Complex Systems & Support

Why are BAE Systems doing OA

- Recognise the need to better understand the military use of the systems we provide
- Understand the options for the future underwater battlespace
- Judge how best to make our internal R&T/Product investments
- Understand how the systems we have designed, procured and deployed are performing in the real world – close the lifecycle loop
- MUFC
 - *"**Experimentation** provides a valuable environment to test hypotheses and understand the technology delta to focus research. However, many of these have traditionally been expensive to run and often demonstrate rather than test systems."*
 - *"Priority areas for Development: **a. Concept of operations and doctrine** – Playing to the strengths of the technology: persistence, flexibility, low cost and, avoiding one to one mapping with a novel project, and understanding integration requirement."*

How are BAE Systems Submarines doing OA

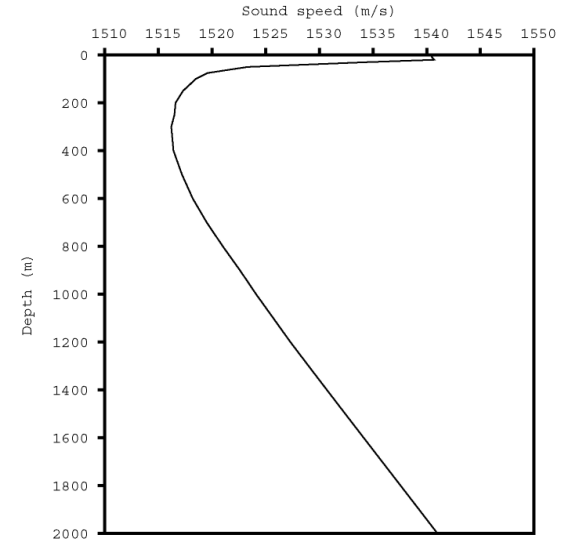
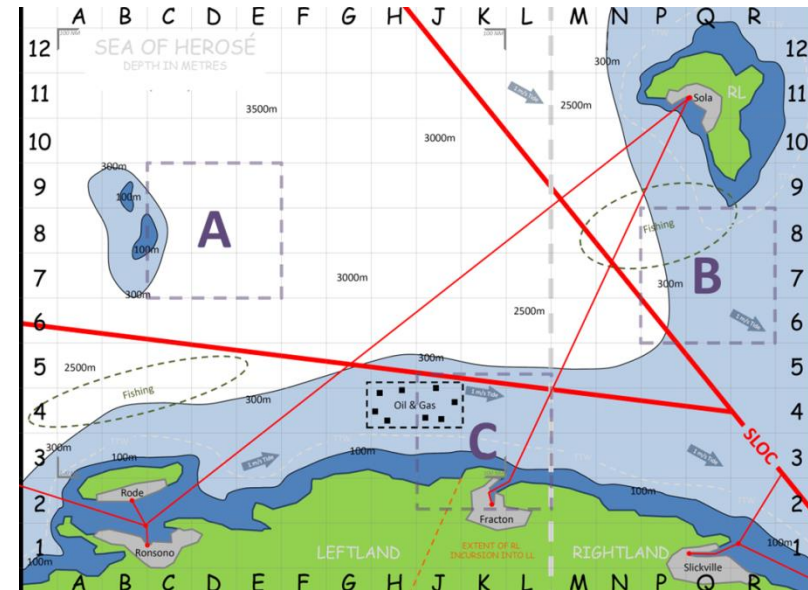
- Small teams developing techniques
 - Teams of OA expertise
 - Significant former submariner community
 - Drawing on wider expertise across BAE Systems (CORDA, Maritime Services)
- Conducted in support of internal R&T projects
- Initially looking at Soft OA
- Identifying needs for further Hard OA
- Increasing commercialisation of concepts (in support of Dstl)

