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Toward Missile Defenses from the Sea

by Hans Binnendijk and George Stewart

Overview

Developments of the past 18 months have created new possibilities for the sea basing of national defenses against intercontinental ballistic missiles. Some conceivable designs would enhance U.S. prospects for defeating a rogue state missile attack on the United States and its allies, but other deployments could undermine the Nation's strategic stability with Russia and China. The most efficacious architecture from both a technical and strategic perspective would include a U.S. Navy boost-phase intercept program and some sea-based radar. Given the complications of using existing Aegis ships for the missile defense mission, the Navy should consider constructing a separate ship designed solely for this purpose.

Current Technology and Policy Status

The Clinton administration developed its national missile defense (NMD) strategy in an effort to defend all 50 states as soon as possible against a limited intercontinental ballistic missile (ICBM) threat from rogue states. To secure the Nation's strategic stability vis-à-vis Russia, the plan emphasized retaining an amended version of the 1972 Anti-Ballistic Missile (ABM) Treaty. The resulting architecture relied on land-based midcourse interceptors guided by land- and space-based sensors. The technologies needed for this architecture had not matured by September 2000, however, and President William Clinton decided not to deploy the system in 2001. Although the researchers made significant progress toward developing naval-based theater missile defenses during the Clinton administration, the basic NMD architecture had no naval component because that administration sought actual deployments by 2005–2006.

Once in office, the Bush administration was determined to accelerate progress on missile defenses, expand research and development efforts, accept a greater degree of technological risk, and redesign NMD architecture. However, no new missile defense architecture has been proposed. The clear line established in 1997 that delineated theater missile defenses and national missile defenses became blurred. The strategy opened the door to a greater seaborne contribution to defense against ICBMs, and the Navy began to analyze the possibility of this new potential. The Federal Government developed a broad array of options to exploit the progress that had been made in Navy theater programs. Then, three events occurred in December 2001 and January 2002 that further shaped the Navy program.

On December 13, 2001, the Bush administration announced that the United States would withdraw from the ABM Treaty in June 2002. Despite the diplomatic drawbacks of this decision, the United States can now experiment with ship-based missile defenses that the treaty constrained. When the treaty expires in June, the Pentagon will test the ability of the Navy's Aegis radar to track both interceptor and target missiles. The decision to withdraw from the ABM Treaty also removes constraints from the development of naval systems designed to be effective against shorter-range ballistic missiles.

Center for Technology and National Security Policy

The National Defense University (NDU) established the Center for Technology and National Security Policy in June 2001 to study the implications of technological innovation for U.S. national security policy and military planning. The center combines scientific and technical assessments with analyses of current strategic and defense policy issues. Its major initial areas of focus include: (1) technologies and concepts that encourage and/or enable the transformation of the Armed Forces, (2) developments by defense laboratories, (3) investments in research, development, and acquisition and improvements to their processes, (4) relationships among the Department of Defense, the industrial sector, and academe, and (5) social science techniques that enhance the detection and prevention of conflict. The staff is led by two senior analysts who hold the Roosevelt Chair of National Security Policy and the Edison Chair of Science and Technology and who can call on the expertise of the NDU community and colleagues at institutions nationwide. The papers published in the *Defense Horizons* series present key research and analysis conducted by the center and its associate members.

As a result, tests of future sea-based systems will begin to move from the virtual world of high-speed computers to the test range.

The day after announcing its intention to withdraw from the ABM Treaty, the Bush administration terminated the Navy Area Missile Defense Program, the program for terminal defense against short-range ballistic missiles, because of cost overruns. Until that point, some administration officials had envisioned using Navy Area as an emergency boost-phase interceptor against North Korean missiles. This program had been scheduled to begin testing this year, with operational deployment to begin by 2004. One likely consequence of the decision to terminate the program will be the delay of any operational (as opposed to an experimental or test-bed) sea-based missile defense system by some 2 to 5 years.

boost-phase missile defense systems also have the advantage of attacking an ICBM during the most vulnerable portion of its trajectory

