EVOLVING **Naval Mine Warfare** for the 2020s and Beyond

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IN HIS 2017 BOOK *SEAPOWER*, RETIRED U.S. NAVY (USN) ADM JAMES STAVRIDIS WOVE THE CORDS OF HISTORY, current events, and potential future of the world's ageless oceans and strategic maritime features. In an odyssey circumnavigating the globe, Stavridis highlighted how conventional and emerging technologies may redefine the global balance of power.

In the 21st century, as depicted by Stavridis, proliferation of autonomous unmanned undersea vehicles (UUVs) will prompt aspiring naval powers to renew interests in naval mine warfare, mine countermeasures, and explosive ordinance disposal (EOD), as well as mining technologies, systems, and platforms. The naval powers that provide affordable and integrated solutions to existing fleets will establish meaningful gains in national strategic competition as well as freedom of maneuver at the operational level and overmatch at the tactical level of war.

A Rapidly Evolving Strategic Landscape

Unprecedentedly large concentrations of people in coastal urban centers are increasing the strategic significance of freedom of navigation. More than 90 percent of the world's traded goods transit the oceans between these dynamic port cities; therefore all nations have an increasing strategic interest in keeping the global commons secure. Since the demographic concentrations on small coastal areas create an ever-increasing strategic need to maintain critical maritime arteries open and safe, coastal countries must prepare for mine and UUV threats in the 2020s. As Robert Kaplan detailed

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in his books *Monsoon* and *Asia's Cauldron*, safe and continuous operation of critical maritime arteries will be essential for maintaining peace in the 2020s and beyond.

Beyond maritime shipping concerns in port cities, modern infrastructure that enabled large-scale commercialization of the undersea is vulnerable to mining and UUV threats. Colossal engineering projects such as Huawei's transoceanic undersea fiber optic cables and transportation links like the Channel Tunnel between Britain and France make the undersea domain an increasingly critical layer in the global infrastructure mesh. Furthermore, many over-sea projects such as the King Fahd Causeway (linking Saudi Arabia and Bahrain) and the proposed Bridge of the Horns (spanning the Bab-el-Mandeb strait between Yemen in Arabia and Djibouti and Eritrea on the Horn of Africa) require foundations in the seabed. All of these examples expose the vulnerability of the undersea domain, and the 2019 accident on the Russian submarine Losharik highlighted the will of nations to develop technologies to exploit these vulnerabilities.

Apart from infrastructure, the variety and complexity of undersea oil, gas, and mineral extraction continue to increase, and the specter of the 2010 Deepwater Horizon disaster of BP oil corporation provides a glimpse of the susceptibility of energy networks to mining and UUV threats. Deep sea hydrocarbon exploration will remain a particularly sensitive national security matter for net energy importers such as China. According to Tufts University researcher Daniel Brutlag, in 2011 more than 70 percent of Chinese crude oil imports sailed through the Strait of Malacca between Malaysia and Indonesia. Such a dependence on energy imports for the world's second-largest economy obviously will shape China's geopolitical engagement strategy. China's strategy is most visible in its flagship Belt and Road Initiative (BRI). Due to the importance of the BRI, China will exercise all elements of national power to ensure its continued access to energy resources as well as export markets.

Despite nations' and global markets' increasing susceptibility to mines and UUVs , legal frameworks governing the undersea are increasingly outdated—particularly in international waters or transition zones between different exclusive economic zones (EEZs). China's excessive territorial claims in the South China Sea provide an excellent example of an open challenge to existing undersea legal frameworks. Beyond legal negotiations, China's pressure on the undersea legal framework has triggered events like the Hai Yang Shi You 981 standoff (also known as the "2014 China-Vietnam Oil Rig Crisis"), which resulted from the deployment of a Chinese state-owned mobile deep-sea oil platform. The Hai Yang Shi You 981 deployed to a contested EEZ in Vietnam and performed months of exploration. Despite Vietnam's furious protests, the Chinese completed their mission and departed the contested EEZ before the international community could be fully mobilized to mount a credible legal intervention. In the future, plaintiff countries like Vietnam may choose to take action rather than wait for a slow and impotent response from the international legal system. Vietnam could credibly and cheaply deny such exploitation with low-cost mining and UUV technologies.