UUV Wargame

- 2 separate teams of 7-9 individuals:
 - Mixture of technologists, engineers, scientists and former submariners
- 2 sessions:
 - Morning – RN Operators to generate understanding via scenario exploration
 - Afternoon – Technology insertion questions to identify opportunities
- Scenario deliberately simple to understand
- OPFOR deliberately equivalent (or superior) to challenge default thinking
- TESTEX absolutely essential to tweak questions, identify 'obvious' answers and understand team dynamics

Scenario Brief

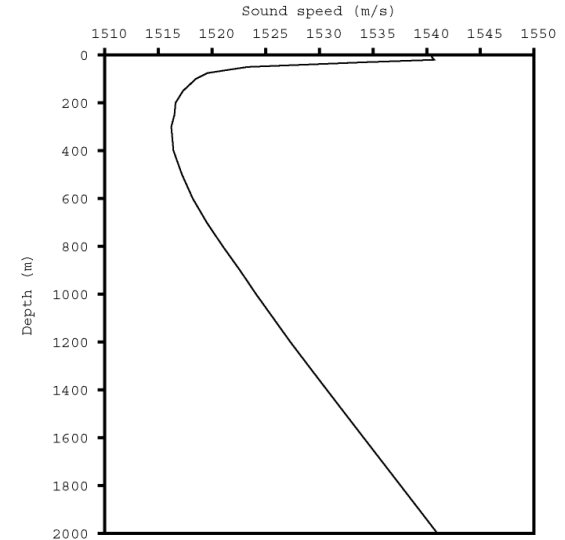
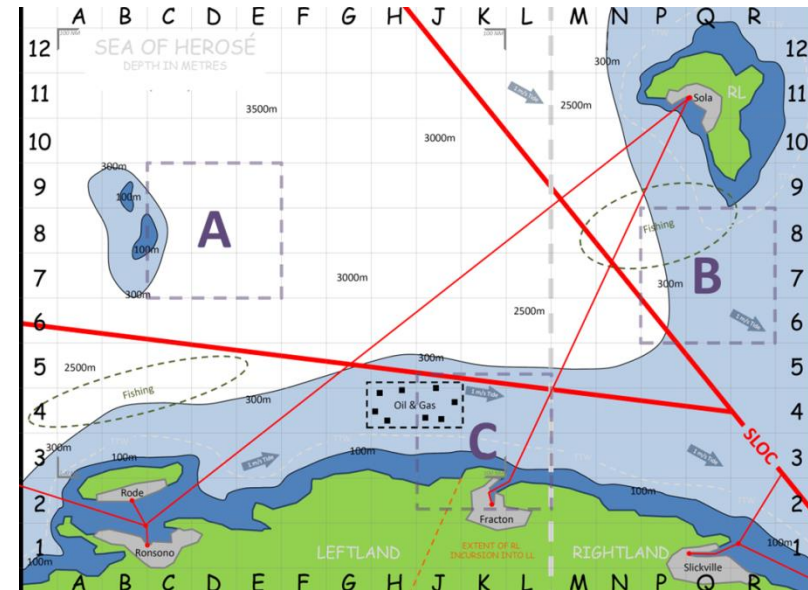
- Left Land (LL) and Right Land (RL) are two non-NATO countries. A conflict between LL and RL has been ongoing for two years.
- In a bid to gain control of oil and gas infrastructure in LL, RL have effective control of the LL region around the port of Fracton. Refugees are heading west and the security situation in LL is desperate, lawless and volatile.
- RL incursion into LL has brought forward UN Security Resolution 1969 to restore national boundaries and NATO forces have been tasked to drive RL forces back over the border.
- But before the Land campaign can commence, Alliance forces must overcome significant RL Ground Based Air Defence (GBAD) and Sea power which has established an effective region of Anti-Access/Area Denial (AA/AD).