Then, the Navy successfully flight-tested the first fully functional Standard Missile (SM)–3 interceptor on January 25 and scored a direct hit, using hit-to-kill technology against a Scud-type test missile. The SM–3 is the missile associated with the core of the Navy Mid-course (formerly Navy Theater-Wide) system. The Mid-course system is the only Navy missile defense program that enjoys any significant funding—seven SM–3 test firings are now scheduled—although there is neither funding for procurement nor any official plan for transitioning what is currently an effort at risk reduction and proof of principle into a procurement program. No one is certain when project leaders will meld the technologies tested as part of the Navy Mid-course program into an operational system. An optimistic guess is about 5 years from now; a pessimistic guess is 10 years.

These three events encouraged additional testing of naval missile defense systems while significantly delaying development of the foundations of that system. Developers are reengineering the Navy program, taking much of the steam out of efforts to focus it on ICBM defenses.

Defending the Nation against ICBMs

One should place the U.S. Navy contribution to missile defenses in the context of threats from emerging rogue states and the need to maintain strategic stability with former adversaries. During the past several years, national intelligence estimates have indicated a growing missile threat from North Korea, Iran, and Iraq that will continue to increase throughout this decade. At the same time, relations with former adversaries have improved, and the recent Nuclear Posture Review suggests that the United States is no longer sizing its offensive nuclear forces based primarily on the need to strike Russian targets. In this context, a reasonable architecture to defend against ICBMs would:

- be oriented primarily against missiles launched from rogue states
- try to intercept a missile as early as possible in flight before countermeasures are dispersed and allow time for secondary attempts, if necessary
- contain a thin layer of ground-based interceptors designed to attack a missile during its midcourse, should the missile leak through the first line of defenses.[1]

These principles call for emphasis on boost-phase missile defense systems. Unless the boost-phase missile defense system is space-based, its operating area will necessarily be within about 1,000 kilometers of the ICBM launch site. This range greatly limits the effect that a terrestrial boost-phase missile defense system could have on Russia's or China's strategic deterrents. Deploying boost-phase interceptors in space is not recommended because such deployments could intercept Russian and Chinese missiles and would therefore prove destabilizing. Similarly, deploying ground-based boost-phase interceptors would require stationing them in Russia to deal with the North Korean threat.

Boost-phase missile defense systems also have the advantage of attacking an ICBM during the most vulnerable portion of its trajectory. During the boost phase, an ICBM is a large object with a bright booster plume. Because of the large stresses of launch, even the slightest amount of damage to the ICBM can result in total destruction of the entire system. Boost-phase missile defense systems also attack the ICBM before the offense can disperse countermeasures or multiple warheads. Another strong advantage of focusing on boost-phase defenses is the U.S ability to defend its allies while defending itself.

The technical and operational challenges of the boost-phase defense require launch of the missile interceptors within 3 to 5 minutes after missile launch. (Some advanced ICBM flight concepts, such as *fast burn* and *depressed trajectories*, can reduce this time still further, but rogue states' first-generation ICBMs are unlikely to have this capability.)

Because the development of most missile defenses to date has concentrated on midcourse or terminal defense, the technical challenges of building a system capable of detecting, identifying, tracking, and engaging a ballistic missile during its boost phase have not yet been fully addressed. Even if the system were fully operable, a barrage attack could result in a few missiles leaking through any boost-phase defenses. Augmenting the boost-phase missile defense systems with a thin layer of perhaps 100 midcourse interceptors that could engage leakers from the boost-phase layer is therefore prudent. Provided that the interceptors can handle the problem of midcourse countermeasures, midcourse defense systems are also advantageous in that they allow a single missile interceptor base to defend large areas. For example, under the Clinton administration NMD program, a single site in Alaska could defend the United States against an ICBM launched from much of the Northern Hemisphere.

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Such a midcourse insurance policy should not affect Russia's deterrent posture.

