STATEMENT BEFORE THE HOUSE ARMED SERVICES SEAPOWER AND PROJECTION FORCES SUBCOMMITTEE ON "GAME CHANGERS – UNDERSEA WARFARE"

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Today the U.S. Navy is dominant in undersea warfare. Its quiet submarines can operate with near-impunity throughout the world's oceans and most littoral waters. Its long-range surveillance systems are able to monitor many of the strategically or economically important maritime crossroads. And its anti-submarine warfare capabilities surpass those of competing militaries in lethality and capacity. As a result, today's U.S. defense strategy depends in large part on America's undersea advantage. Multiple Quadrennial Defense Reviews, National Military Strategies, and Congressional hearing statements highlight how quiet submarines, in particular, are one of the American military's most viable means of gathering intelligence and projecting power in the face of mounting anti-access and area denial (A2/AD) threats being fielded by a growing number of countries.

But America's undersea dominance is not assured—or permanent. U.S. submarines are the world's quietest, but new detection techniques are emerging that don't rely on the noise a submarine generates and may make some traditional manned submarine operations riskier in the future. America's competitors are likely pursuing these technologies even while growing and quieting their own undersea forces. To affordably sustain its undersea advantage well into this century, the U.S. Navy must accelerate innovation in undersea warfare by evolving the role of manned submarines and exploiting emerging technologies to field a new "family of undersea systems."

How America came to dominate the undersea

The U.S. Navy did not always "own" the undersea domain. It was an early adopter of submarine technology, but American boats were fewer and less capable than European countries until the middle of World War II. By that point, the U.S. Navy had grown a relatively large force of ocean-going U.S. submarines to sustain a successful counter-shipping campaign against the Japanese. Except for Germany and Russia, European submarine fleets had shrunk due to disrepair, combat losses, and capture. In the aftermath of World War II, the Soviet Navy had the world's largest submarine force, owing to its own construction program and that it gained control of about half the German fleet following its surrender.

With the addition of Germany's fleet, the Soviets also took possession of the most advanced submarines then in production. For example, the German Type XXI U-boat incorporated a snorkel to enable continuous submerged operation, as well as burst communications and X-band radar warning receivers (RWR) to reduce its vulnerability to detection by radar or signals exploitation. This caused great concern in the United States as leaders in and outside the Navy assessed the Soviets could reverse-engineer German submarines and produce them in large numbers to threaten U.S. and allied shipping or the U.S. homeland.

The U.S. Navy pursued ASW capabilities based on active and passive sonar to address the potential Soviet threat. Active sonar showed promise, but passive sonar was not initially effective against diesel submarines because snorkeling submarines sounded like diesel-powered surface ships, and submarines running on battery gave off very little radiated noise.

The U.S. Navy found passive sonar was much more effective against nuclear submarines. In initial exercises against the new USS Nautilus, ASW forces determined they could track the submarine by listening for the pumps and turbines that run continuously in its propulsion plant. Recognizing this potential vulnerability, the U.S. Navy started a methodical sound-silencing program for its nuclear submarines. When the Soviet Navy began fielding nuclear submarines, the American Navy exploited its "first mover" advantage in passive sonar to establish the passive Sound Surveillance System (SOSUS) network off the U.S. coast and at key chokepoints between the Soviet Union and the open ocean.

The combination of passive sonar ASW systems and its own sound-silencing efforts gave the U.S. Navy a significant advantage over relatively noisy Soviet submarines. This overmatch, however, slowly began to erode in the mid-1970s after the Soviet Union learned of their submarines' acoustic vulnerability from the John Walker-led spy ring and obtained technology for submarine quieting from a variety of sources. Newer Soviet submarines such as the *Akula* and *Sierra* classes were much quieter than their predecessors, but were only fielded in small numbers before the Soviet economy began to falter, leading to delayed construction and inadequate sustainment.

