Layered Anti-Submarine Warfare Operations Reimagined

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Abstract — Recognising the established doctrine of a layered approach to Anti-Submarine Warfare within the Underwater Battlespace, this paper seeks to explore innovative and disruptive approaches to current and future actors and effectors, enhancing overall capability. Seeking to stimulate discussion within the underwater sector, this paper will address:

- Descriptions of what constitutes the various layers of an engagement, from both an offensive and defensive perspective, and how the boundaries between them are defined;
- Descriptions of the different actors and effectors that could be deployed at each stage, with reference to the capabilities and enabling technologies;
- The interoperability between all actors and effectors, and how this can be exploited as a force multiplier to improve overall effectiveness, with a consideration of any design or functional changes and key technology enablers required to achieve this.

This concept will be presented through the use of sample vignettes, designed to demonstrate this approach within the context of realistic scenarios, painting a picture of engagements from an operational perspective. This will compare and contrast scenarios to highlight the potential benefits leveraged through application of these novel approaches, taking advantage of improved operational flexibility, increased stand-off and speed of effector delivery.

1. Introduction

The submarine threat is ever increasing, becoming more versatile and threatening in recent years. The proliferation of conventional submarines by smaller nations provides significant capability for a relatively low investment, potentially increasing their ability to limit freedom of manoeuvre of NATO maritime forces. As demonstrated by the 2010 sinking of the ROKS Cheonan, on any given day, any given submarine, no matter how crude or unsophisticated, can sink nearly any surface ship.

The Allied Anti-Submarine Warfare (ASW) manual ATP-28 [1] states the following factors as having a fundamental influence on ASW operations:

- Submarines are fundamentally difficult adversaries. They operate below the surface of the sea; they are manoeuvrable and can rapidly change speed and depth;
- The location of a submarine may only become known after it poses an immediate threat or has conducted an attack;
- The anti-submarine warfare commander may be far from any particular scene of action. Therefore, significant responsibility may be delegated to lower ranks or units;
- Action may require coordination from a wide range of ASW units to deliver effect;
- Situational awareness of both red ASW targets and blue ASW assets is critical. Acoustic detection and counter-detection ranges are subject to significant variation with environmental conditions and equipment.

ASW missions may be concerned with searching for, screening against, placing barriers to or avoiding red submarine platforms. These operational objectives may be achieved through the employment of tactics which fundamentally seek to detect, deceive, and/or deter the red submarine platform.

It is important to note that ASW engagements lack any meaningful method of Rules of Engagement escalation. In a surface engagement, initial VHF warnings may be escalated through a shot across the bow, further VHS warnings, non-disabling fire, disabling fire and ultimately deployment of a hard-kill effect. In a subsurface engagement, the single and limited option for escalation prior to deployment of hard-kill effects is through active sonar transmissions.

In addition to developments in conventional large submarines (e.g. SSBN, SSN, SSK), there is an increasing threat of smaller shallow water threats such as midget submarines and XLUUVs; swimmer deliver vehicles; semisubmersibles (e.g. the North Korean Taedong-B or Iranian Kajami) and fast inshore attack craft (e.g. Iranian Zolfaghar). Threat weapons are also expected to have developed, with extended ranges, advanced homing, multimode operations and counter-countermeasure logic far surpassing that of previous generations. As such, it is critical that modern navies are capable of meeting modern threats with equal capability as a minimum.

Comparing the ASW approach of yesterday with the conceptual ASW of tomorrow, this paper provides a very
basic outline of ASW doctrine and then describes new technologies and concepts which may offer the opportunity to close capability gaps. The intent of the paper is to stimulate discussion and identify where novel disruptive technologies may offer a capability enhancement to ASW engagements.

2. Layered Anti-Submarine Warfare

The concept of ‘full spectrum ASW’ [2] recognises that ASW should be focussed on defeating an enemy submarine rather than simply destroying it. As such, it lays out the ten threads of ASW as follows:

1. Discourage, deter or prevent the submarine from leaving port. Convence your adversary that, by deploying their submarine assets, they will put their crews in peril that is not balanced by strategic advantage;
2. Defeat the submarine in port. It is better to destroy the archer than the arrow;
3. Defeat the submarine’s shore-based command and control capability. Therefore reducing the situational awareness of the submarine to that which it can ascertain by its organic sensors;
4. Defeat the submarine entering or leaving port. Deny the adversary sanctuary within their defensive perimeter;
5. Defeat the submarine in choke points. Funnelling locations that constrain the search area;
6. Defeat the submarine in open water. Deep water engagements requiring the ability to search large volumes of water for an adversary before the reach a firing position;
7. Draw the submarine to a position of tactical disadvantage. This may be achieved through deceit of the adversary with false contacts (i.e. using countermeasures);
8. Defeat the submarine’s ability to find, classify and target friendly forces. Again, this is achieved by deceit of the adversary with false contacts;
9. Defeat the submarine at close quarters. Short range engagement within threat weapon range;
10. Defeat the submarine attack. Rendering the incoming torpedo threat ineffective.