An increasingly globalized world amplifies the strategic nature of existing and future maritime choke points due to the increasing susceptibility to and desirability as targets for offensive mining technologies. Current oceanic traffic schemes burden critical arteries such as the Straits of Malacca and Hormuz with incredibly dense container and energy related traffic. As illustrated by the 2019 oil tanker attacks in the Persian Gulf, oceanic choke points possess the potential for great political standoffs with outcomes that may shape global norms for generations to come. And receding Arctic ice will create new narrow passages during certain months of the year for commercial traffic. While an increase in the number of available deep-water routes will provide some flexibility to the global transportation network, the security of these choke points from mining and UUV operations will remain a strategic concern.

Gaps and Solutions for the Operational Level of War

In an era when the United States enjoys a marginal lead in conventional military capabilities, asymmetric defense technologies continue proliferating globally on a dramatic scale. As a prime example, undersea capabilities such as submarines, defense-oriented undersea communication networks and UUVs have received massive investment. This revolutionary increase in undersea capabilities shapes the effectiveness of mine warfare at the strategic level of war, and thus requires a closer examination of the current operational level capabilities of the USN and its sister Sea Services.

The aging Avenger-class minesweeper warships (MCM) lack a dedicated replacement platform. This is largely due to focusing limited acquisition dollars on expensive multi-mission surface combatants, such as the $1.8 billion Arleigh Burke-class guided missile destroyers with ballistic missile defense capabilities and limited success with the Littoral Combat Ship's mission modules. Furthermore, 18 years of protracted land-based conflicts in the Near East and South Asia (NESA) focused the majority of USN EOD training and deployments on counter-improvised explosive device (IED) missions. While USN EOD technicians achieved great proficiency in NESA combat zones, the focus on IEDs in Iraq and Afghanistan may have created

an opportunity for atrophy in more traditional underwater EOD competencies.

Though the USN faces a shortage of mine capable warships, several affordable paths exist to grow the USN's mine warfare capability at the operational level. USN submarines—while standing well clear of mined waters—can serve as covert launch platforms for UUVs equipped with mine or mine-clearance payloads. For example, the large ocean interface (LOI) of guided-missile submarines (SSGNs) allows for a variety of UUV payloads. For submarine classes that lack LOIs equivalent to the SSGN, torpedo tubes are capable of launching remotely piloted or autonomous UUVs. To enable submarines to help close the gaps at the operational level, existing programs such as the Long-term Mine Reconnaissance System (LMRS) must be brought to full maturity. Further, the USN should ensure that technical updates occur regularly to ensure the LMRS fleet is ready to meet the maximum number of scenarios.

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Integrating other emerging technologies with undersea launched platforms could further bridge existing gaps in current operational frameworks while simultaneously enabling affordability. The USN could use existing programs like the Mission Reconfigurable UUV (MRUUV) as a platform to fuse the two acquisition priorities of UUVs and additive manufacturing. The USN could establish a metric for success such as "percentage of UUV that can be produced by a multi-medium 3-D printer on a deployed asset." In this way, a submarine could deploy with the fundamental building blocks for potentially thousands of MRUUV variants—including autonomous mines or mine clearance applications.

For decades, the USN marine mammal program (NMMP) has trained and deployed dolphins and sea lions for port security, mine detection, and mine-clearance operations. While marine mammals require a logistical footprint in theater, latent potential exists in the NMMP. By mirroring the success of man-animal-machine teaming in the special operations force's military working dog program, the NMMP could equip marine mammals with sensors and mine clearance tools that dramatically increase effectiveness. The NMMP could showcase these capabilities during combined exercises such as Artemis Trident 2019 that aimed to provide safe passage of humanitarian relief supplies through mined water. Using marine mammals brings many benefits such as distancing humans or expensive naval platforms from the mine field. Additionally, the NMMP provides an excellent platform for building partner capacity and host nation engagement since it does not require the acquisition or stationing of lethal military hardware.

