UNMANNED UNDERSEA VEHICLES AND GUIDED MISSILE SUBMARINES:
Technological and Operational Synergies

by
Edward A. Johnson, Jr., Commander, U.S. Navy

Unmanned Undersea Vehicles and Guided Missile Submarines: Technological and Operational Synergies

Edward A. Johnson, Jr., Commander, U.S. Navy

February 2002

Occasional Paper No. 27
Center for Strategy and Technology

Air University
Maxwell Air Force Base, Alabama 36112

Contents

Disclaimer

The views expressed in this publication are those of the author and do not reflect the official policy or position of the Department of Defense, the United States Government, or of the Air University Center for Strategy and Technology.

I. Introduction

During the Cold War the United States developed the Trident class ballistic missile submarine (SSBN) to replace the aging fleet of forty-one Poseidon ballistic missile submarines. Each of the eighteen Trident class submarines built to carry the mantle of strategic nuclear deterrence was extremely large and quiet with tubes for twenty-four ballistic missiles. Following the breakup of the Soviet Union and the end of the Cold War, the United States conducted a review of its nuclear posture, which determined that only fourteen of these submarines were necessary to meet the needs of U.S. national security. Since these submarines are due for nuclear core refueling and overhaul and thus are no longer required to support U.S. nuclear policy, these submarines will be deactivated or refueled and converted to other purposes. These submarines are only halfway through their design life of forty-two years, and once refueled could be used for other missions. Furthermore, their large size makes these ships a prime candidate for conversion to a large variety of missions that require space, stealth, and endurance.

This excess capability has convinced the U.S. Navy that it should develop a concept for converting the first four Trident class ballistic missile submarines into guided missile submarines (SSGN). This program would equip these submarines both for cruise missile operations and as special operations force insertion platforms. Each submarine could carry more than 100 Tomahawk cruise missiles and up to sixty-six special operations personnel with dual Dry Deck Shelter or two Advanced SEAL Delivery System mini-submarines for SEAL deployment.[1]

While not currently being programmed by the U.S. Navy, Trident submarines could also be converted to carry unmanned undersea vehicles (UUVs). When the author had an opportunity as Deputy Commander of Submarine Squadron SIX to observe an at sea demonstration of an UUV, the versatility of this system was striking, and paralleled the versatility of the unmanned aerial vehicles (UAVs) developed by the U.S. Air Force. For example, the war in Kosovo provided the first opportunity to use the Predator UAV with a laser to identify targets from below the clouds and guide precision munitions from a manned aircraft above the clouds to

destroy a target. This use of unmanned vehicles is truly the wave of the future. Just as the Air Force is developing the unmanned Global Hawk system so that it can perform autonomous capabilities, the U.S. Navy is developing a variety of unmanned undersea systems with independent qualities for many operational roles.

The large size of the SSGN torpedo tubes enables the use of larger and more versatile UUVs. In any submarine the UUV must be launched and recovered from the torpedo tubes, which can severely limit its size, weight, and capacity. The concept of using the SSGN with its larger diameter tubes to contain UUVs offers intriguing possibilities. Each of the two concepts for the SSGN large diameter and long length missile tubes would be adequate to support a robust unmanned undersea vehicle system. Additionally, the SSGN will be capable of remaining on station in any theater of operation where it can covertly employ special operations personnel or launch cruise missile strikes in support of national policy.

If the UUV system is to be useful, it must fulfill a requirement that is not being adequately met with the current capabilities of the SSGN. An indigenous SEAL team, cruise missiles, and current torpedo-launched UUV systems leave a void in capabilities. Special Operations Forces deployed from a submarine can perform many operations but cannot sustain these activities indefinitely and current unmanned systems have limited duration and mission radius because of their small size. This operational niche for long-range, long-durations missions can be filled with a new class of autonomous (or semi-autonomous) UUV systems that have improved loiter times, and latency. This would give them the ability to stay in one place for extended duration, or the ability to remain dormant and activate when required. Certain missions could be more practical and safe with such a system, and thereby minimize the risks to the submarines for such tasks.

This study proposes a new system and concept of operation for using unmanned systems with guided missile submarines. While not currently under consideration by the U.S. Navy, this system integrates the capabilities of current systems in order to consider how future technologies create new military capabilities. The system conceived in this study, which is called a Self-contained Environment and Autonomous Housing for Ocean Reconnaissance and Surveillance Equipment (SEAHORSE), can propel itself, drift with ocean currents, or hold itself in place.

This study investigates how an unmanned undersea vehicle system could be used to meet requirements for littoral warfare and maintaining sea lines of communication. It will provide an understanding of the current state of unmanned undersea vehicles systems, and how these might be included in a guided missile submarine. It examines the strategic implications of such a system and how autonomous and semi-autonomous components could have force-multiplying effects, and concludes with observations and recommendations for the U.S. Navy. This study does not discuss the technical issues associated with this system, but focuses instead on concepts for operating UUVs, its role in various missions, and the status of current research and technological challenges.

II. Understanding Unmanned Undersea Vehicles

Current Systems and Development

The current generation of unmanned undersea vehicle systems that are available to the U.S. Navy were created to support the vision of extending the clandestine reach of submarines to the entire littoral. Operating for long periods of time in shallow water is very difficult for submarines given the constant challenges of remaining clear of the bottom to prevent damage and minimizing the exposure of the ship to prevent detection. For operations conducted in a hostile ocean environment, the potential for enemy attack is great. Since seventy-four percent of the Persian Gulf and sixty-three percent of the Yellow Sea are shallower than thirty fathoms,[2] the use of Unmanned Undersea Vehicles could covertly extend the reach of the submarine in these cases by 100 and 200 nautical miles, respectively.[3] In principle, UUVs could make irrelevant the water depth restrictions on submarines, which is critical to extending the reach of the ship's sensors to the littoral areas that were previously denied.