In preparation for a time when more quiet submarines were in opposing fleets, the U.S. Navy began exploring other ASW technologies that did not depend on the sound a submarine makes, including new forms of active sonar and non-acoustic methods of detection. These efforts yielded some effective capabilities, such as low-frequency (less than 1000 hertz) active sonar, which was eventually installed on U.S. Navy Surveillance Towed Array Sensor System (SURTASS) ships along with their existing passive sonar arrays.

The urgency behind America's pursuit of new ASW technologies dissipated with the demise of the Soviet Union. Soviet submarine construction and overseas deployments largely stopped, and their advancements in submarine technology did not make their way into other navies. The U.S. Navy was left with undisputed superiority in the undersea domain.

Undersea game changers

Today, new competitors are rising to challenge America's undersea advantage. A resurgent Russia resumed overseas deployments of quiet submarines, a rising and revisionist China is fielding a growing fleet of conventional and nuclear submarines, and competitors including Iran and North Korea are expanding the use of mini-subs in their littorals. At the same time technological advancements, many of them driven by rapid increases in computer processing power or "big data," are empowering new undersea capabilities. Importantly, these new technologies are available to the U.S. military as well.

ASW capabilities. Efforts to protect submarines from being detected since the Cold War have emphasized quieting, since passive sonar is the predominant sensor used for ASW. But today a growing number of new ASW systems do not listen for a submarine's radiated noise. For example, low-frequency active sonar is now widely used by European and Asian navies in variable depth sonar (VDS) systems and will be part of the U.S. Littoral Combat Ship (LCS) ASW mission package. Non-acoustic ASW technologies that detect chemical or radiological emissions or bounce laser light off a submarine are becoming more operationally useful due to improved computer processing and modeling of the undersea environment.

These active sonar and non-acoustic capabilities are likely to be best exploited by mobile platforms such as unmanned vehicles, aircraft, and ships because they are smaller than passive sonar systems. In contrast, to achieve long detection ranges passive sonars must be physically large so they can hear faint noise at the lower frequencies that suffer less attenuation. This makes fixed systems on the sea floor like SOSUS or towed systems such as SURTASS better able to exploit passive sonar improvements.

New ASW technologies, however, will not likely make the ocean transparent or dramatically increase the threat to American submarines in the next one to two decades. Turning a possible submarine detection into a successful ASW engagement involves sifting through a large number of possible submarine detections to find an actual target and then precisely placing an effective weapon on it. What new ASW capabilities could do is increase the chance an American submarine is detected and attacked (albeit ineffectively) in coastal areas where adversary ASW systems are concentrated. Meanwhile, U.S. undersea forces can take actions to defeat enemy ASW capabilities and reduce their vulnerability.

Platform enhancements. The same advancements that are improving ASW capabilities will also enable a new generation of sophisticated counter-detection technologies and techniques. For example, against passive sonar a submarine or unmanned undersea vehicle (UUV) could emit sound to reduce its radiated noise using a technique similar to that of noise cancelling headphones. Against active sonars, undersea platforms could—by themselves or in concert with UUVs and other stationary or floating systems—conduct acoustic jamming or decoy operations similar to those done by electronic warfare systems against radar.

New power and control technologies are improving the endurance and reliability of UUVs, which will likely be able to operate unrefueled for months within the next decade. The autonomy of UUVs will remain constrained, however, by imperfect situational awareness. For example, while a UUV may have the computer algorithms and control systems to avoid safety hazards or security threats, it may not be able to understand with certainty where hazards and threats are and what they are doing. In the face of uncertain data, a human operator can make choices and be accountable for the results. Commanders may not want to place the same responsibility in the hands of a UUV control system—or its programmer.

As sensors and processing improve, UUVs will progressively gain more autonomy in operating safely and securely while accomplishing their missions. In the meantime, the U.S. Navy can expect to shift some operations to unmanned systems for which the consequences of an incorrect decision are limited to damage and loss of the vehicle, rather than loss of life or unplanned military escalation. These missions could include deploying payloads such as sensors or inactive mines, conducting surveillance or surveys, or launching UAVs for electronic warfare. For missions where a human decision-maker is needed, unmanned systems can operate in concert with submarines or use radio communications to regularly "check-in" with commanders.