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Scenario Brief

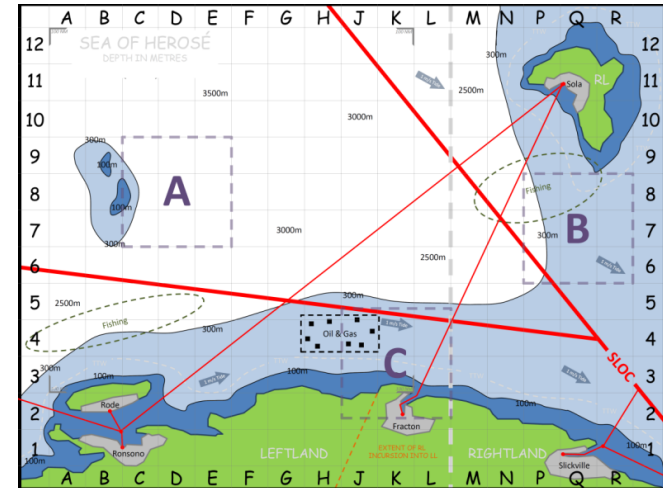
- Intelligence reports that RL has 1 submarine and 1 helo equipped OPV patrolling the Sea of Herosé.
- As part of this effort you are to remove the threat of the RL submarine from the Sea of Herosé, in preparation for mine warfare and amphibious operations.
- RL Rules of Engagement (RoE) are unknown, but recent history has demonstrated that RL can be aggressive and unpredictable.
- Your Rules of Engagement (RoE) are to drive RL submarines into RL waters, you have the right of proportional response and self defence.
- The chart provided marks out your Area Of Interest (AOI)
- The region is in the North Atlantic and it is now April.
- You enter the region at A12.
- Your Aim: to search and potentially prosecute.



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Scenario design considerations

Scenario Brief	
Strength	Weakness
<p>Straightforward naming convention – e.g. Left Land.</p> <p>No unnecessary material.</p> <p>Can be quickly understood – this is important given limited time.</p>	<p>Does not allow for synonyms and naming ambiguity that may confuse the warfighter.</p> <p>Does not test the warfighter in sifting out relevant information.</p>



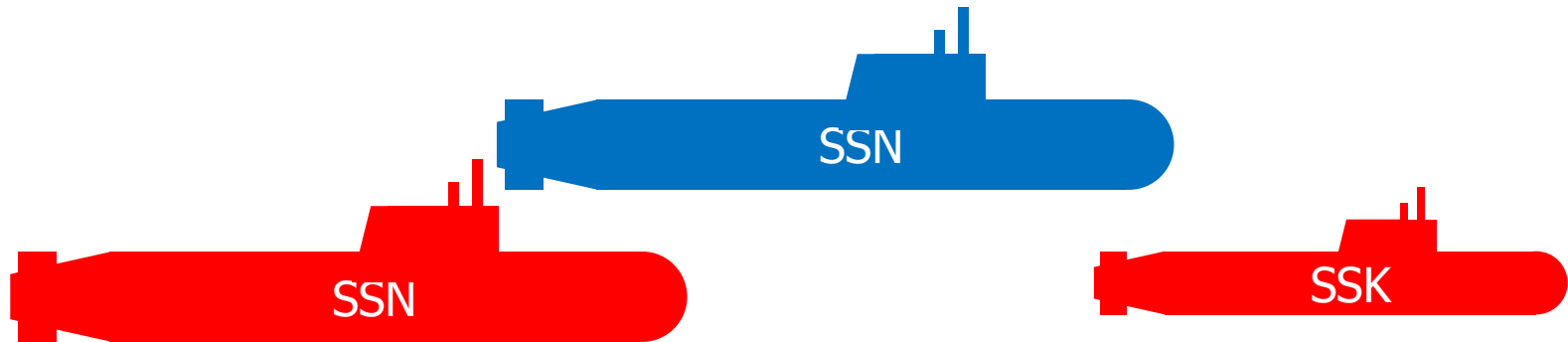
Fictional Chart

Strength	Weakness
<p>Avoids a single participant dominating conversation through intimate experience of a real-world area.</p> <p>All participants start with the same knowledge.</p> <p>Allows the game designer to have absolute control over a environmental stimuli.</p> <p>Allows the game designer to introduce a wide range of stimuli in compact form, that may represent a number of environments in the real world.</p>	<p>May be unrepresentative of the real-world, i.e. care needs to be taken to ensure a realistic physical and human environment</p>