With this in mind, the Navy established the UUV program plan in 1994 with the objective of fielding a mine detection system by 1998. As Admiral Jay Johnson, Chief of Naval Operations, stated in the 1997 United States Posture Statement, to the House Armed Services Committee, "knowledge of the full dimension of the mine threat, without exposing reconnaissance platforms, is vital to exploiting the tactical benefits of maneuver warfare."[4] While many mine detection and avoidance systems have been deployed on submarines in the past, these met with only limited success. Since anything less than 100 percent effectiveness in detecting mines could lead to the loss of the ship and crew, the ability to remotely detect mines is a critical operational requirement for UUV systems.

There are several design challenges associated with the Near Term Mine Reconnaissance System. In order to deploy this system from current submarines, it must be launched and recovered through torpedo tubes, which limits the diameter, length and ultimately the weight of the vehicle to a package of approximately twenty-one inches in diameter, twenty-one

feet in length, and less than 5,000 pounds. This UUV would provide an early, timely, and clandestine mine reconnaissance capability, and with its onboard sonar system could provide the reconnaissance data on navigation features and choke points to support amphibious operations.[5] The Near-term Mine Reconnaissance system can be deployed and retrieved from a torpedo tube. As the vehicle backs out of the torpedo tube, the employment drogue deploys the system. As the vehicle is separated from the drogue, it is free to maneuver while remaining attached to the submarine by a fiber-optic cable. When the mission is completed, the vehicle docks with the drogue and is reeled back into the torpedo tube. If the fiber-optic cable breaks while the vehicle is conducting its mission, the vehicle is programmed to return to the launch location and to conduct an autonomous docking with the drogue for recovery.[6] Such autonomy is critical to making the transition to fully autonomous vehicles.

The successor program is the Long-term Mine Reconnaissance System (LMRS), which will improve the performance by an order of magnitude. The LMRS will have ten times the range and three to five times the area coverage rate as its predecessor. The long-term system is a twenty-one-inch diameter, self propelled, autonomous vehicle with a 100 nautical mile round trip range. This vehicle will be capable of eight knots and will use the Global Positioning System (GPS) for precision guidance, navigation and control. The vehicle will be able to communicate via Ultra High Frequency (UHF) fleet satellite communications with the shore and via underwater acoustic communications with the host submarine. The technology associated with this program is well tested, and an operational system is on schedule for a 2003 production start date.[7]

Unmanned Undersea Vehicle Master Plan

The U.S. Navy has a master plan for developing new capabilities for unmanned undersea systems. The concept that will expand current capabilities is the mission reconfigurable UUV program, which will start after the LMRS reaches its initial operational capability. In designing the mission reconfigurable UUV, there are several new capabilities sought by the U.S. Navy. Among the highest priority capabilities are mine detection, maritime reconnaissance, electro-magnetic and electro-optical sensing for localization and intelligence and warning functions. Other capabilities sought include signals and radar intelligence, meteorological data, and the

ability to conduct underwater measurements. The goal is for this UUV to produce visual images that are at least as good as those provided by current submarine periscopes. The possibility of having an active target designation laser also ranked high on the list of desired capabilities, as did on station time greater than 100 hours.[8]

After the mine detection mission, the second priority in the UUV master plan is undersea search and survey, which includes platform-based reconnaissance operations that support peacetime and wartime missions. The requirement is to have a large area oceanographic survey mission for environmental sampling and reporting without the actual presence of a military vessel. This survey data could then be used for follow-on missions of large area mine reconnaissance and clearance, which would utilize a large number of small UUVs to cover an area as quickly as possible. However, the near-term focus is to a rapid overt reconnaissance capability that could be expanded in the future.[9]

The master plan seeks to develop additional capabilities that are desirable for unmanned undersea systems. Among these are communication, navigation aid, and information relay, which would allow it to support other UUVs by relaying information. This capability could enable the system to communicate with the host submarine while the ship is operating at speed and depth and would permit Special Forces divers or shore personnel to communicate with the system via satellite or acoustic communications. This could then be used to retrieve and exchange data with submerged systems, such as buoys and arrays. Such UUVs could be covertly planted to designate a lane that is free of mines or other obstructions to support amphibious or special operations. Since these small low cost systems could be combined with other missions to be retrievable or expendable, UUVs and other undersea forces could create nodes in a larger network centric warfare sensor grid.[10]

The final capability described in the Navy UUV master plan is the ability to track or trail submarines, which could be utilized whenever there is a choke point or port from which submarines are departing. This is important because a submarine departing from a protected known port might submerge at a minimum safe water depth that might be too shallow for a U.S. submarine to remain submerged while it waits for the departing submarine. With this capability, an UUV could wait in shallow water for the departing submarine, establish a trail, contact the U.S. submarine waiting in deeper water, and hand over the contact to a submarine. The desired capability for the UUV is to have passive sensors with an

operational radius of ten to 100 nautical miles and an endurance of at least 200 hours.[11] It is conceivable that this unmanned system might be able, among other options, to attack the submarine with a torpedo or attach itself to an enemy submarine with a remotely detonated explosive charge.

