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MARITIME COMPETITION

IN A MATURE PRECISION-STRIKE REGIME

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MARITIME WARFARE IN A MATURE PRECISION-STRIKE REGIME

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EXECUTIVE SUMMARY

This paper provides a preliminary assessment of the prospective characteristics of a mature maritime precision-strike regime and explores some of its implications. This subject is of increasing importance for senior U.S. defense policymakers. For over two decades, the U.S. military has enjoyed a near-monopoly in precision-guided weaponry and their associated battle networks. Recently, however, the proliferation of these capabilities to other militaries and non-state entities is gathering momentum.

The extended period during which the U.S. military has enjoyed a major advantage in this aspect of the military competition suggests it may be slow to appreciate the progressive loss of this advantage. Nowhere is this more the case than in the maritime domain, where U.S. freedom of maneuver has rarely been challenged in conflict since World War II, and then with only modest effects. This era, which now stretches over nearly seventy years, may make it more difficult for the U.S. military to adapt to the "new normal" in which existing and prospective enemies have precision-guided munitions (PGMs) and, in some cases, the associated battle networks and long-range strike systems that form what the Russians termed "reconnaissance-strike complexes."[1]

Further complicating matters is the fact that the maritime *competition* has long since moved beyond purely a contest of ships and submarines at sea. Since the early days of World War II, land-based aircraft have played a major role in the maritime balance, followed by missiles of ever-greater range, speed, and lethality. In recent years, military capabilities and systems in space and cyberspace have become major factors in

[1] For a discussion of "reconnaissance-strike complexes," see Mary C. FitzGerald, "The Impact of New Technologies on Soviet Military Thought," in Roy Allison, ed., *Radical Reform in Soviet Defence Policy: Selected Papers from the Fourth World Congress for Soviet and East European Studies* (New York: St. Martin's Press, 1992). See also Marshal N. V. Ogarkov, "The Defense of Socialism: Experience of History and the Present Day," Красная звезда [Red Star], May 9, 1984; translated by the Foreign Broadcast Information Service, *Daily Report: Soviet Union*, Vol. III, No. 091, Annex No. 054, May 9, 1984, p. R19.

determining the balance, further complicating efforts to assess the competition. Thus while naval forces, strictly speaking, are those that operated on or below the surface of the water, the maritime competition is influenced by forces operating in all domains.

Further increasing the "degrees of difficulty" in assessing the emerging mature maritime precision-strike regime are changes in the character of the maritime domain itself. Maritime geography has undergone a marked transformation since the last time U.S. maritime power was seriously challenged in war. This stems from the expanding undersea economic infrastructure. A state's economic assets at sea were once thought of primarily as cargo-bearing ships. Today, undersea continental shelves in many places host a complex energy extraction and transport infrastructure that is increasingly accessible, even to non-state entities. Add to this a thickening web of undersea telecommunications cables. Aside from the challenge of defending this undersea infrastructure, there are concerns that some states with expansive views of what constitutes their exclusive economic zone (EEZ) could also affect the competition in ways that would limit freedom of maneuver in the maritime domain, including a maritime power's ability to map the undersea and maneuver in neutral states' EEZs in wartime.

As has been the case for millennia, maritime access will likely remain contested most strongly in littoral regions. Similar to the Royal Navy's experience when it encountered torpedo boats and torpedoes, mines, and submarines—the first modern anti-access/area-denial (A2/AD) defenses—in the late nineteenth and early twentieth centuries, today's U.S. surface fleet may find it prohibitively costly to operate in the littoral regions against adversaries in a mature maritime precision-strike regime. And since modern scouting and strike systems can operate over much greater distances than those of a century ago, a robust maritime A2/AD defensive network could extend out hundreds of miles from the shore, intersecting with a rival's similar network to create a no man's land or "no-go zone" of operations. This would affect a wide range of maritime missions, to include sea control and denial, strike, presence, commerce raiding and defense, and blockade and counter-blockade.