Scenario Brief

Criteria	BLUFOR	OPFOR (Group X)	OPFOR (Group Y)
Type	 SSN	 SSN	 SSK
Length	85.4m	113m	58.5M
Beam	9.8m	13.6m	6.1M
Draft	9.5m	9.7m	5.6M
Std Displacement	4740 tons	8470 tons	1150 tons
Full Displacement	5208 tons	13400 tons	1300 tons
Crew	97	73	28
Max Depth	300M	450m	300M
Weapons	15x Torp	16x 533mm Torp, 16x 650mm Torp	6x 400mm Torp (80's), 6x 533mm Torp (80's)
DAS	Acoustic Decoys	Acoustic Decoys	Acoustic Decoys
Max Speed	32kts	35 kts	20 kts (AIP) 10kts (Diesel)
Range	Unlimited	Unlimited	AIP 200 hrs, Battery 100 hrs
Nominal SPL @ 100Hz	100dB	100 dB	96dB

Platform inject considerations



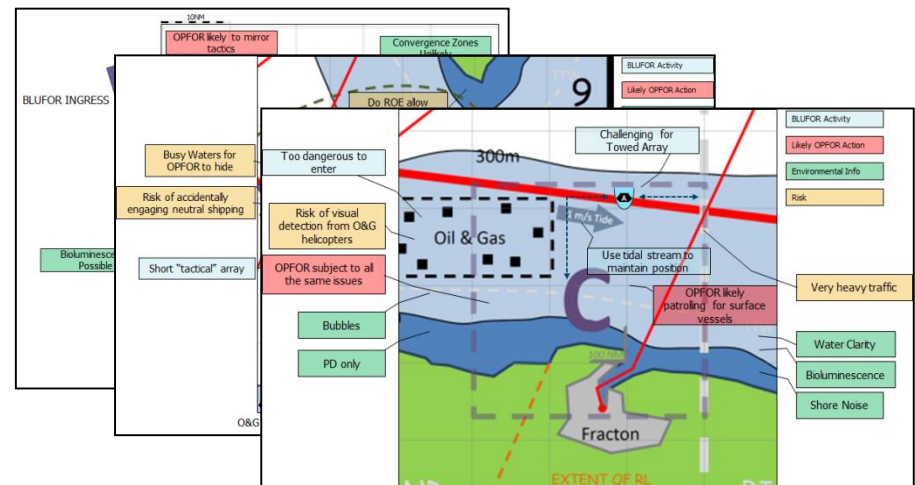
Platforms	
Strength	Weakness
<p>Fictional boats! a few key parameters describe the platform in compact form. (avoids single "expert" domination)</p> <p>Max Depth, Max Speed, Weapons and SPL seen as particularly useful stimuli.</p> <p>Blue Platform Participants advised that sensor fit equivalent to T Class</p> <p>Red Platforms Explore how an engagement with an equivalent SSN differs to an quieter but slow SSK.</p>	<p>No capability statement presented for the OPV (but participants filled gaps adequately)</p> <p>Given that groups considered the SSN or SSK, there was no opportunity to compare group findings based in identical injects. (but the game will be repeated in Barrow in July)</p>

Morning Session Generate Understanding

- Q1 - Who are the stakeholders in UK SSN operational deployment, what is their role and what information do they provide/require?
- Q2 - What are the distinct phases of an SSN operational deployment?
- Q3 - How will you exploit this environment (opportunities and challenges)?
- Q4 - Story board the phases of the engagement