After the development of the U.S. Navy UUV master plan, a major review of the status of the technologies that would support these operational goals was conducted in the following support areas: communications, navigation, energy, propulsion, mission equipment, sensors, data processing and autonomy. In principle, maritime reconnaissance, navigation, and communications capabilities could be developed quickly if sufficient resources and national priority were provided. The undersea and survey mission areas would involve more time for developing technologies for operational systems. Finally, the most difficult and technologically challenging task is to conduct the submarine track and trail mission. The power consumption and autonomy required for this type of submarine operations would be the most difficult to overcome and might require until the year 2012 before it could be fielded.[12]

The desired level of autonomy for these systems requires advancements in several areas. The U.S. Navy UUV master plan states that, "By combining the ability to build and maintain the 'tactical scene' onboard and the ability to plan at both the path and mission level from that scene, significant advances in the level of adaptive behavior and autonomy can be achieved."[13] Despite improvements in autonomy, data fusion, and artificial intelligence; fully autonomous operations will require sensors that can perceive information and build precision maps of the tactical scene. In addition, the system must be able to adapt and re-plan based on data acquired, while maintaining mission priorities and reacting on short notice to newly emerging threats. Finally, the vehicle must know when to call for help or to report in real time when it is necessary to provide critical data to U.S. forces.
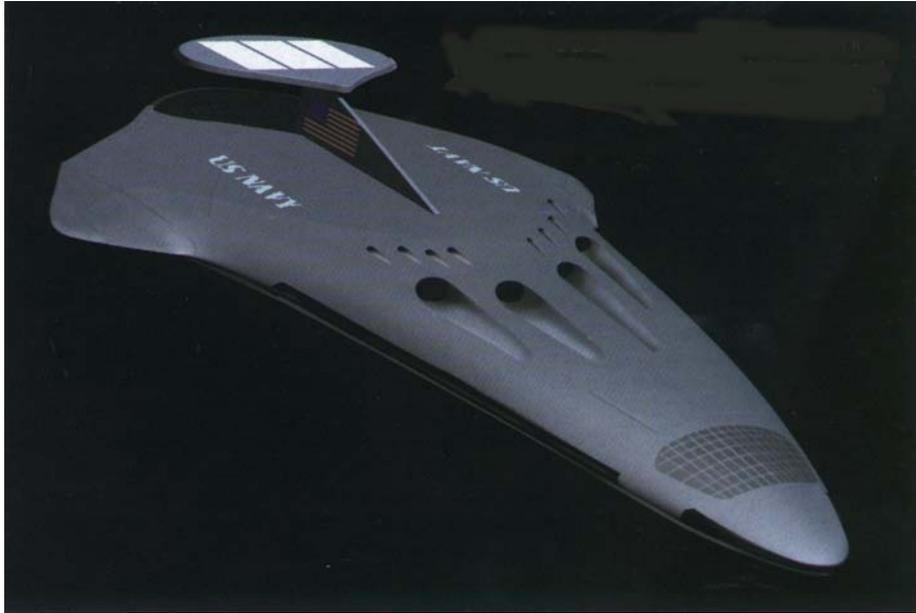
Figure 1: The Navy's Vision: Manta

The U.S. Navy's center of excellence for naval undersea warfare systems is the Naval Undersea Warfare Center (NUWC) in Newport, Rhode Island. By developing the master plan, NUWC has created the Navy's vision for the future in unmanned undersea systems, which includes a fleet of UUVs known as Mantas in support of manned platforms.[14] Mantas are conceptual systems that extend the coverage of naval forces while greatly reducing the risk. These systems are envisioned to operate from standoff ranges, transit covertly to the mission area, and use advanced payloads to perform intelligence, surveillance and reconnaissance, tactical oceanography, and anti-submarine warfare. While their exact size, range, and cost has not been determined, Manta vehicles will be deployed from submarine or surface platforms.[15] This envisioned system contains multiple vehicles that are attached to the outside of the hull of a submarine in a manner which would allow the submarine to operate quietly whether or not they were in place on the hull.

III. The Path to the Future: An Illustrative Unmanned Undersea System

As the U.S. Navy pursues its vision in the development of unmanned undersea systems toward the ultimate vision of a system like Manta, there are many hurdles that must be overcome. The technology must be matured to support the eventual fielding of this type of system. Additionally, the integration of this vehicle into the design of a chip will be very expensive. The current submarine design and building process takes nearly twenty years from the initial concept to the delivery of the first hull. Based on this type of timeline, the earliest that a ship could be developed to exploit this concept would be 2020. But, it may be unnecessary to design a new ship to make this type of system. The Navy may be able to use ballistic missile submarines to provide a near-term solution.

The proposed SEAHORSE system could demonstrate the value of the Manta system, perform the missions that Manta will provide, and be developed in parallel with the conversion of four Trident ballistic missile submarines to guided missile submarines. Using these ships in this fashion would save significant resources, and would allow technological research and development to proceed without the costs of long-lead submarine development times. By mating the technology with the platform more quickly, the final cost of the Manta system would be less.

Guided Missile Submarine (SSGN) Concept

The Navy's decision in 1994 to support the ballistic missile submarine mission with fourteen of the eighteen Ohio class submarines generated significant debate about the disposition of the four oldest ships when they reach their mid-life nuclear refueling overhaul. This point in the ship's life is important because once a ship is refueled it can operate for another 20 years, which is significantly less costly than building new ships, which cost roughly one billion dollars each. By converting all or some of these four submarines to guided missile submarines, these ships would be capable of launching more than 100 conventional cruise missiles within six minutes as well as deploying more than sixty-six Special

Operations Forces personnel from either two dry deck shelters or two advanced SEAL delivery system mini-submarines.