While it is easy to make the case for a mature maritime precision-strike regime differing from today's maritime environment, actually spelling out those differences poses many problems. The first concerns the broad development of military capabilities beyond those assumed in this assessment—that is, the diffusion of precision-guided munitions and development of extended-range scouting forces linked to strike forces through battle networks. Recent promising advances in directed energy (DE) could greatly enhance communications along with air and missile defenses. New generations of nuclear weapons could enable their use while creating far less destruction than those associated with Cold War "Armageddon" arsenals. Hypersonic missiles, should they prove practicable and affordable in substantial numbers, could greatly reduce engagement times. Cyber weapons may prove able to fracture battle networks and corrupt information provided by scouting forces. Advances in artificial intelligence could enable robotic systems to conduct complex operations independent of human control, moving from an era of unmanned weaponry controlled by humans to autonomous weaponry. The broad advance of military capabilities greatly increases the uncertainty entailed in describing the salient characteristics of a mature maritime precision-strike regime.

This assessment is further limited by a lack of data. It has been roughly seventy years since two major maritime powers fought each other. In that time the advances in maritime capabilities have been dramatic. Yet the data on the relative value of these new capabilities are meager, culled from minor conflicts that may stimulate as many false conclusions as useful insights.

The challenge is further compounded in that the more advances there are in military capabilities, the wider the range of paths competitors might pursue in exploiting their potential within a mature maritime precision-strike regime. While some light might be shed on this matter by examining a competitor's geographic position, strategic culture, stated geopolitical objectives, economic and technical resources, and the ability to mobilize them for military purposes, at best it reduces uncertainty at the margins. As several prospective key competitors—India, Iran, and Japan, in particular—have yet to move aggressively toward fielding the forces that would characterize a mature maritime precision-strike regime, it seems ill-advised to predict what path they may pursue, let alone the ultimate outcome.

There is the matter of operational concepts. Competitors may choose a certain path in fielding new capabilities (and blending them in with existing capabilities), but this does not necessarily tell us how competitors will employ those capabilities in war.

While these barriers to predicting the character of a mature maritime precision-strike regime are formidable, they are not an excuse for failing to try. An informed assessment of such a regime that takes these conditions into account can serve two useful purposes. First, it can reduce the level of uncertainty, though modestly, as to what will characterize the competition. Second, an assessment can provide an informed point of departure—a "Mature Maritime Precision-Strike Regime 1.0"—at the outset of what must be an ongoing, persistent, iterative process to refine and enhance our understanding of this emerging competitive environment.

Absent a major break in the arc of history, there is no uncertainty about at least one aspect of a mature maritime precision-strike regime: it will emerge in time. What might characterize the competition in a mature maritime precision-strike regime? Among the major findings of this assessment are the following:

- The seas, especially for the United States, will become more highly contested than they have at least since the Cold War. The gradual expansion of what we today call A2/AD zones that began over a century ago will continue, following what appears to be a period of aberration since the Cold War's end.

- Advances in military capabilities since World War II, such as satellites, sensors, very long-range intelligence, surveillance, and reconnaissance (ISR), and strike platforms and missiles, have created the potential to "shrink" the world's oceans to what we might call "Mediterranean Size."
- There will be different classes of maritime powers. Modest maritime powers will be able to strike fixed targets in their littoral region, whereas a smaller number will have the ability to strike fixed targets at extended ranges, defined as beyond the littoral and perhaps out to a 1,000 nautical miles (nm) or more. Although more advanced powers will be able to strike mobile targets, only some will be able to do so on a significant scale at extended range. Maritime powers will also be distinguished by their ability (or lack thereof) to attack the undersea infrastructure and mobile undersea targets, and to do so at extended range. The ability to frustrate and defend against this range of attacks will also differentiate the maritime powers from one another.
- The vulnerability of surface vessels—warships and merchant ships—will increase dramatically in such an environment. Absent a major breakthrough in anti-submarine warfare (ASW) and undersea craft—submarines, unmanned under-sea vehicles (UUVs), and autonomous undersea vehicles (AUVs)—will preserve their stealth.
- In this environment, attempting to operate surface warships and merchant ships in the enemy's littoral regions, at least early in a conflict, will likely be prohibitively costly for even the most formidable maritime power. Even beyond the littoral, the growth of extended-range scouting and precision-strike forces may find competitors creating a "no man's land" for surface ships.
- In such a wartime environment, a surface fleet may spend most of its time operating outside the enemy's A2/AD maritime "bastions"[2] (and perhaps no man's land as well), conducting periodic short-duration dashes inside the enemy's A2/AD perimeter to launch strikes and execute other missions. The fleet's ability to do so will be influenced greatly by the range and stealth of its strike systems, by its ability to counter the enemy's command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) systems—its battle network—that supports its weapons, and by its ability to survive an attack.
- Thus although today aircraft carriers possess the U.S. fleet's greatest combat potential, unless they can project that potential over much greater ranges than is currently possible, they will run a high risk of detection and damage or destruction in a mature maritime precision-strike regime. Under these conditions, smaller surface platforms with longer-range, survivable strike elements may be