Although the United States need not have many sites from which missile interceptors are fired for a midcourse defense, the system would require a large network of sensors (for example, radars, infrared, visible) to detect, identify, and track all ICBM components.

This proposed architecture would be both highly effective against a rogue state and relatively cost effective. During the next few decades, rogue states are unlikely to possess more than about 20 ICBMs. Assuming all are launched at the same time, a robust boost-phase system should successfully engage considerably more than 60 percent of those missiles. In this stressful scenario, the remaining 8 missiles, containing a total of 8 warheads, and additional decoys would face 100 U.S. midcourse interceptors. The United States could afford to launch 4 midcourse interceptors against each real warhead and up to 17 decoys as a further insurance policy. The cost of this system would be no more than the two phases of the system that the Clinton administration proposed, which included as many as 250 midcourse interceptors.

Pros and Cons of Sea Basing

Given the events of the past 18 months, the Navy and the new Missile Defense Agency are now considering systems for a sea-based ICBM defense that are not unique to ships; at an appropriate site, all these missiles could be deployed equally well on land. Thus, asking why the United States should deploy the ICBM defense systems at sea is reasonable. The primary advantages offered by sea basing include:

- *flexibility offered by making part of the ICBM defense architecture mobile.* The radars and missile interceptors required for defense against ICBMs are large and heavy. Placing them on board a ship is a cost-effective way to make them mobile. Mobility offers two advantages: it makes the defensive missile system less vulnerable to a preemptive strike, and it allows the United States to change the architecture quickly in response to changes in the world situation. Officials could withdraw ships if they were no longer needed or move them if new threats appear.
- *unambiguous control over ICBM defense sites in international waters.* Oceans cover more than two-thirds of the world's surface. Navy ships can operate year-round in any ocean—with the notable exception of the ice-covered Arctic Ocean—without the approval of foreign governments. Thus, sea basing may allow the appropriate placement of ICBM defense elements outside the United States without a host nation's permission, which the host nation could revoke under different circumstances if their and U.S. interests diverge.

Officials must balance the advantages of sea basing, significant though they may be, with potential disadvantages, including:

- *Operation of a single ICBM defense site continuously requires multiple ships.* No matter how efficiently the Navy operates, ICBM defense-capable ships will eventually need to return to port for maintenance and rest for crews. Consequently, the United States will need to purchase multiple copies of each ICBM defense system if it desires a continuous presence on one station. In addition to cost and efficiency, the potential ability to put all the ships to sea at the same time might create political concerns.
- *Officials must integrate missile defenses deployed on Navy ships with other combat systems.* Current Navy ships are complex platforms capable of performing multiple missions. Technicians must resolve shipboard integration problems of each new combat system added to the ship, as well as the technical issues inherent in the system itself. This integration requires significant resources, particularly when the system is as complex as the Aegis weapon system, which has figured prominently in many proposals for hosting missile defense capabilities on Navy ships. Officials can resolve integration issues, but they must factor these issues into the costs and time required to put a missile defense system to sea.
- *Missile defenses deployed on Navy ships create the potential for conflicts between defending against ICBMs and other Navy missions.* In practice, several considerations might rule out simultaneous use of ships for their traditional missions and defense against ICBMs. Some ICBM defense areas overlap neatly with expected Navy crisis-operating areas, but others do not. For example, the Clinton administration's original architecture relied on radars in the United Kingdom and Greenland. If a host nation's concerns prompted the United States to place these radars on Navy ships instead, the radars would not be useful for other missions during a crisis in the Middle East. In addition, executing many of the Navy's traditional missions requires putting the ship in harm's way. If a ship is participating in defending the United States against ICBMs, limiting that ship's exposure to risks not associated with ICBM defense might be preferable.

Policymakers must make an important decision regarding hosting missile defense systems at sea: Will existing Navy ships or new special-purpose ships host the missile defense systems? For example, interceptor missiles could be deployed on special ships akin to the canceled arsenal ship, and radars could be deployed on special radar ships, similar to the Cobra Judy radar on the USNS *Observation Island*.