Undersea payloads. The ability of undersea platforms to conduct and coordinate operations will improve with the introduction of new onboard and offboard weapon, communication, and sensor systems. For example, the Navy's compact very lightweight torpedo (CVLWT) is a short-range weapon less than a third the size of the Mk-48 heavyweight torpedo; it could be used as a self-defense weapon on submarines or employed by large UUVs quiet enough to carry them close to targets. Similarly, small UAVs such as the Experimental Fuel Cell (XFC) UAV have relatively short endurance but can be launched by submarines or UUVs close to adversary coasts. They can take advantage of continued miniaturization in electro-optical, infrared, and radar sensors to conduct surveillance or electronic warfare missions.

Communications are a longstanding vulnerability of undersea platforms. New or improved undersea communication methods will likely enable undersea platforms to communicate with each other, systems on the ocean floor, and the larger joint force without having to expose a mast. Acoustic communications are increasingly able to operate over operationally relevant distances with low bandwidth, while at shorter ranges LEDs and lasers can achieve nearly the same data rates as wired systems. And new floating or towed radio transceivers enable submerged platforms to communicate with forces above the surface without risking detection.

The same power, communication, and processing advancements that are benefitting ASW capabilities and UUVs are making possible a growing variety of deployable payloads that sit on the sea-bed or float in the water column. For example, payloads like the Forward Deployed Energy and Communication Outpost (FDECO) can act as a rest stop for UUVs where they can download data and upload orders while recharging their batteries. The DARPA Upward Falling Payload (UFP) program is building a module that holds missiles or UAVs. And portable sensors such as the Shallow Water Surveillance System (SWSS) and Persistent Littoral Surveillance (PLUS) system can be placed in areas such as chokepoints where adversary submarines or UUVs are likely to travel.

The Next Chapter in Undersea Competition

While undersea research and development has been a distinct U.S. military advantage since the end of WWII, the wide availability of new processing and sensor technology and the increased exploitation of ocean resources are making undersea expertise more broadly available. This will result in increased undersea competition, even as U.S. forces are likely to retain a significant advantage for the next one to two decades. Some operational features of this competition are:

- A new predominant sensing technology. The effectiveness of traditional passive sonar will decline as submarines become quieter, their stealth is enhanced with countermeasures, and rivals deploy more unmanned systems that radiate little noise. While ASW relied primarily on passive sonar for the last 50 years, the dominant detection method by the 2020s may be low-frequency active sonar, non-acoustic detection, or some other previously unexploited technique made possible by ongoing technological advances.

- Undersea families of systems. Submarines will increasingly need to shift from being front-line tactical platforms like aircraft to being host and coordination platforms like aircraft carriers. Large UUVs and other deployed systems that are smaller and less detectable could increasingly be used instead of manned submarines for tactical missions close to enemy shores including coastal intelligence gathering, surveillance, mining, or electronic warfare.

- Undersea "battle networks." New longer-range sensors and emerging undersea communication capabilities will enable undersea fire control network operations analogous to those that use radio signals above the surface of the water. Undersea networks could also enable coordinated surveillance or attack operations by swarms of UUVs operating autonomously or controlled from a manned submarine or other platform.

- Seabed warfare: U.S. forces will need more immediately available undersea capacity inside areas contested by adversary surface and air A2/AD networks.

Deployed and fixed sensors, payload modules, and UUVs supported by systems like FDECO could augment U.S. submarine capacity and be managed by them during a conflict. Increased reliance on these capabilities will create a competition in the ability to place or eliminate systems on the coastal seabed, including capabilities for rapidly surveying and assessing the sea floor.