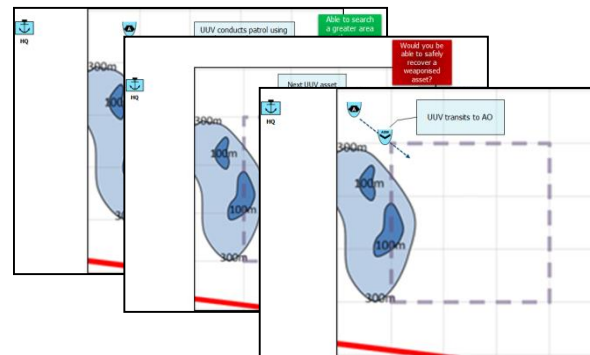
CATEGORY	HARBOUR	WATER	TRANSIT	PATROL
Phase Transition	Along the open sea	Along the coast	Along the coast area (200m-400)	At Inland
Typical Duration	Short	Short	Long	As Required
Features				
Tide				
Depth	Shallow	Deep	Shallow	Deep
Speed	Very Slow (<5kts)	Slow (5-15kts)	Very Slow (<5kts)	Slow (5-15kts)
Characteristics				
Sea state Characteristics	Sea state Characteristics (2-3m)			
Light	Tactical, Visual & Administrative	Tactical, Visual & Administrative	Tactical, Visual & Administrative	
Visibility				
Weather	Dependent on location & other vessels			
Other Vessels				
Other Assets				
Submarine Assets				
Maritime Assets				
Maritime Assets				

CATEGORY	WATER	TRANSIT	PATROL
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Other Vessels			
Other Assets			
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Afternoon Session Technology Choices

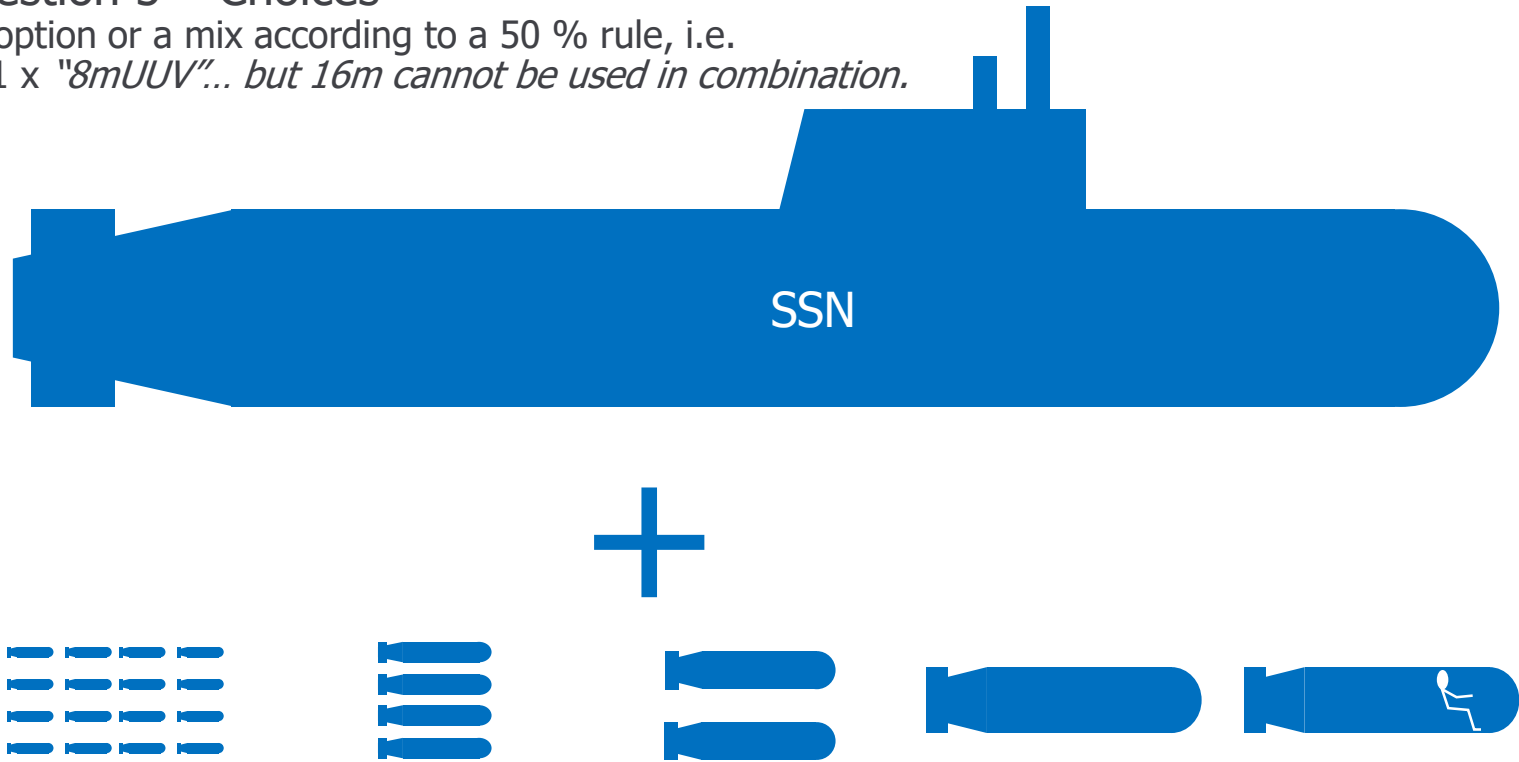
- Q5 - Rate these technologies against the mission aim* in environment A
- Q6 - Select a technology option and develop a CONEMP, as a set of steps, for environment A
- Q7 - Provide 3 strengths for your chosen capability that support the mission aims, and 3 research questions that need to be answered to assure an effective capability.
- Q8 - As OPFOR (RED) Maritime Commander and with reference to the Capability provided, suggest 3 weaknesses that will help you gain military advantage. (Recall that you have access to a submarine and OPV with Helo)