Hosting the systems on existing combatant ships such as an Aegis cruiser offers the advantage of enabling the ship to participate in its own defense. Solid policy reasons also call for keeping major weapon systems, such as missile interceptors, on military platforms. However, adding missile defense to the list of existing missions incurs overhead both in the form of integration of the missile defense system with other combat systems and a potential opportunity cost of diverting the ship from its original mission designations. Hosting sea-based systems on special-purpose Navy ships avoids the integration and potential opportunity costs but does not eliminate other costs. The United States must still procure additional platforms and provide for their defense. Nevertheless, this solution might be preferable for some applications.

Contributions to Boost-phase Defense

Although the radar currently in place on Aegis combatants has enough power and resolution to detect and track ICBMs during the boost phase, the Navy has optimized system performance and displays to defend against cruise missiles and missiles launched from airplanes. The required modifications for ICBM defense are not trivial, but they are achievable. What is totally missing at present is a suitable boost-phase missile interceptor.

Some Navy officials proposed using SM–2 Block IV missiles to engage boosting ICBMs in the upper atmosphere; that proposal, however, was fraught with a great deal of technical risk and required the ship to be within 50 kilometers of the launch site, making the ship itself vulnerable. A more practical approach might be developing a missile interceptor intended to engage the boosting ICBM later in its boost phase above the atmosphere, allowing ships to be as far as 1,000 kilometers from the launch site.

Developers could use the SM–3 test missiles being produced for the Navy's midcourse risk-reduction effort as a starting point for suitable interceptor missiles.[2] Successful boost-phase intercept missiles, however, would have to be faster than the test missiles. Fortunately, the launching system on Navy combatants has enough growth potential to support a variety of solutions.

One can only speculate about the length of time required to develop a suitable missile and to integrate it with the Aegis weapons system. Prior to the cancellation of the Navy Area program, optimistic estimates by some Navy officials were as low as 6 years to produce boost-phase missile interceptors for ship tests. Because all work on shipboard integration of missile defense systems is currently suspended, this timeline has probably increased.

Using the modified SM–3 or wide-diameter missiles (fast-accelerating interceptors with high terminal speeds), the ship could be as far as 1,000 kilometers from the launch point. Navy ships thus equipped in international waters could engage missiles launched from all of North Korea or Iraq. The effectiveness of sea-based boost-phase missile interceptors against ICBMs launched from Iran would depend on the part of the country from which the ICBMs were launched. In some cases, U.S. forces would need ground-based or airborne supplements.

A sea-based boost-phase capability has clear political advantages and some disadvantages. Its main advantage is the ability to provide a potential defense against ICBMs launched from North Korea and most parts of the Middle East. At the same time, sea basing would present no threat to Russia's and China's land-based ICBM deterrents because those launch points are far inland.

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As for disadvantages, a sea-based boost-phase system would potentially threaten Russia's submarine-launched deterrent, assuming a capability existed to estimate the general location of the submarine. Second, any boost-phase defenses would require the establishment of a "no-launch zone" or other special procedures over the rogue state and a willingness in extremis to delegate the engagement decision to the local U.S. commander. Both requirements might be difficult to sustain politically. Finally, any boost-phase concept would require launching the interceptors in the direction of the country launching the ICBMs as well as toward third parties that might not be involved. For example, launches against North Korean missiles with boost-phase missile interceptors would entail launches on azimuths toward both North Korea and China. When defending against Iraqi and Iranian missile launches, the boost-phase missile interceptors would fly over several countries on an azimuth toward Russia. Additionally, debris from the engagement (for example, damaged warheads or spent interceptor boosters) could have an impact on uninvolved countries.

If the United States accepts the political disadvantages, the operational advantages of a sea-based boost-phase interceptor are significant. With the potential exception of Iran, these interceptors are most effective against the countries in need of dissuasion and deterrence, and they are less effective against former adversaries that need reassurance. If the United States requires continuous protection, the mission would require the deployment of several missile-defense ships, but that investment is relatively small compared with the potential cost of a missile strike against the United States. Considering the short time frame involved in such an attack, however, developing an additional layer that would help achieve the goal of designing a robust defense against ICBMs launched by rogue states seems prudent.