However, there are problems with converting these ships. If the current missile tubes are utilized for SSGN conversion, these tubes will count against the number of warheads assigned to the Trident missile system under the terms of the START II treaty with Russia. Since missile tubes must be physically removed from the ship in order to be compliant with the treaty, the United States must decide what to do with the current missile tubes. Here, the U.S. has two options. The first is to remove the current missile tubes and install a whole new missile compartment, which would require the fabrication of a new hull section with missile tubes of a different diameter so they can be verified to contain a weapon system different from the ballistic currently carried. This option makes the SSGN exempt from on-site inspection and verification, but involves a nearly one billion dollar per ship refit cost. The second option leaves the current missile tubes in place while reducing the number of warheads that could be maintained on the other fourteen SSBNs. This plan is roughly half the cost because it is not necessary to cut all the piping and electrical systems that enter the missile compartment in order to remove the hull section.[16]

Since the SSGN conversion is neither currently fully funded nor approved, the earliest date that either of these plans could produce an operationally converted submarine would be 2006, which allows a UUV system to be developed in parallel with ship refueling and conversion. Both submarine conversion options create similar capabilities in terms of the missiles carried and forces deployed since the new SSGN missile compartment will have sixty-five-inch diameter tubes in comparison with the eighty-eight-inch tubes on the current submarine. Another change with the new missile compartment is that half of the tubes will be close to the ship's centerline while the remainder will be outboard, which means that the outboard tubes will be about twenty-four feet tall in comparison with forty-six feet for the inboard tubes.[17] Importantly, however, for the purposes of a UUV system, either of these tubes has sufficient volume to house and deploy a system of this type.

SEAHORSE Pod

At the heart of the SEAHORSE system is a "pod" that provides the environmental, launch platform, and self-protection systems for the entire

SEAHORSE system. It will contain many individual UUVs that may be individually or collectively employed from this "mother" platform, and provide the capabilities that are common to other devices – notably the power storage, navigational information, and heading reference that are needed for SEAHORSE deployment. Once the pod is launched it can anchor, rest on the bottom, or float at a specified depth until it is needed for a mission. The pod to will have the ability to reposition, fix its position, maintain contact with the host ship or shore facility, and maintain contact with its individual UUVs.

The pod can conduct multiple missions and be reconfigured accordingly. The pod could provide an independent source of position by deploying a system such as the Remote Intelligence, Surveillance and Reconnaissance (RISR) system. This combined US/UK system, co-sponsored with the Ministry of Defence, is a buoy that is connected to the "mother" ship by a tethered cable to provide imaging, signal intelligence direction finding, and communications sensors.[18] This system could provide an accurate Global Positioning System position source, enabling the pod to determine whether it is properly positioned to perform its mission, and report position data via satellites to shore or acoustic communications to the host submarine.

The maintenance and monitoring of the condition of individual UUVs is vital to the proper operation of the SEAHORSE system. Since the system will be located in the harsh environment of the oceans for extended periods, it must be able to assess the "health" of a UUV and alter its mission accordingly. The pod will need to maintain environmental controls on the enclosed vehicles since the pod would monitor for environmental problems.

Deployment System. To make full use of the volume of the SSGN launch tube, the SEAHORSE will be cylindrical so that it could be launched from the missile tube. Once the tube is flooded, the pod may use an upward pushing propeller to move the platform out of the tube. Alternatively, SEAL forces could launch the platform in the same fashion as SEAL delivery vehicles are removed from their shelter. In order for the pod to be launched, it must be near neutrally buoyant with respect to the surrounding water, which implies that the pod will have temperature and water density detectors and a ballast system to establish the proper weight and distribution.

The pod will have several design features to allow for the deployment and recovery of various UUVs. The pods cylindrical shape

will allow for the installation of deployment tubes of varying sizes. Twenty-one inch diameter tubes can be used for the current generation of UUVs. Larger diameter tubes can be used to house larger UUVs that will have longer endurance and can perform more demanding missions. Very small diameter tubes (say, roughly, five inches) might be useful for expendable vehicle technologies currently under development. The pod must be able to launch and recover autonomous or semi-autonomous (tethered) devices, which could be deployed from the bottom or the top. Accordingly, the pod must have top and bottom sensors to ensure that sufficient clearance is available in the proper direction for UUV deployment or recovery, and to ensure the UUV steers clear of any anchor or tethering lines. SEAHORSE will also need the capability to ensure its survivability and recovery. SEAHORSE will need to be able to leave an anchor behind, and reposition to a new location to accomplish a secondary mission or to escape retrieval by enemy forces.

Upon mission completion, the SEAHORSE must be retrieved or destroyed, depending on its location and the sensitivity of the mission. If the platform is located in a denied area, it could release the anchor and move under its own power to be recovered by the host submarine. Alternatively, SEAL forces could recover the system with the assistance of a SEAL delivery vehicle. If the pod is not to be recovered, then the platform must be able to flood the internal compartment and destroy the circuits and internal memory to ensure that critical parts of the system do not fall into enemy hands. Likewise, a system that prevents tampering and subsequent loss of information must be developed.

Propulsion System. Once launched, the pod could use a propulsion system to move to the target location. This propulsion system could be a single motor that can apply thrust in all directions or three separate propellers to provide movement in the desired direction. This propulsion system could get the pod to the desired location and depth except in the case of large or unpredictable currents, when it could be towed by a SEAL delivery vehicle to the correct location and secured.