[2] A bastion can be generally defined as a maritime region where an enemy can operate in wartime with a high degree of freedom, and where friendly maritime forces operate at great peril. In this assessment friendly maritime bastions are referred to as "rear areas," to differentiate them from enemy bastions.

attractive for a fleet in a mature maritime precision-strike regime. During the interwar period aircraft carriers were able to conduct effective strikes at ranges far greater than could the other ships in the order of battle. The advent of the missile age, particularly the rise of precision-guided missiles, however, has significantly altered—if not reversed—the situation: *Some missiles can now outrange the aircraft on today's American carriers,* and will continue to do so for the foreseeable future, at least with respect to *manned* aircraft.

- While surface warships may have the option of not steaming in harm's way, transport ships that provide badly needed supplies may not have that option. Indeed, with the range of scouting and strike systems (including nuclear-powered submarines) having increased so dramatically, commerce protection may prove difficult or even impractical in a mature maritime precision-strike regime. If so, a competitor's level of economic self-sufficiency could represent a major advantage, especially in an extended conflict. Those competitors who are relatively self-sufficient may be incentivized to posture themselves for protracted war, and be content to keep their seaborne commerce outside an enemy's effective scouting and strike ranges. Those who are not highly self-sufficient may be compelled to posture for a short campaign, undertake a major (and costly) program to stockpile strategic materials, or both.
- While precision offers accuracy independent of range, it does not offer range independent of cost. Thus only maritime powers of the first rank are likely to possess significant numbers of extended-range scouting and strike systems to threaten mobile targets, as well as the battle networks to enable the effective coordination of their activities. Hence a key aspect of initial operations between two first-class maritime powers will likely involve efforts to seize control of the maritime no man's land that is contested primarily by their extended-range scouting and strike forces as a precursor to defeating their A2/AD forces.
- In this fight, as in much of the overall struggle for maritime supremacy, winning the "hider-finder" or scouting competition will prove crucial to establishing a maritime balance sufficiently favorable for a competitor to accomplish key missions at and from the sea. Winning or at least dominating this competition will almost certainly be essential for maritime forces to strike mobile targets effectively and avoid wasting strikes on low-value fixed targets. The ability to "scout" by reading the enemy's codes through cryptanalysis, jamming of communications links, or deleting or corrupting an enemy's scouting data through cyber operations could prove decisive.
- When scouting forces are mutually degraded, mobile targets may need to be engaged quickly, especially at extended range where scouting forces are likely to be minimal. This may put a premium on arming the scouting elements where possible, or, engaging with missiles, as opposed to munitions carried by air plat-

forms, given that missiles—particularly ballistic missiles—can travel substantially faster than any aircraft or, with submarines employing homing torpedoes.