Noting that the first four of these threads are effected before the enemy submarine sets to sea, this paper will focus the subsequent six. These may be distilled down to four fundamental tasks of detect, deter, destroy and defend. ATP-28 [1] notes this approach as:

- Stop (detect, deter);
- Explore (detect);
- Hamper (detect, deter);
- Mask (deceive).

ASW may be undertaken by surface or submarine platforms. A surface ASW frigate (e.g. Royal Navy City Class or US Navy Arleigh Burke Class) may operate as part of a larger task group, protecting a High Value Unit (HVU), or on detached lone operations. An attack submarine (e.g. Royal Navy Astute Class or French Navy Rubis Class) typically only undertakes ASW operations alone, up-threat of a task group or wholly detached.

Both platform types may conduct ASW in defensive or offensive roles. The typical defensive role is likely to be in protection of an HVU as part of a task group. Offensive may be actively hunting threat submarines, pinning them down and hampering them from undertaking their mission.

Regardless of engagement nature, a strict process must be followed when undertaking an ASW engagement – the ‘ASW engagement chain’- detect, locate, track, classify and prosecute. In any engagement, the primary aim is to proceed through the chain as quickly and efficiently as possible, without having to repeat any steps.

3. Yesterday’s Engagement

In order to employ these fundamental tasks, fleet formation is important. Taking a task group transiting through a restricted body of water (e.g. littoral waters or straits) as an example, ASW is enacted through establishing defensive layers (colloquially called the ‘onion skin model) around the central HVU. Traditionally, as a result of threat submarine speeds,

Given the restricted speed of legacy threat submarines, defensive ASW has been conducted on a forward-looking, ‘limited lines of approach’ basis, assuming the threat submarine would be lying in wait for the approaching task group.

Defensive ASW for this task group is provided by establishing a number of layers:

- HVU placed at centre, possibly fitted with short-range torpedo defence such as countermeasures;
- Inner layer defence may be provided by a destroyer, fitted with hull-mounted sonar;
- Outer layer defence may be provided by an ASW frigate. This is likely to have both active and passive sonar as well as an ASW helicopter (with active dipping sonar and sonobuoys) armed with lightweight torpedoes and/or depth charges;
- Far ahead of the task group, airborne early warning may be provided by a Maritime Patrol Aircraft (MPA) fitted with numerous on-board and deployable sensors and lightweight torpedoes.

As an example engagement vignette, initial contact is made via the MPA, whose radar flood identifies the periscope of a threat diesel-electric SSK inside the ASW frigate’s sphere of influence. The frigate then scrambles its ASW helicopter, which, once transited, uses its active dipping sonar to confirm the contact. A helicopter-dropped lightweight torpedo or depth charge is then employed to engage the target.
It should be noted that the endurance of the ASW helicopter may be maximised by deploying without munitions. However, if a contact is confirmed and the decision is made to engage, it will either have to return to platform to outload munitions or (if available) another ASW helicopter will be called in to support the engagement.

In this situation, it is considered that there are a number of shortfalls:
- The time required to scramble the helicopter and transit;
- Should the MPA be unavailable, engagement range is limited to that of the ASW helicopter. It is critical that engagement is made beyond the range of the threat torpedo hazard zone;
- As detailed in the introduction, there is no opportunity to de-escalate the situation through rules of engagement escalation.

4. New Technologies

The authors would like to consider a number of concept technologies, which may offer a capability enhancement to ASW engagements.

4.1. Naval Gun Launched Modular Carrier System

This concept proposes utilising the ASW frigate’s organic naval gun to quickly deliver multiple variants of payload at range. Payload options may include:
- Depth charge. While recognised that these are unlikely to offer a direct replacement for conventional air-dropped depth charges in terms of energetic output, these may offer the opportunity for harassment, warning and escalation;
- Intelligence, surveillance, target acquisition, and reconnaissance (ISTAR) natures such as airborne electro-optics, sonobuoys, hydrographic sensors or unmanned aerial vehicles to improve situational awareness at range;
- Countermeasures, such as decoys and structured signal jammers;
- Communications nodes, enabling improved interconnectivity of assets in the underwater battlespace;
- Smoke/Illumination (dark/light) effects.

All options are suggested as concepts for discussion, but would enable deployment of effects quickly at long range. As an example, the BAE Systems Mk45 5” naval gun (as fitted to the Royal Navy Type 26) is capable of firing an initial burst of 20 rounds within a minute at ranges of 13 NM (24 km).