Midcourse Defense

Any midcourse ICBM defense system depends critically on sensor support. Therefore, the possibility of basing high-power, fine-resolution radars at sea to provide sensor support must precede a discussion of the possibility of sea-basing midcourse missile interceptors. These two issues are treated separately, but putting both on the same ship would be quite possible.

Sea-based Radars. Although the ABM Treaty has prohibited formal testing, the current S-band radar (SPY–1) used by the Aegis weapon system can track large objects, such as boosters, at distances well above the atmosphere. Testing is required to determine the extent of the current SPY–1 radar's contribution to a midcourse defense system, but any solution to the countermeasure problem will likely require the development of radars with even higher power and finer resolution.

Navy officials have stated that using the existing SPY–1 radar coupled with software modifications to track objects in space is one near-term possibility. Depending on the target, the maximum detection and tracking range of the radar would be 500 to 1,000 kilometers. This capability would support midcourse engagements of early-generation ICBM systems developed by rogue states with few or no countermeasures. The same Navy officials estimate that it will take about 9 years to increase the power and resolution of the systems to detect objects, to provide discrimination clues, and to track all the individual elements of a cluster as far away as 3,000 kilometers. The effort will also involve developing X-band and S-band radars, both of which are new technology.

Using the current X-band technology developed for the NMD program, adapting it for use at sea, and placing it on board a ship is another possibility. The maximum detection and tracking range of these radars is 2,000 to 4,000 kilometers. Whereas the Navy could retrofit these radars onto existing Navy combatants, their weight, power, and cooling needs would require removal of many combat systems currently in place. As a result, some proponents of this idea suggest that the sensor ship should be a noncombatant and should use a commercial hull. The minimum time required for the integration, design, and conversion of an existing hull is about 5 years.

Sea-based radars contribute uniquely to midcourse intercepts. The curvature of the Earth limits the detection and tracking ranges of any radar. Officials will find presumably appropriate land-based sites for radars to track incoming missiles as they approach the

United States. Sea basing can place a radar that is completely under U.S. control much closer to the launch site than is possible from sovereign U.S. territory. Indeed, if support from a host nation is not forthcoming, sea basing might be the only option for placing high-power radars closer to the launch site. Two factors make this radar placement desirable:

- Sea basing would help develop sufficient information to engage the ICBM in early midcourse, an important consideration in a battle that will be over, for better or for worse, in 15 to 30 minutes.
- Observing deployment of the payload would provide additional information that might help identify the warhead(s) amid the cluster of debris and deliberate countermeasures.

Naval deployment of radars to detect ICBMs might be useful for two other reasons. First, both Great Britain and Denmark have been reluctant to accept the Clinton administration's suggestion to deploy X-band radars at Fylingdales and Thule, respectively. Even though ground-based radars are more reliable, naval deployments provide an alternative. Second, if the Space-Based Infrared Systems (SBIRS)-High and -Low now in development continue to face technological and funding problems, demand for naval radar deployments could increase.

Sea-based radars should not undermine strategic stability. They would not enable similar early detection and tracking of ICBMs launched from the interior of Russia and China, reducing the political risks. Verification for future arms control regimes, however, is one potential political complication. If the United States links existing Aegis radars (or any other radar the Navy uses widely) into an ICBM missile-defense network, then all ships with that radar become potential strategic assets and a likely topic of future arms control negotiations with Russia. Russia would probably seek on-site inspections, restrictions on the operating areas of ships, and limits on the number of capable ships, inhibiting the Navy's freedom to use these ships in other missions.

Using radars on board existing naval combatants for a midcourse defense system against ICBMs appears feasible and might have definite advantages. The disadvantage again would be the opportunity cost of diverting those ships from the missions for which the Navy originally constructed them. This disadvantage is offset somewhat when the ships are employed in forward locations where they might simultaneously participate in other missions that do not put their strategic mission at risk.