- Aside from preserving one's own scouting force, a major challenge for competitors will be to determine when the enemy's scouting force has been defeated or depleted. Thus accurate battle damage assessment (BDA) will be critical; however, it will also likely prove challenging, especially in the case of cyber and electronic attack. If a competitor has high confidence in his BDA against the enemy's scouting element, he can move forces that would otherwise be highly vulnerable into no man's land or even the enemy's A2/AD maritime bastions. Given the importance of effective scouting in a mature maritime precision-strike regime however, friendly forces must anticipate that the enemy may feign a loss of his scouting ability, particularly in the cyber and electromagnetic domains, in the attempt to draw friendly forces into an ambush.
- As increasing the range of precision strike forces cannot be achieved independent of cost, these forces will likely be in relatively short supply and limited to only the most advanced maritime powers. This suggests there may be a need to rethink the relative value of surface warships' staying power, including not only active air and missile defenses, but also armor and damage control. Put another way, measures such as armor and damage control may drive up significantly the number of scarce extended-range strike assets required to achieve a mission kill or to sink a ship.
- What will likely be plentiful are advanced sea mines. Moreover, over time it seems increasingly likely that the distinction between "smart" mines and UUVs will blur, making mines even more formidable. Yet the cost of even the most advanced mines will be only a small fraction of that for a modern warship. This suggests that mines will become an increasingly important part of a maritime competitor's A2/AD littoral defense force, particularly if they can be emplaced in deeper waters.
- The undersea domain is almost certain to play an increasingly important role in a mature maritime precision-strike regime for several reasons. First, submarines (especially nuclear-powered submarines) are likely to be one of the few naval assets (in addition to extended-range missiles and long-range carrier aircraft) capable of operating at acceptable risk in the maritime no man's land and penetrating the enemy's A2/AD defenses. Submarines may continue evolving into "mother ships," carrying AUVs, UUVs, mines, towed payload modules, and special operations forces (SOF), along with their traditional complement of torpedoes and missiles—creating an undersea "combined arms" force capable of conducting a range of missions, albeit on a relatively modest scale. Second, since the last clash between major maritime powers in World War II, an undersea economic infrastructure has emerged centered primarily on energy extraction and communications cables. This infrastructure will likely prove an attractive

target in future wars. To the extent multiple competitors are involved in such a war, a major challenge for a competitor attempting to defend his infrastructure may be *accurately identifying the source of an attack*.

Despite the many uncertainties regarding the competition, if history is any guide it will involve many of the weapon systems and other military capabilities that are either in the competitors' armed forces today, or in their current procurement programs. This is due in part because competitors are often hesitant to scrap expensive existing capital stock, such as major surface warships and submarines, aircraft, and satellites whose service life spans decades. The problem may be compounded for many traditional major maritime powers, the United States in particular, that have entered a protracted period of fiscal limits, in part owing to a dramatic rise in personnel costs and an increasingly dysfunctional weapons acquisition system. Ironically, those maritime powers with the most maritime capital stock—the United States especially—may have the least flexibility in terms of fielding new capabilities. This may be mitigated, however, to the extent that a maritime platform is designed with an open architecture that enables enhanced or alternate sensors, electronics, weapons, and other payloads to be upgraded quickly.

That said, history suggests that even a modest shift in the composition of maritime capital stock when combined with appropriate operational concepts can make an enormous difference in the overall balance. This was demonstrated by Germany's small submarine force at the outbreak of World War I and the handful of carriers possessed by the U.S. and Imperial Japanese navies at the beginning of World War II in the Pacific. Hence an important factor in determining the future maritime balance will be the ability of the competing military institutions to innovate, or transform (innovate on a scale sufficient to exploit a military revolution), with advantage accruing to those competitors that identify the best methods (i.e., operational concepts) for employing existing and emerging capabilities to their advantage. Thus the ability to identify, test (through analysis, gaming, simulation, and exercises), and refine these concepts is often crucial to maintaining or enhancing a competitor's position. Limitations on manpower—both its quantity and quality—will be a major factor in limiting and shaping a competitor's approach to the mature maritime precision-strike regime.

There are several operational concepts that have merit in advancing thinking beyond the environment assumed here—that is, one in which the spread of precision-guided weaponry has reached its mature stage along with corresponding scouting forces (such as UAVs and satellites) and battle networks. While a detailed assessment of these concepts is beyond the scope of this assessment, several general operational concepts associated with maritime missions are outlined.

A key part of the competition will involve restoring maritime freedom of maneuver by reducing an enemy's long-range A2/AD capabilities and seizing control of the maritime no man's land. How might this be accomplished? Options include operational concepts centered on:

- Winning the "scouting campaign," in part by introducing attractive false targets, making real targets less detectable (such as through stealth and curtailing electronic emissions), degrading enemy communications, and injecting false information into the enemy's battle network. This will permit the employment of maritime forces and "shell-game" tactics, enabling forward land-based forces to operate at an acceptable cost;
- Depleting the enemy's long-range strike systems that, given their cost, are likely to be a relatively small part of its force structure, thereby enabling friendly forces to operate relatively freely in no man's land and to operate more aggressively within the enemy's A2/AD defenses, or maritime bastion;
- Drawing the enemy out from his maritime bastion through, for example, distant blockade, to compel him to seek a quick resolution to the conflict; and
- Engaging in peripheral campaigns (e.g., physically seizing key areas outside the immediate area of competition, such as sources of key resources for the enemy). This may compel the enemy to over-extend his military resources (especially his extended-range scouting and strike systems), while enabling friendly forces to concentrate theirs at the key point of decision.