Inject for Question 5 – Choices

Choose a single option or a mix according to a 50 % rule, i.e.

2 x "4mUUV" + 1 x "8mUUV"... but 16m cannot be used in combination.



	< 1m SWARM	4m UUV	8m UUV	16m UUV	16m Midget
Qty. (#)	64	4	2	1	1
Endurance (days)	<1	1.5	4	>8	>8
Max Speed (m/s)	<1	3	6	8	8
Max Depth (m)	300	1500	6000	1500	300

Question 5: Rate these technologies against the mission aim* in environment A.

	<1M Swarm	4M UUV	8M UUV	16M UUV	16M Midget
Quantity	64	4	2	1	1
Endurance (days)	<1	1.5	4	>8	>8
Max Speed (m/s)	<1	3	6	8	8
Max Depth (m)	300	1500	6000	1500	300
Launch and Recovery Considerations	★★★★★ Fire and Forget, Disposable. Launch through SSE. Environmental concerns.	★★★★★ Able to be launched from CHF/Casing/Tubes. Park on bottom for recovery. Similar to Talisman TDP.	★★★★★ Size challenge for CHF. Launch and recovery from casing/tubes. More challenging to recover.	★★ Likely difficult and noisy to recover. Could be recovered by another asset. Only on-sub option is from the casing	★★★ Human in the loop makes recovery easier. Driver able to maintain tactical state. Casing launch & recovery
Replenishment Considerations	★★ Non-recoverable and not replenishable at sea. May need to operate swarm in batches due to short battery life. Battery safety considerations.	★★★★★ Recoverable via CHF and rechargeable from the plant. Could be fire & forget if cost low enough. Battery safety considerations.	★★★★★ Recoverable via CHF and rechargeable from the plant (may need custom dock). Battery safety considerations.	★ Unlikely to recover onto submarine (too big). Docking option?	★★ Unlikely to recover onto submarine (too big). Docking option? Human pilot makes docking safer/easier.
Payload SWAP Capacity	★★ "Sensors - single hydrophone or very small array. Effectively a mobile sonar buoy. Weapons - Nil"	★★★ Text="Sensors - small active/passive sonar array; simple optronics. Weapons - Archerfish/Stingray"	★★★★★ Text="Sensors - moderate size active/passive sonar array; simple optronics. Weapons - medium size torpedo/Archerfish/Stingray"	★★★★★ Text="Sensors - capable active/passive sonar array; capable optronics. Weapons - Spearfish/Archerfish/Stingray"	★★★★★ Text="Sensors - capable active/passive sonar array; capable optronics. Weapons - Spearfish/Archerfish/Stingray"
Likely Level of Autonomy	★★ Swarm characteristics. Intelligence limited more by sensors than computational power. Could be wired together.	★★★ More capable due to improved sensors. Greater processing power.	★★★★★ More capable due to improved sensors. Greater processing power.	★★★★★ Highly capable due to improved sensors. Greater processing power.	Nil - man in the loop