Sensors and Capabilities. In addition to the sensors for the deployment of the UUVs, the pod will need several sensing and communications capabilities. It will need a passive sonar system to employ with other vehicles. The ability of the pod to communicate both covertly and overtly both underwater and through the atmosphere is critical to maintain contact with the submarine and/or Special Forces personnel. For reconnaissance missions, a visual imaging ability and

digital image transmission capability is essential. The monitoring of each component must be a high priority for a collective UUV system that could lay dormant for days or weeks before it awakens to deploy its devices.

Autonomous and Semi-autonomous Operations. In order for this system to operate independently of the host ship, it must have autonomous capabilities for navigation, communication, data transfer, and data fusion from different vehicles, among other enabling technologies. The system will need "artificial intelligence" algorithms to make decisions about courses of action, including when to communicate and what types of vehicles to deploy.

SEAHORSE should be able to operate overtly and covertly, and conduct traditional missions including: mine detection and clearance, intelligence, surveillance, reconnaissance, information operations, and electronic and acoustic signature deception. Thus, this system will be consistent with the stealthy, standoff, and autonomous strike capability that minimizes the risk to systems and personnel and should be cost effective and potentially decisive in its employment.

System Size and Weight. The weight of the system must be nearly the same as the seawater displaced if the ballast control system is to maintain neutral buoyancy, which has significant implications for the overall size and weight of SEAHORSE. In terms of the first SSGN concept, which removes the existing missile tubes and installs smaller ones, the SEAHORSE system size would be limited to sixty-five inches in diameter. In addition, its length would differ depending on whether it is in an inboard or outboard tube. The length of the SEAHORSE pod would be limited to twenty-four or forty-four feet with the total displacement of eighteen to thirty-five tons, respectively. If the larger second concept was selected, it would have a diameter up to eighty-eight inches, a length up to forty-four feet, and possible displacement of up to sixty tons.

IV. Unmanned Undersea Systems: Roles and Missions

There are many important missions in which this system could be employed in future conflicts.

Amphibious Operations

The ability to conduct amphibious operations is critical to the U.S. Navy's Operational Concept of "Forward…From the Sea" and the U.S. Marine Corps "Operational Maneuver From The Sea." Guided missile submarines currently support this objective because these can strike land-based targets with cruise missiles and deploy Special Operations Forces. However, this capability could be greatly enhanced with the SEAHORSE system in the areas of intelligence, surveillance and reconnaissance, environmental monitoring, mine detection and clearance, and assault preparations. Additionally, the ability to support forces on the beach without manned presence would greatly enhance U.S. amphibious capabilities.

Intelligence. The current means of using submarines for intelligence gathering requires that the submarine operate at or near periscope depth in shallow water with hull-mounted sensors. While this technique provides outstanding capabilities, it cannot be performed at more than one place at any given time by one submarine. The SEAHORSE system could greatly assist the intelligence collection capability of an individual SSGN because one submarine could cover the intelligence collection requirements for several ports at once by using the capabilities provided by SEAHORSE and its associated UUVs. A submarine with a pod could be deployed in the vicinity of shipping lanes and outside the ports to be monitored. From this position, it could deploy sensors to monitor marine band communications signals, record those that contain important intelligence information, and thereby analyze and monitor the movement of naval and support ships. This ability would be particularly useful if overhead sensors were obscured by clouds or otherwise unavailable.

The ability to conduct electronic intelligence about ports is critical to shaping the battle space for covert or overt amphibious operations as well as developing amphibious assault plans. Since the collection of image intelligence is critical to understanding the tactical picture, UUVs could take digital pictures of warships entering or leaving harbors and transmit that information to shore for analysis. The result is that the United States would gain "real time" coverage of the port without using highly valuable platforms, which would aid planners in determining the level of risk shore-based facilities posed to friendly forces.

Surveillance and Reconnaissance. Some missions assigned to submarines, such as harbor surveillance, are extremely time consuming. As a result, it would be valuable to have an unmanned platform to perform these missions. Long-term monitoring would yield data useful to mission planners such as when harbor traffic is usually at its lowest. The SEAHORSE system could provide such data, even in shallow waters where traditional submarines cannot go. Further, this system would be able to monitor changes in activity that were different from historic trends. For example, if the number of warships leaving a port were to increase dramatically, the UUV system could alert shore forces that a naval operation is occurring, which could trigger deploying forces to determine enemy intentions and to respond appropriately.

The ability to gain accurate information about an area or port can be critical in planning and executing military operations. The SEAHORSE system could be programmed best available information about the bottom topography and features of the target harbor. The system would deploy a UUV to map the bottom contours of the harbor and/or shipping lanes. This updated information could be stored within the pod, retrieved, and used to update friendly forces' understanding of the underwater terrain. This tactical information could be used to locate ingress and egress routes not on current charts. As such it would enhance the strategic planning for an operation, and increase the element of surprise when U.S. forces approach from an unexpected direction.

Environmental Monitoring. While a subset of reconnaissance, for submarines this information is collected and utilized separately because of its potentially dramatic effects on the ship. The manner in which sound propagates through the water is the most important factor in avoiding detection in a submarine, which means that the detection of objects in the water depends on accurately collecting environmental information. For example, temperature, salinity, and the sound-velocity

profile—how the speed of sound varies with depth—are crucial in object detection. This data, when combined with data on bottom characteristics, aids in the development of a model for sound propagation within the littoral region, which is vital to planning and executing military operations.