In brief, U.S. planners will likely confront an increasingly dynamic environment in which they must address both how the emergence of a mature maritime precision-strike regime will affect the U.S. military's ability to conduct maritime missions *and* what countermoves the United States could undertake. The objectives of these countermoves should be to improve the U.S. competitive position, and include those actions that could shape the competition's path in ways favorable to U.S. interests.

Where do we go from here in understanding the emerging maritime competition? If history is any guide, success will require persistent effort over time. This assessment is only a first step in what will be a long and fitful path toward the mature maritime precision-strike regime.

To the extent this assessment has merit, it can inform the debate within the professional military and strategic studies community regarding the regime's characteristics. The debate can be further enriched by considering how some of the key variables—such as DE, electronic warfare, advanced-design nuclear weapons, cyber munitions, and competitor paths—could significantly shape and influence the regime and the U.S. competitive position. Priority should also be given to identifying how the United States would like to see such a competition evolve over time. Success here will enable further thought as to how the United States might influence competitors to pursue competitive paths less threatening to U.S. interests. This effort has historically been facilitated by first developing operational concepts that enable maritime forces to address challenges and exploit opportunities that might emerge in the new regime. Since the competitive environment is dynamic, and since analysis of the operational concepts should provide additional insights into their strengths and weaknesses, these concepts must be regularly refined. This can be accomplished through well-designed wargames, simulations, and maritime exercises.

The process described here need not be expensive; indeed, the savings realized from such an effort are potentially substantial. Accurately gauging the characteristics of a mature maritime precision-strike regime could help the U.S. military avoid investing in capabilities ill-suited to meet future challenges, thereby allowing resources to be allocated to areas that provide the United States with a distinct and enduring competitive advantage.

Although the benefits of embarking on such an effort are clear, it will occur only if senior leaders—particularly senior civilian policymakers and U.S. Navy leaders—take up the challenge and find a way to institutionalize the process described here. This is their great opportunity to sustain U.S. maritime dominance. Should they fail to seize it, they run the risk that U.S. dominance will not endure in the coming decades.

INTRODUCTION

[T]he whole naval art has suffered a revolution beyond all previous experience, and it is possible the old practice is no longer a safe guide.

Julian S. Corbett[3]

With regard to estimating military power there seem to be only problems and very few, well-accepted adequate methods of making such estimates. There are conceptual problems in defining appropriate measures of military power, and many practical problems in carrying out even those partial formulations that seem appropriate. Indeed there are so many problems and difficulties that I can touch on only a few of them.

Andrew W. Marshall[4]

No competitor has ever been able to maintain an enduring monopoly over an important new military technology or capability.

Why This Assessment?

The history of military affairs consistently demonstrates that technology diffuses over time. No competitor has ever been able to maintain an enduring monopoly over an important new military technology or capability.

While the United States has maintained a near-monopoly in precision-strike capabilities[5] for over two decades, recent trends indicate that this advantage is waning. Once the advantage is lost, it will be lost forever, and the U.S. military will find itself operating in a far less permissive maritime environment than it has over the past several decades.

3 Julian S. Corbett, *Principles of Maritime Strategy* (Mineola, NY: Dover Publications, 2004), p. 124. Originally published as *Some Principles of Maritime Strategy* (London: Longmans, Green & Co., 1911).

4 A. W. Marshall, *Problems in Estimating Military Power*, P-3417 (Santa Monica, CA: RAND, August 1966), p. 1.

5 As used in this assessment, the term "precision-strike capabilities" refers to an ability to scout and strike effectively many targets over extended ranges within a relatively short period of time with a high degree of accuracy.

The U.S. military either adapts to maintain its ability to sustain power in the new environment, or finds its options greatly limited and its level of risk greatly increased. How might the U.S. military best adapt? The answer to this question depends a great deal on the characteristics of a mature maritime precision-strike regime. As used in this assessment, the term "mature maritime precision-strike regime" refers to a state in military affairs when the major maritime competitors have advanced ISR as well as precision-strike capabilities all linked together to form a battle network—what Soviet military theorists referred to as a "reconnaissance-strike complex"—and where minor maritime powers and even some non-state entities have those capabilities as well, albeit on a significantly lesser scale and with a more modest range of capabilities.