Likely Communications (C2)	Laser; Acoustic; VHF; Satellite; Optical; Power limited	RF; Shore Data Line; GPS; Laser; Acoustic; VHF; Satellite; Optical;	RF; GPS; Laser; Acoustic; VHF; Satellite; Optical;	RF; GPS; Laser; Acoustic; VHF; Satellite; Optical;	No required for C2. I&W only. Communication with HQ not own SSN.
Search Performance (coverage and persistence)*	★★★★★ Good, but only single use. Assets will be slow to deploy. May need more units to search reasonable area. 1000NM	★★★★ Reasonable - can maintain an asset in the area by cycling them, but sensors performance isn't great. 200NM	★★★★ Better sensors but cannot remain on station. 600NM	★★★★★ Very good search range and endurance. 800NM using Flank and Towed array.	★★★★★ Very good search range and endurance. 800NM using Flank and Towed array.
Prosecution performance (Hard and Soft)*	Nil / Noisemaker only	★★★★ Capable of damaging/crippling SSN. Likely ineffective vs surface vessels.	★★★★★ Capable of carrying significant weapons loads. Highly effective against subsurface threats. Capable of engaging limited surface vessels.	★★★★★ Highly credible threat due to spearfish capability	★★★★★ Highly credible threat due to spearfish capability
Safety Considerations	▲▲▲ Likely low risk of damage due to collision. Concerns predominantly environmental	▲▲▲▲ Likely low risk of damage due to collision. Risk of recovering armed asset. UUV could fall into propulsor.	▲▲▲▲▲ Moderate risk of damage due to collision. Risk of recovering armed asset. Likely noisy to recover.	▲▲▲▲▲▲ Significant risk of damage due to collision. Risk of recovering armed asset. Likely noisy to recover.	▲▲▲▲▲▲ Lower risk to boat due to human pilot, but higher risk of loss of life to pilot.
Stealth Considerations	🔊🔊🔊🔊 Risk of capture (accidental/intentional) highly likely. Active sensor & comms detectable.	🔊🔊🔊 Risk of capture (accidental/intentional) moderate. Tamper alarm required. Active sensor & comms detectable.	🔊🔊🔊 Risk of capture (accidental/intentional) moderate. Tamper alarm required. Active sensor & comms detectable.	🔊🔊🔊 Risk of capture (accidental/intentional) moderate. Tamper alarm required. Active sensor & comms detectable. Hydrodynamic impact on larger UUVs. Aim for fairing.	🔊🔊 Risk of capture (accidental/intentional) low. Pilot making tactical decisions. Active sensor & comms detectable. Hydrodynamic impact on larger UUVs. Aim for fairing.
Likely Cost	🕒 <£100k - Still too expensive for disposable assets	🕒🕒 roughly £100k (plus weapons & sensors)	🕒🕒🕒🕒 roughly £7M-10M (including weapons & sensors, based on Proteus AUV)	🕒🕒🕒🕒🕒 Estimated £200M (including weapons & sensors, based on Echo Voyager funding)	🕒🕒🕒🕒 Likely similar to 16M UUV as costs driven by sensors & weapons