While the NMMP inherently lacks the agility the global force desires, permanent investments in key locations such as Singapore (Malacca), Djibouti (Bab-el-Mandeb), and the United Arab Emirates (Hormuz) will add depth to existing defense strategies. Also, the NMMP could integrate with forward deployed squadrons such as MCM Squadron 5 in Bahrain during security crises.

Tactical Level Challenges and Considerations

In his book, *Wired for War: The Robotics Revolution and Conflict in the 21st Century*, P.W. Singer chronicles the Department of Defense's two decades of experience deploying unmanned aerial vehicles (UAVs) as a part of a "networked warfare" framework. However, as argued by LCDR Dave Barnhill in the March 2019 issue of *Proceedings*, the USN still lacks tactical employment frameworks for UAVs across the range of military operations (ROMO). Furthermore, while experience with UAVs provides some context for the employment of UUVs, significant differences in the physics of the air and sea domains pose added tactical challenges for successful employment of UUVs. Due to the rapid attenuation of light and electronic signals in the undersea domain, data exchange between platforms occurs at relatively low speeds over comparatively limited distances unless connected by wire. This means that—while not

impossible—multi-vehicle coordination is much more complicated undersea than in the air.

Despite challenges, former Chief of Naval Operations (CNO) ADM John Richardson has repeatedly expressed the priority of UUVs for the future of naval warfare. In his January 2019 report, "Design for Maintaining Maritime Superiority," Richardson highlighted the critical importance of unmanned systems to deliver kinetic and non-kinetic payloads in the 21st century. More than words, the CNO's actions to place UUVs in the "acquisition express lane" reveal the priority of UUVs in the emerging U.S. naval strategy. The Defense Science Board Taskforce's 2016 report on Next-Generation UUVs provides an unclassified roadmap of desired capabilities. To complement the acquisition programs, the Assistant Secretary of the Navy for Manpower and Reserve Affairs designated mine warfare in the Top 5 most critical skills for officer promotion boards to the grade of Commander (O-5) and Captain (O-6).

While senior leaders prioritized funding, the USN also recently established the first UUV squadron (UUVRON). UUVRON-1 reports directly to Submarine Development Squadron-5 (COMSUBDEVRON-5), which serves as the tactical development authority for UUVs as well as for undersea acoustic arrays and arctic warfare. Recognizing that much effort is still needed to fully integrate UUVs into tactical frameworks, the leadership at COMSUBDEVRON-5 must produce agile tactical guidance that empowers unit commanders to employ UUVs across the full ROMO. While working in a submariner-dominated command, COMSUBDEVRON-5 must guard against working in submarine centric silos and ensure that tactical doctrine possesses interoperability for a range of naval air, sea, undersea, and space platforms.

COMSUBDEVRON-5 Arctic warfare equities present an excellent example of how the USN can support its sister service, the U.S. Coast Guard (USCG), in developing mine and UUV security solutions. The six planned Polar Security Cutters will provide desperately needed relief for the USCG's one heavy icebreaker, Polar Star, which was commissioned in 1976. In order to improve executive and congressional support for the Polar Security Cutter acquisition, the Sea Services must jointly articulate a compelling narrative that links ice-capable ships with maritime security. A tangible way to tactically integrate the Polar Security Cutter acquisition with mine and UUV lines of effort is to ensure these hulls are prepared to operate with USN air mine counter measure assets such as the MH-60S and SH-60S. Beyond providing a helo-capable platform, Polar Security Cutters should provide the needed staging capability for systems such as the AN/AES-1 airborne laser mine detection system. Together, the Sea Services must strategically communicate that maritime security relies on open sea lanes, which necessitates investment in interoperable heavy ice-breaking Polar Security Cutters.