Sea-based Missile Interceptors. Defense missiles currently procured for testing have a maximum speed of about 3.1 kilometers per second. This speed would adequately defend against intermediate-range ballistic missiles, but designers must increase the speed of the interceptor missile for a robust capability against ICBMs. Engineers estimate that they could modify the current launch systems used on Navy combatants to accept missiles with larger diameters and capable of speeds of 6.5 kilometers per second or more. That type of interceptor missile could defend an area the size of a continent or larger and could handle ICBMs with advanced capabilities. Generally, developing these newer, faster missile interceptors with improved kill vehicles will take 6 to 15 years.

A priority for the Navy and regional CINCs is developing missile defense systems effective against longer-range theater missiles under development in some rogue states. Given appropriate sensor support, such missiles would also possess at least a rudimentary capability against ICBMs. In fact, at times, these missiles could perform both missions simultaneously. For example, with proper sensor support, a ship with fast midcourse missile interceptors in the North Sea could defend large parts of Europe and the U.S. eastern seaboard against missiles launched from the Middle East. This feature is beneficial because it enhances the utility of these weapons systems but also damaging because it blurs the boundary between strategic and nonstrategic uses regarding strategic stability.

Notwithstanding the large areas that a single missile interceptor facility can defend, launching midcourse-system missile interceptors from multiple sites has several advantages:

- Suppression of the sea-based midcourse missile interceptor system is more difficult.
- Interceptors offer greater flexibility regarding the location of target engagement, an important consideration when dealing with nuclear warheads designed to detonate when successfully engaged.[3]

Midcourse interceptors allow for a *shoot-look-shoot* firing doctrine: the defense fires one interceptor missile, evaluates the results, and fires a second (or more) interceptor missile only if the first interceptor misses. The shoot-look-shoot concept preserves missile inventory and greatly simplifies battle management by minimizing the number of interceptor missiles in flight at any given time, again an important consideration when one envisions defending against small raids of more than one ICBM.

The ability to build a land-based capability on U.S. territory to permit more than one engagement in the latter part of the midcourse suggests that decisionmakers should choose operating areas for ships with midcourse ICBM interceptors based either on the ability to engage the ICBM early in the midcourse or the extension of the defensive area to cover allies or U.S. forces deployed forward in portions of the world far from the United States. Nevertheless, even with these general guidelines, determining definitive operating areas for Navy ships in support of midcourse missile defense against ICBMs is difficult.

Maintaining Strategic Stability

Without the ABM Treaty, which will effectively end in June, the United States must maintain strategic stability with Russia and China in other ways requiring even more vigilance, now without the treaty's negotiated guidelines. For the Bush administration to conclude a long-term strategic framework with Russia successfully, the United States may need to accept some constraints on missile defenses. Would those constraints allow for the eventual deployment of a limited number of naval ships with radars and interceptors capable of defeating an ICBM?

The United States could negotiate such a new framework without abandoning sea-based missile defenses. If the sea-based interceptors are limited to the boost phase, they would not have adequate range to intercept ICBMs launched from Russia. Line-of-sight radars based on ships deployed near North Korea and the Persian Gulf would also have limited capabilities against Russian ICBMs. Russia might seek to limit the number of ships deployed with ICBM defense capabilities, their stationing area, or the range of sea-based radars.

Moscow also might seek assurances that the United States will not use sea-based systems against Russia's submarine-launched missiles.

The most difficult strategic stability problem to resolve is the possibility that Russia might assume that all Aegis radars and interceptors have at least some NMD capabilities if some naval systems with theater missile defense capabilities are networked into the NMD system. Thus, during negotiations for a new strategic framework, the task will be to convince the Russians that this capability is limited and does not undermine Russian deterrence. One possibility would be, first, to create a boost-phase interceptor that requires a modified launch system visible from outside the ship for inspection and verification purposes and then, second, to limit the number of those systems deployed on Aegis ships.