Summary Findings for Question 5:

Rate these technologies against the mission aim in environment A.?*

- Launch and recovery
 - Swarm may be launched via SSE
 - 4m and 8m UUVs may be launched from the torpedo tubes
 - 16m platforms required casing launch
 - Swarm and 4m UUVs may be considered disposable
 - 8m and 16m need not be recovered by SM, useful in the case where the unit has been armed or might have been tampered with.
- Scales with unit size:
 - SWAP – greater capacity in larger UUVs.
 - likely level of autonomy – greater capacity for more sophisticated processing given better sensors
 - safety considerations – larger UUVs present bigger risk of own-ship damage.
 - search performance - greater capacity for larger apertures and processing
 - prosecution performance - greater warhead capacity.
- Scales inversely with unit size,
 - Requirement for communication, i.e. small units required to communicate more frequently.
 - Stealth, i.e. small units are likely to be picked up/lost.

Concept Development

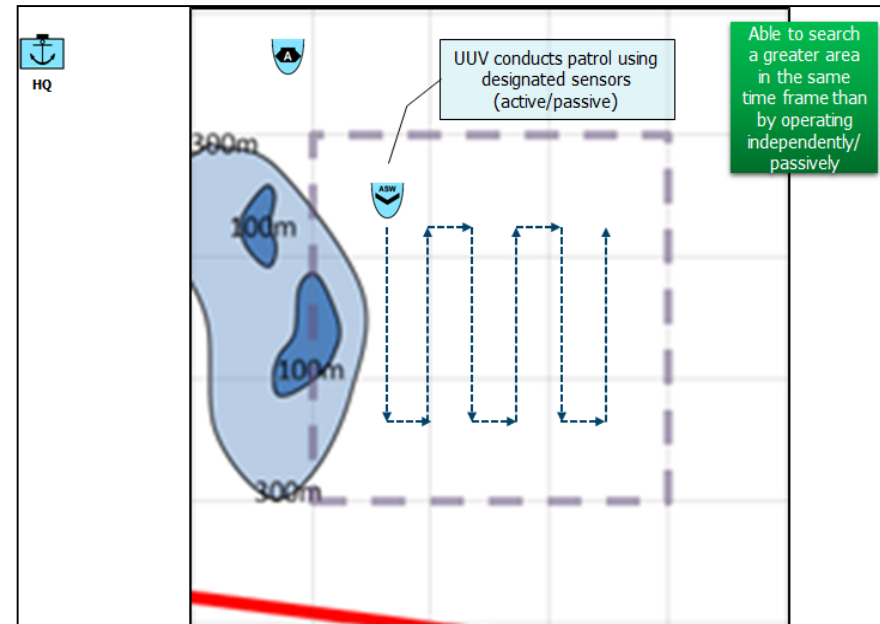
Questions 6,7 and 8

- Question 6: Select a technology option and develop a CONEMP, as a set of steps, for environment A.
- Question 7: Provide 3 strengths for your chosen capability that support the mission aims, and 3 research questions that need to be answered to assure an effective capability.
- Question 8: As OPFOR (RED) Maritime Commander and with reference to the Capability provided, suggest 3 weaknesses that will help you gain military advantage.
(Recall that you have access to a submarine and OPV with Helo)

CONEMP

Both groups developed CONEMP suggestions

- Outputs as a series of slides (as per example)
- Generated research questions around:
 - Communications
 - Authority to act
 - Capability
 - Logistics
- Useful output for simulation & modelling evaluation



SETTX Conclusions (Redacted)

- Submarine C2 is complex
- Submarine CO has significant autonomy
- Risk of grounding and collision dominant in congested littoral waters.
- Environment is a significant influence on decision making.
- Unlikely that two Commanders will exploit the environment in the same way.
- Challenging to obtain FCS and classification evidence.
- SWAP dictates performance and scales with UUV size.
- Communication and stealth scales inversely with UUV size.
- Many useful research goals that may be pursued further through modelling and simulation

END