Are We Overselling the Threat?

At the outset of World War I, the British and French Allies possessed a preponderance of naval firepower, which they intended to use to establish supremacy over the maritime approaches to the heart of Asia. To achieve this objective, the Allies sailed an 18-ship fleet to the Eastern Mediterranean to assume control of the Dardanelles and the Bosporus Strait, thus solidifying the Allies' sea lines of communication from the Atlantic to the Black Sea. In response, an under-resourced Ottoman Empire mined the Dardanelles in order to prevent the Allies' fleet from an effective naval bombardment of land-based fortifications. The effective use of mines inflicted heavy casualties and repelled the Allies' fleet. Study of the Dardanelles Campaign underscores the asymmetric benefits of mine warfare, and it suggests that early 20th-century mine warfare bares striking similarities to more contemporary mine warfare. As a result, prudent naval strategists and budget analysts must objectively consider whether mine warfare in the 2020's and beyond will differ dramatically from the early 20th century.

Furthermore, proponents of modern and proposed technologies, such as space-based monitoring systems, suggest that most mining technologies are losing value as credible asymmetric tools. For more than a decade, China has sought to erode the perceived U.S. supremacy in the undersea domain—a key objective for China's anti-access area denial strategy in the South China Sea. China's "Project Guanlan" claims to monitor undersea systems to a depth of 500 meters, which greatly reduces the value and stealth of mining in littoral seas. When such space-based sensors combine with other ambitious projects like China's "Undersea Great Wall" of acoustic listening stations, the previously opaque undersea domain yields to greater transparency and reduces the asymmetric threat of naval mining. Thus, while mine warfare will remain affordable but dangerous, some argue the uncertainty and asymmetrical benefit of mining operations could diminish as the 21st-century advances.

Real Threats and Undersea Proliferation

The proliferation of affordable UUVs capable of delivering mines continues to grow faster than detection systems. Specifically, the low cost and increasing number of UUVs relative to space-based detection systems delegitimize claims that the world's oceans are now transparent for overhead satellites. Also, engineers optimized existing space-based systems to detect submarines—giant steel structures. UUVs constructed from plastics or composites will be all but invisible to instruments so optimized. Finally, economic theory and history suggest that low-cost UUVs will proliferate in a number of middle-to-low income

coastal nations whereas only a few rich nations will pursue expensive satellite technologies.

Conclusion

In his 2018 article in the National Defense University's journal *PRISM*, "NATO's Adaptation in an Age of Complexity," France's Gen. Denis Mercier, the former Supreme Allied Commander Transformation for NATO, argues that the global security environment is transitioning from complicated to complex—with complexity denoted as an environment where the interacting factors are so numerous that it is impossible to accurately predict situational outcomes. The 2019 limpet mine attacks in the Persian Gulf demonstrate the correctness of Mercier's thesis. In the presence of the increasingly blurred lines of undersea responsibilities between national governments, multinational corporations and an inadequate legal apparatus for law of the sea, the asymmetric qualities of 21st-century mine warfare and UUV threats establish the exact sort of unpredictable nonlinear scenarios Mercier fears.

In such an uncertain future, naval powers capable of providing affordable and integrated solutions to existing fleets will establish meaningful gains in national strategic competition and ensure continued access to global markets. To secure a continued U.S. lead in conventional military capabilities, the national defense enterprise must understand the threat and develop appropriate solutions to not only mitigate the risk of mine warfare but remain capable of establishing local maritime superiority in areas susceptible to mining operations. With the support of political and military leaders who recognize the strategic importance of undersea security, solution providers must deliver capable and affordable technologies such as mine warfare platforms and autonomous UUVs. In parallel, military strategists must create frameworks that incorporate these capabilities in order to enable strategic, operational and tactical success.

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