This assessment seeks to describe these characteristics and, in so doing, hopefully ease, if only modestly, the work of those responsible for determining the characteristics of the country's future maritime forces. Some argue that it might be better to wait to undertake such an effort, as a mature maritime precision-strike regime may not arise for another decade or two. There is some merit in this argument. This assessment argues, however, that given the long lead times involved in adapting the U.S. military to new ways of operating and introducing new equipment, it makes sense to try and anticipate at least the general characteristics of a mature maritime precision-strike regime.

Absent such an effort there is a danger that the U.S. military may fail to position itself to compete effectively during the emergence and maturation of such a regime. There are reasons for concern. The extended period of U.S. dominance in precision warfare and the declining resources likely to be available for defense may raise barriers to such an effort. Moreover, American military leaders have spent most of their careers and all of the last two decades in a world where the United States has all but been ceded the field when it comes to precision warfare. Consequently the U.S. military has generally become accustomed, among other things, to:

- Enjoying maritime "sanctuaries" in littoral regions and at naval bases;
- Operating in relatively safe operating environments for aircraft carriers (hereafter "carriers"), resulting in a preference for carrier aircraft whose strike ranges today are not significantly greater than their World War II ancestors, even though the range of land-based combat aircraft and missiles has increased greatly since then;
- Emphasizing kinetic missile defenses as the preferred means for defending its surface combatants, even though development and deployment of missile defenses is more expensive than missile offense; and

- Discounting offensive mining operations, even though mine capabilities have improved markedly in recent decades and have shown themselves to be a highly cost-effective weapon when employed properly.[6]

This combination of a low-threat environment and an expanding defense budget[7] provided the U.S. military with a maritime "comfort zone" that it will be reluctant to abandon. This reluctance will likely be strengthened by the prospect of decreasing defense budgets. When budgets are being cut, the Services, particularly in the absence of strong civilian leadership, tend to protect what they have rather than divesting capabilities whose value will likely depreciate dramatically in the new environment (i.e., a mature maritime precision-strike regime) in order to invest in more relevant capabilities.[8] The complexity and inefficiency of the U.S. defense acquisition process further exacerbates this problem. Absent significant streamlining of the current process, the U.S. military's ability to adapt quickly to adversarial fielding of mature regime capabilities is very much in doubt.

Moreover, as we shall see presently, the U.S. military's efforts to adapt successfully to an emerging mature maritime precision-strike regime will depend to a significant extent on the willingness of *all* of its Services to adapt. Once the exclusive province of naval forces, the maritime domain is now shaped by capabilities operating in the land, air, cyber, and space domains as well. Thus, any concept for operating in a mature maritime precision-strike regime must take these capabilities into account.

This assessment explores the characteristics of a mature precision-strike regime in the maritime domain, and assesses some of its strategic implications from a U.S. perspective. The maritime domain is chosen both to limit the scope of what is an ambitious undertaking and because it is the focal point of military competition in the Western Pacific and the Persian Gulf, the two regions where vital U.S. interests are being most severely contested.

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6 Sophisticated mines (e.g., those capable of "counting" ships and those with acoustic signal discriminators that enable them to hit only certain kinds of vessels) have been around since the early 1980s. At present the U.S. Navy has no surface mine-laying capabilities, and the U.S. Air Force has the country's only "high-volume" ability to lay mines. Mines accounted for fifteen of the nineteen U.S. Navy ships damaged since World War II. Between them, Russia, China, and North Korea have roughly 400,000 mines with a wide range of capabilities. Scott D. Burleson, David E. Everhart, Ronald E. Swart, and Scott C. Truver, "The Advanced Undersea Weapon System: On the Cusp of a Naval Warfare Transformation," *Naval Engineers Journal*, March 2012, p. 60; and Scott C. Truver, "Taking Mines Seriously: Mine Warfare in China's Near Seas," *Naval War College Review*, Spring 2012, pp. 32, 35.