How the U.S. Navy should respond

The U.S. Navy is already developing new technologies and operational concepts to prepare for the emerging era in undersea warfare. These efforts will need to transition into acquisition programs and fielded capabilities, however, to sustain America's undersea advantage. The Navy should consider the following actions:

- Achieve organizational alignment: Submarines, UUVs, and fixed and deployable sonars are funded and managed by different headquarters, divisions, and separate acquisition organizations within the Navy. To ensure the performance characteristics, networking requirements, and development schedules of these programs are aligned, the Navy should make its undersea warfare resource sponsor and acquisition organizations responsible for all undersea vehicles and systems once they transition out of research and development.

- Ensure ballistic missile submarine (SSBN) survivability: Sound silencing will likely decrease in importance as U.S. noise reduction efforts reach an affordable limit and new ASW detection techniques, such as low-frequency active sonar, become more common. While becoming noisier is not an option, since passive sonar will still exist, the design for the next SSBN should address other ASW capabilities through the use of onboard and offboard systems and tactics.

- Establish UUV design priorities: The Department of Defense (DoD) has pursued a large variety of UUVs during the past decade, mostly for mine clearing and ocean surveillance, launched from surface ships or shore. These applications did not require particular sizes of UUVs. As UUVs become more integrated with submarines as part of a family of systems, the Navy should focus on UUVs that can use the submarine's ocean interfaces and conduct the most likely UUV missions. Specifically, the Navy should pursue the following UUV types as part of its undersea family of systems:

    - *Micro UUVs* (about 6" or less in diameter) are inexpensive and improving in their endurance and on-board power. They could be procured and deployed in large numbers or swarms as weapons, to survey the ocean floor, or to interfere with enemy ASW operations.

    - *Small UUVs* (about 12" in diameter) are commonly used today for surveys and minehunting, such as the Navy's Mk-18 UUV. They will be able to take on other surveillance or attack missions as part of the Fleet Modular Autonomous Undersea Vehicle (FMAUV) program and operate from submarines as well as surface ships and aircraft.

- *Medium UUVs* (about 21” in diameter) are the size of the Navy’s Mk-48 submarine-launched torpedo. And while the Navy is not operating UUVs of this size today, the Modular Heavyweight Undersea Vehicle (MHUV) program plans to make the torpedo of the future able to be configured to conduct a range of missions, from mining and long-range attack to electronic warfare.

- *Large UUVs* (about 80” in diameter) such as the Navy’s Large Displacement UUV (LDUUV) are designed to use the planned Virginia Payload Module (VPM) tubes in Block V *Virginia*-class submarines. The LDUUV will provide a way for submarines to increase their sensor reach, expand their payload capacity, or deliver payloads into areas that are too risky or constrained for the submarine to reach.

- *Extra-Large UUVs* (More than 80” in diameter) in development would be designed to launch from shore or very large ships with well decks or “moon pools.” They could be used for long-endurance surveillance missions or primarily as “trucks” to deliver other payloads and UUVs. Experience with LDUUV will help inform concepts for using XLUUV.

- <u>Evolve attack submarines (SSN) for their new roles:</u> Submarines will be central to the future family of undersea systems and their design should reflect submarines’ growing use as host and command and control platforms. The Navy should have a plan for evolving the existing *Los Angeles, Seawolf,* and *Virginia*-class submarines to incorporate features that expand their payload capacity and ability to interface with unmanned systems. This plan should also ensure the Block V *Virginia* submarines are able to host a wide range of payloads in addition to strike missiles.

- <u>Move from research to acquisition:</u> As described above, the Navy is very actively pursuing new undersea capabilities and demonstrating them at sea. But these new systems and concepts are slow to make it into acquisition. Several projects over the last decade including the Mission Reconfigurable UUV, Advanced Deployable System, and Deep Water Active Deployable System were prototyped but never fielded. The Navy cannot continue to delay the transition of new undersea systems into wider operational use.

The coming era in undersea competition will require a reconsideration of how military forces conduct undersea warfare. In particular, a new family of undersea vehicles and systems will be essential to exploit the undersea environment. If the United States does not begin fielding this new family soon, it could fall behind rivals who will field their own new technologies and operational concepts to threaten America’s use of the undersea.