4.2. Future Lightweight Torpedo

Leveraging technologies developed from other modern torpedo systems, a new generation of lightweight torpedo is possible. This could offer:
- An improvement in ASW performance over contemporaries through better false target environment capability;
- More capability against a wider range of countermeasures and deployment methods;
- New scenarios and threat types (as described in Section 1);
- Increased platform interoperability, including MIL-STD-1760 compliance;
- Salvo fire capability, improving $P_{\text{KILL}}$ and $T_{\text{KILL}}$ through cooperative weapons deployed without mutual interference, inter-system interoperability and inter-system communications;
- Anti-Torpedo Torpedo (ATT) capability, minimising the number of qualified and deployed systems;
- Removal of the reliance on organic ASW helicopter through employment of enhanced vertical launch capability. Taking advantage of future off-board sensors, this offers the opportunity to increase ASW helicopter search endurance, mitigate the threat of submarine-launched counter attack capabilities such as the Interactive Defence and Attack System (IDAS) and provide an alternative fast-response long-range deployment method for lightweight torpedoes.
- Range extension through application of wing kits, following deployment from high altitude platforms such as Medium-Altitude Long-Endurance (MALE) Unmanned Air Vehicles (UAV), MPA or future unmanned rotary wing platforms (e.g. RWUAS).

4.3. Off-Board Sensing

As a parallel to the air domain ‘loyal wingman’ concept, this concept sees autonomous surface and subsurface vehicles fitted with sensor packages deployed either from surface or submarine platforms to provide up-threat ISTAR capability.

4.4. Increased Interoperability

Pulling all the preceding technology threads together, a significant benefit may be gained by ensuring overall interconnectivity and interoperability of platforms and effectors. For example, an electrically propelled Rigid Hulled Inflatable Boat (RHIB) fitted with sensor packages and a tactical data link could provide increased situational awareness prior to firing of a salvo of lightweight torpedoes operating in concert.

5. Tomorrow’s Engagement

The proliferation of modern submarine technologies has resulted in faster, quieter threat submarines with the capability to engage at significantly increased ranges. As
such, yesterday’s ‘limited lines of approach’ scenario is no longer valid and a mind-set shift from the defensive force protection focus is required. The modern unknown threat can be considered to present itself on any bearing and at longer ranges. As such, situational awareness and area denial techniques (e.g. monitoring and controlling choke points and lines of approach) are of increased importance.

Taking into account the concept technologies outlined in Section 4, the vignette described in Section Error! Reference source not found. above should be reconsidered as a NATO task group transiting a body of open ocean, approaching the continental shelf to establish a carrier operating box from which to provide air support to a land engagement. In this situation, it is the ASW assets’ task to proceed ahead of the task group, monitoring and controlling key seaways and ensuring the freedom of manoeuvre required.

Offboard sensor platforms positioned at key locations make initial contact. This may be through radar flood of a MALE UUV, passive towed sonar array of an autonomous Rigid Hulled Inflatable Boat (RHIB) or passive sonar of a 21” Unmanned Underwater Vehicle (UUV). The ASW frigate uses its naval gun to fire a ‘confirmation’ salvo of payloads containing a number of sonobuoys, deployed at long range within minutes. Communicating back to the platform via the MALE UAV, the sonobuoys confirm and alert the contact, providing an opportunity for de-escalation.

Should the engagement continue, the naval gun then fires a salvo of depth charge payloads to provide a barrier of charges, forcing the submarine target to remain beyond torpedo engagement distance and providing time to refine the hard-kill firing solution. Additionally, soft-kill countermeasures may be deployed by naval gun.

Upon order of a hard-kill response, one or more vertically-launched lightweight torpedoes may be fired to engage the threat submarine. In addition, the MALE UAV may deploy lightweight torpedoes, extending their range through use of bolt-on wing kit technologies. Their capability to operate as a salvo is enabled through the employment of advanced tactics, resulting in increased probability of kill.

Should the threat submarine deploy torpedoes of its own, the tenth thread of ASW comes into effect, seeking to render the incoming torpedo threat ineffective. This could be achieved through deployment of hard-kill ATT capability built into future lightweight torpedoes, soft-kill countermeasures or hard-kill point defence using supercavitating bullet technologies or a combination thereof.

6. Summary

In order to provide a minimum baseline of matched capability in response to the evolving submarine threat, capability gaps in the contemporary ASW engagement should be addressed and opportunities taken to increase the speed of progression through the engagement chain. Emergent technologies may fill these capability gaps through agile, flexible and interoperable effectors, offering the opportunity to defeat the threat submarine rather than simply destroy it. Deployment of effectors through atypical means (naval gun, vertical launch, high altitude wing kits) may offer an increased range and speed of response, enabling engagement at safer distances.

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References


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