Similarly, the presence and magnitude of currents are very important for planning covert insertions when using swimmers or un-powered boats. While it is difficult to monitor currents in a harbor where the water is too shallow for submarine operations, this is easily accomplished with a UUV. Using GPS for external position information and inertial guidance makes the mapping of currents possible. Since the UUV must account for these currents in order to operate in these waters, logging these currents and transmitting them for analysis to the host submarine or shore will enable mission planners to accurately plan for currents and tidal fluctuations.

Mine Detection and Clearance. A critical aspect of reconnaissance is the determination of whether an area is mined and unsafe for ships or amphibious operations. By using an independent mine detection vehicle deployed from SEAHORSE to locate mines, mine locations could be sent to mission planners to determine how to create a route free of mines to the beach. Currently available mine clearance measures involve the use of U.S. Navy mine sweeping ships or sleds pulled by helicopters, both of which would disclose the location of future operations. The SEAHORSE system could deploy a mine clearance vehicle from the pod to disable mines, while detection operations verify that the proposed amphibious assault lane is clear. In this way, the U.S. Navy would possess a covert mine clearance capability.

Assault Preparation. If during preparations for amphibious assault there has been no visible presence to the enemy, the covert aspects of this system represent significant advantages. However, when an assault is imminent, the overt abilities of the UUV system may be useful. Before amphibious landings, vehicles could be deployed to mark the lane to the beach with radar markers, providing an alternative to the precision track that is given to craft operators and increasing their chance of success. Just before a landing, UUVs could detonate explosives on other beaches to confuse the enemy about the location of the assault. In addition, other vehicles would be deployed to destroy ships in the harbor. Overall, the chaos created by this deception could divert attention from the primary objective and make the landing less costly in terms of casualties.

Support Submarine Tracking

The traditional role of the submarine is to hunt, track, and, if required, destroy enemy submarines. However, a submarine that is operating in its home waters can submerge in the shallow, protected waters to make detection by other submarines difficult, if not impossible. Tracking these submarines is a task well suited to the SEAHORSE system. It can wait in a harbor or choke point for the enemy submarine to pass. If SEAHORSE were utilized to perform detection, localization, track, trail, and hand off to a waiting submarine or attack if desired, it would represent a significant force multiplier.

   Detection and Localization. To detect quiet nuclear submarines or submerged diesel electric submarines, sonar sensors will be required for SEAHORSE. The best option is to use passive sonar UUVs with target recognition capabilities built into the pod. This type of sonar could be used to distinguish between departing submarines and ships that are operating in the port. Once a submarine has been recognized, the system will report this information to shore for tracking. Once the submarine is tasked to track the target, one of two handoff methods could be employed. The UUVs could continue reporting until contact is handed over to the tracking submarine, which can be done via satellite or covert acoustic communications. Once the waiting submarine has established a trail and a message is sent to shore acknowledging the track, the UUV would be commanded to shutdown. In some environments, this transmission from the waiting submarine could give away a covert mission. Alternatively, the UUV could broadcast target data in the blind and stop tracking the outbound submarine at a predetermined water depth, distance from shore, or time – any of which would protect the operational security of the waiting submarine and increase its probability of success.

   Attack. The outbound submarine could be destroyed with an unmanned vehicle eliminating the risk to American or allied forces. During the target detection and localization phases of the mission, mission planners and commanders would review information sent by the UUV to decide whether to destroy the target. The UUV would be able to close in on the target, obtain a firing solution, and either employ a light-weight torpedo, or attach itself like a limpet mine to a point just below the propeller and explode. The charge does not have to "kill" the submarine directly but merely render it useless. If the outbound submarine is

attacked while on the surface, UUVs could assess the target's capability to proceed using other clues that could be evaluated and transmitted to shore for verification. Importantly, SEAHORSE gives U.S. forces the ability to put a submarine out of action without any significant risk to friendly military personnel, and does so before the submarine reaches the open ocean.

Support to Psychological Operations

During the campaign in Kosovo, more than 100 million leaflets were dropped to inform the Serbian people about the bombing and their role in the conflict. One observer suggested that the same effect could be generated with the precise placement of leaflets rather than covering the entire countryside.[19] This and other psychological operations would be suited to SEAHORSE because this system could place leaflets and conduct radio missions as well as deploy a small Unmanned Aerial Vehicle (UAV) to support the distribution of leaflets and transmit radio messages for a small area in the theater.

Unmanned Aerial Vehicle Deployment. One current system under development for littoral operation is a mast (or sail) mounted system that contains four UAVs. These vehicles, which could be launched from a submarine that is on the surface or at a shallow depth, could conduct missions using nuclear, chemical, or biological sensors.[20] This capability could be deployed from the SEAHORSE system.

The notional flight profile for this aircraft is a 100-125 nautical mile range, two hours of loiter time on station, and altitudes of 4,000 to 10,000 feet at speeds of 50 to 75 knots. The UAV could sprint for short periods up to 100 knots, and when the mission is completed, the UAV would return to sea and ditch. This capability opens up a number of interesting operational possibilities.

The aircraft could provide radio coverage for a small area to support psychological operations. While it is not feasible to replace a large-area system as the Air Force's "Commando Solo," it would be possible to cover a very small area, such as one building, with a small UAV capable deployed from the SEAHORSE system. The message to be transmitted to the facility could be sent to the UUV that is already on station, which could launch the UAV to transmit the message for a predetermined period of time, return to sea, and drop into the ocean.

Using this revolutionary concept, psychological operations would provide coverage in small areas for which there is no presence on the ground.