The problem vis-à-vis China is more difficult because the Chinese have only a few dozen land-based single-warhead missiles capable of striking the United States. Sea-based boost-phase interceptors should not present a threat to Chinese ICBMs launched from the country's interior. On the other hand, China could view sea-based X-band radars linked to even a limited number of midcourse interceptors as affecting their current deterrence. The Chinese are modernizing their ICBM force anyway, though, and the number of warheads capable of striking the United States could multiply several times during the coming decade, even without U.S. missile defenses. Ideally, China will not pursue options to place multiple warheads on its missiles. The missile defense architecture suggested above provides the best prospect to dissuade the Chinese from this path while still providing credible protection against rogue states.

The Sea-based Advantage

Using missile interceptors based at sea to defend the United States against ICBMs offers several advantages, the most important of which are flexibility and control. The system involves costs as well, however, including operational limitations for other missions and competition for resources to build new ships.

The most cost-effective option for a potential seaborne deployment is the use of upgraded Aegis radars and modified SM–3 missiles for boost-phase intercepts on board existing combat ships stationed near the Korean Peninsula and the eastern Mediterranean. In addition to providing a layer of boost-phase defense, ships at these locations would provide radar coverage early in the flight of an ICBM—a valuable asset to the midcourse defense layer. These locations overlap with current Navy forward-operating areas, which would help mitigate the opportunity cost to existing missions that the new mission entails.

Estimating the availability of this capability is difficult. Assuming the United States decides to pursue this approach in the near future, the end of the decade is a reasonable deadline expectation. Land-based systems for the midcourse defense layer could mature earlier. Then, deployed ships could initially provide radar support, and the boost-phase capability could be added as it becomes available.

This option involves several costs that officials must manage. The United States must maintain strategic stability with the Russians and Chinese and convince them that such deployments would not undermine their deterrents—a difficult but not impossible task. The Navy would need to accept that Aegis ships deployed with this capability would have missile defense as their principal mission and that all other missions would be secondary. Finally, the President would have to delegate the authority to shoot down a missile in boost phase to the commander of the ship or to some other commander who could act in seconds. That situation might cause potential diplomatic problems, but in practice other missile defense concepts would probably also entail delegation of similar authority to personnel at the operational level.

An alternative, which might benefit arms control and operations, would be the construction of separate ships designed solely for intercept and radar missions. The missile defense ships would then be separate from the Aegis fleet, and the other side could verify any limitations more easily. The cost constraints associated with new construction, however, might slow the existing Navy shipbuilding program.

Sea basing of midcourse missile interceptors or terminal defense systems against ICBMs is a much less attractive alternative. Better land-based alternatives for midcourse intercepts, which would be less destabilizing and would not mix theater and national missile defenses, are available. Defense of a large enough area to be anything other than the last-ditch defense of important strategic facilities is simply impossible for terminal defense systems of the continental United States. Those defense facilities, however, generally do not move; therefore, paying a premium for making the defense system mobile does not seem sensible.

In summary, deployment of a small number of sea-based radars and boost-phase interceptors is sensible for dealing with a limited threat from a rogue state. The United States must manage the difficulties, not the least of which is persuading Russia and China that such deployments do not undermine strategic stability. If U.S. military officials properly design the architecture, however, overcoming that problem should not be an impossible task.

Notes

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[1] See Hans Binnendijk, "How to Build an International Consensus for Missile Defense," *International Herald Tribune*, March 7, 2001.

[2] The SM–3 was designed to intercept a shorter-range missile during the midcourse of its flight and is therefore often called a midcourse interceptor, but it could be used against an ICBM during the exo-atmospheric part of its boost phase.

[3] Commonly called salvage-fusing, the premature nuclear detonation temporarily blinds sensors attempting to detect targets in the vicinity of the explosion and creates a potentially damaging pulse of electromagnetic energy that can damage nearby systems in space and on the ground below.

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