Signal Jamming, Disruption, and Location. The UAV could jam low power signals such as cellular phones. The UAV could be programmed to launch when a transmission is detected, fly to the source of the transmission, and employ jamming signals. It could identify an individual suing a cell phone, which could allow other forces to take appropriate action. Furthermore, higher power signals, such as radio and television, could be jammed over small areas and interrupted for short times. If it is useful to send a message to a person whose location was uncertain, a television and/or radio message could be loaded into the system for transmission by a UAV that is launched to transmit over that area.

Leaflets. The mission of accurately dispensing small numbers of leaflets could be performed with SEAHORSE, including pre-selected missions in which UAVs are loaded with a specific leaflet that will be deployed in the future against known targets. Since leaflets must be printed and loaded onto the UAV prior to the operation, there must be some preplanning. One approach is to make the message generic, as exemplified by, "This facility has been targeted for destruction in the next 24 hours. Leave this area or be destroyed," or "we know that you are in this facility and you may remain there at your own personal risk." With this capability, the United States tells its potential adversaries that its military can strike on a global basis.

Support Deception and Denial

While U.S. military forces are technologically advanced and highly capable, there is an opportunity to increase their capabilities through deception. The purpose of deception is to persuade adversaries to expend ordnance against false targets or confuse battle damage assessment during a coordinated attack. Interestingly, SEAHORSE could produce signals that would make the enemy believe that much larger forces were present.

Signals Generation. SEAHORSE could produce communication and radar signals to create the impression that different classes of ships are operating off the coast, which would require the enemy to deploy air- or sea-based scout to verify whether those forces actually are present. These scouts could engage forces, and engaging the scout would suggest that

forces are present but the full extent of their presence is unknown, which would increase the fog and friction of war, provide a force multiplier effect, and confuse the enemy.

   Sound Generation. If the enemy can use sonar to determine that warships are present, then SEAHORSE could produce sound signatures to suggest that more ships are present. In effect, it could confuse enemy hydrophones and sonar with phantom sounds of "ships" or "traffic" that do not exist, sounds of the insertion of Special Operations Forces from a submarine that is not real, or false signals of torpedo or missile launches or active sonar. The ability to deceive the enemy into believing that more ships are stationed off their coast than is actually the case could tip the strategic balance and persuade the adversary to take actions that are ineffective or disruptive.

   Maintain Sea Lines of Communications. The United States uses several systems to maintain sea lines of communication in all theaters of operation. While shore-based systems frequently lack sufficient range to accurately cover large ocean areas, undersea-based systems have significant coverage. Finally, space-based systems require radio transmissions or do not have the necessary loiter time and revisit rates that are necessary to maintain tracks on events in ocean shipping lanes. SEAHORSE could provide a niche capability that helps other national assets maintain sea lines of communications.

   Drifting with the Sea. Since shipping lanes are well defined and published, a merchant ship transiting from one port to another usually takes the shortest and hence least expensive route. Deploying SEAHORSE from submarines near shipping lanes and allowing it to drift with ocean currents would allow it to examine changes in shipping routes, and give wide area coverage by sonar that could be combined with electronic intelligence and image intelligence to create integrated pictures of shipping lanes. This system could maintain data on the number and types of ships operating within normal routes, which are periodically gathered and transmitted to shore.

V. Conclusion

The ability to ensure unrestricted access to the sea for all countries is a vital U.S. strategic and economic interest. To complicate matters, the number of U.S. Navy surface ships and submarines is declining, which makes coverage of the oceans more difficult and expensive. For various reasons, the SEAHORSE system provides capabilities that fill several existing niches not currently covered by existing U.S. Navy systems. Further, it will create more cost-effective options for achieving operational capabilities. While initially conceived as an instrument for enhancing guided missile submarines, the use of unmanned undersea vehicles, of which SEAHORSE is one example, could be deployed more quickly and less expensively than competing options.

While the operational possibilities for this system are virtually endless, the strategic objective is to use autonomous unmanned undersea vehicles as an instrument for shifting the strategic balance in the littoral and the open ocean. SEAHORSE could be thoroughly field-tested before it is deployed on a submarine with the Advanced Concept Technology Demonstration program. More importantly, this system would give the U.S. Navy and the operational community a wider array of options for using its nuclear submarines than is currently the case.

This system creates capabilities for theater commanders that are consistent with the operational objectives of the U.S. military as well as concepts that are described in the U.S. Navy's Unmanned Undersea Vehicle Master Plan. While it will take years to develop and field advanced UUVs, this technology has important implications for U.S. military capabilities. If coordinated with its ship conversion programs, the U.S. Navy should explore the SEAHORSE concept as part of an advanced concept technology demonstration project. This concept demonstration should allow for a full comparison between SEAHORSE and Manta, as should define the trade-space between manned and unmanned systems. At the same time, it is essential to being development and procurement of such a system, to attempt to field a deployable system by 2007. If all of this is done, the United States will take advantage of the operational

capabilities that are created by nuclear submarines in an era when deterrence with nuclear-armed missiles is less relevant to U.S. military capabilities than a series of technologies that enhance the ability of the United States to conduct conventional operations against adversaries in many corners of the globe in the twenty-first century.

Notes

[1] Babb, John, Briefing on the SSGN program delivered to Air University, November 15, 1999.

[2] Dunn, Paul M., Briefing on the UUV Acquisition Program delivered to Air University, November 5, 1999.

[3] Ibid.

[4] Johnson, Admiral Jay, United States Navy, 1997 Posture Statement, Testimony before House Armed Services Committee, March 5, 1997, available at http://www.house.gov/hasc/testimony/105thcongress/97-3-5jkd.htm.

[5] Dunn, Paul M., Briefing on the UUV Acquisition Program delivered to Air University, November 5, 1999.

[6] Near-Term Mine Reconnaissance System (NMRS), at http://www.onr.navy.mil/sci_tech/ocean/jcm/mnrs.htm.

[7] Ocean Systems: LMRS Capabilities, at http://boeing.com/defense-space/infoelect/lmrs/sld002.htm.

[8] Dunn. Dunn, Paul M., Briefing on the UUV Acquisition Program delivered to Air University, November 5, 1999.

[9] Ibid.

[10] Ibid.

[11] Ibid.

[12] Ibid.

[13] Ibid.

[14] Lisiewicz, John S., "Unmanned Undersea Vehicles," Naval Forces, March 1999, p. 31, who noted that, "Manta is a vision that uses technology to perform missions in difficult environments."

[15] Ibid.

[16] Babb, John, Briefing on the SSGN program delivered to Air University, November 15, 1999.

[17] Ibid.

[18] Submarine Electromagnetic Systems Brief, November 15, 1999, n.p.

[19] Frank Goldstein, Briefing on Psychological Operations, Air War College, November 1999.

[20] Perry, Joe, Briefing on Submarine Electromagnetic Systems delivered to Air University, November 15, 1999.

Center for Strategy and Technology

The Center for Strategy and Technology was established at the Air War College in 1996. Its purpose is to engage in long-term strategic thinking about technology and its implications for U.S. national security.

The Center focuses on education, research, and publications that support the integration of technology into national strategy and policy. Its charter is to support faculty and student research, publish research through books, articles, and occasional papers, fund a regular program of guest speakers, host conferences and symposia on these issues, and engage in collaborative research with U.S. and international academic institutions. As an outside funded activity, the Center enjoys the support of institutions in the strategic, scientific, and technological worlds.

An essential part of this program is to establish relationships with organizations in the Air Force as well as other Department of Defense agencies, and identify potential topics for research projects. Research conducted under the auspices of the Center is published as Occasional papers and disseminated to senior military and political officials, think tanks, educational institutions, and other interested parties. Through these publications, the Center hopes to promote the integration of technology and strategy in support of U.S. national security objectives.

For further information on the Center for Strategy and Technology, please contact:

Grant T. Hammond, Director
Theodore C. Hailes, Deputy Director
John P. Geis II, Director of Operations

Air War College
325 Chennault Circle
Maxwell Air Force Base, Alabama 36112
(334) 953-6996/2985/5579
(DSN 493-6996/2985/5579)

Email: Grant.Hammond@maxwell.af.mil
Ted.Hailes@maxwell.af.mil
John.Geis@maxwell.af.mil

Titles in the Occasional Papers Series

1
Reachback Operations for Air Campaign Planning and Execution
Scott M. Britten, September 1997

2
Lasers in Space: Technological Options for Enhancing U.S. Military Capabilities
Mark E. Rogers, November 1997

3
Non-Lethal Technologies: Implications for Military Strategy
Joseph Siniscalchi, March 1998

4
Perils of Reasoning by Historical Analogy: Munich, Vietnam, and the American Use of Force Since 1945
Jeffrey Record, March 1998

5
Lasers and Missile Defense: New Concepts for Space-Based and Ground-Based Laser Weapons
William H. Possel, July 1998

6
Weaponization of Space: Understanding Strategic and Technological Inevitables
Thomas D. Bell, January 1999

7
Legal Constraints or Information Warfare
Mark Russell Shulmann, March 1999

8

Serbia and Vietnam: A Preliminary Comparison of U.S. Decisions to Use Force
Jeffrey Record, May 1999

9

Airborne and Space-Based Lasers: An Analysis of Technological and Operational Compatibility
Kenneth W. Barker, June 1999

10

Directed Energy and Fleet Defense: Implications for Naval Warfare
William J. McCarthy, February 2000

11

High Power Microwaves: Strategic and Operational Implications for Warfare
Eileen M. Walling, March 2000

12

Reusable Launch Vehicles and Space Operations
John E. Ward, Jr., March 2000

13

Cruise Missiles and Modern War: Strategic and Technological Implications
David J. Nicholls, March 2000

14

Deeply Buried Facilities: Implications for Military Operations
Eric M. Sepp, March 2000

15

Technology and Command: Implications for Military Operations in the Twenty-First Century
William B. McClure, July 2000

16

Unmanned Aerial Vehicles: Implications for Military Operations
David Glade, July 2000

17

Computer Networks and Information Warfare: Implications for Military Operations
David J. Gruber, July 2000

18

Failed States and Casualty Phobia: Implications for Force Structure and Technology Choices
Jeffrey Record, December 2000

19

War as We Knew It: The Real Revolution in Military Affairs/Understanding Paralysis in Military Operations
Jan S. Breemer, December 2000

20

Using Lasers in Space: Laser Orbital Debris Removal and Asteroid Deflection
Jonathan W. Campbell, December 2000

21

Weapons for Strategic Effect: How Important is Technology?
Collin S. Gray, January 2001

22

U.S. Army Apache Helicopters and U.S. Air Force Expeditionary Forces: Implications for Future Military Operations
Brad Mason, June 2001

23

The End of Secrecy? Military Competitiveness in the Age of Transparency
Beth M. Kaspar, August 2001