7 The base U.S. defense budget grew 59 percent in real terms from the low in FY 1998 to the peak in FY 2010. Data derived from Office of Management and Budget (OMB), *The President's Budget for FY 2013* (Washington, DC: U.S. Government Printing Office, 2013), Historical Table 5.1; and Department of Defense (DoD), *National Defense Budget Estimates for FY 2013* (Washington, DC: DoD, 2013), p. 34.

8 This is sometimes referred to as the "Volunteer's Dilemma." Its premise is that if a Service offers to cut some capability out of its budget in order to invest the savings in more relevant (i.e., effective) capabilities, it runs a high risk that its savings will be "banked" to bring the defense program in balance with a shrinking budget.

Describing the characteristics of a mature maritime precision-strike regime is a challenging undertaking. There are many factors and uncertainties that bear on the future maritime competition. Among these uncertainties are: the durability of stealth; progress in directed-energy and hypervelocity-projectile weapons systems such as rail guns; the relative value of manned and unmanned aircraft and missiles versus strike aircraft; the ability of artificial intelligence to enable the fielding of autonomous (robotic) systems and robust battle networks; the durability of satellite architectures in war; and the roles advanced-design nuclear weapons, advanced forms of electronic warfare, and cyber operations will play in conflicts.

The prospect for shifting geopolitical alignments must also be considered, as well as the paths existing and prospective rivals to pursue in developing capabilities for the maritime competition and the doctrines devised for their employment. Moreover, given their enormous destructive potential and concerns over nuclear proliferation and advanced nuclear weapon designs, the possible employment of these weapons in a mature maritime precision-strike regime cannot be discounted. Although these factors hardly represent an exhaustive list of those that would exert significant influence on the character of a mature maritime precision-strike regime, they make clear the difficulty of attempting to predict the character of such a regime with a high degree of precision.

This does not mean, however, that thinking about such a regime is a useless enterprise. A willingness not only to challenge the existing way of "doing business" but also to advance a vision of a new way of conducting military operations appears to be essential to enabling the military to transition effectively to a new warfare regime, such as would occur with the emergence of a mature precision-guided weapons regime. Crafting a vision informed by rigorous analysis can reduce the level of uncertainty a competitor confronts, thereby making planning less of a "crap shoot."

Consider, for example, the so-called "Dreadnought Revolution" in naval warfare that occurred in the early years of the twentieth century. Aside from leading to the launching of the first modern battleship, HMS *Dreadnought*, it saw the emergence of a range of other capabilities, such as submarines, torpedoes, the global cable telecommunications network, oil-fired propulsion, and new engine types.[9] The Royal Navy's success in effecting the transformation to a new form of warfare saw its leading proponent,

9 The Dreadnought Revolution is described in detail in Nicholas A. Lambert, *Sir John Fisher's Naval Revolution* (Colombia, SC: University of South Carolina Press, 1999).

Admiral John "Jackie" Fisher, challenge the centuries-old dominance of the battle ship-of-the-line, declaring,

> There is good ground for enquiry whether naval supremacy of a country can any longer be assessed by its battleships. To build battleships merely to fight an enemy's battleships, so long as cheaper craft destroy them, and prevent them of themselves protecting sea operations, is merely to breed Kilkenny cats unable to catch rats or mice.[10]

Fisher went on to advance a new and comprehensive vision known as "the scheme." A key element of Fisher's vision involved exploiting advances in torpedoes and submarines. He argued that "[I] don't think it is even faintly realized—*the immense impending revolution which the submarines will effect as offensive weapons of war*."[11]

Similarly, the U.S. Navy succeeded between the world wars in positioning itself to transform from a fleet centered on battleships to one that adapted quickly to a carrier-centric fleet after the Japanese attack on Pearl Harbor. Success was enabled in no small measure because of the vision advanced by Admiral William Sims, who challenged the battleship admirals comprising the Navy's "Gun Club." Sims stated that:

> A small, high-speed carrier alone can destroy or disable a battleship alone… a fleet whose carriers give it command of the air over the enemy fleet can defeat the latter. [Consequently], the fast carrier is the capital ship of the future.[12]

Although Sims made his prediction in 1925, years before the U.S. Navy had even built a carrier,[13] his foresight was borne out during World War II when the U.S. Navy relied heavily on aircraft carriers to defeat the Japanese in the Pacific.

While the visions advanced by both Fisher and Sims were imperfect, in the main they were remarkably accurate. Since predicting the future is a fool's game, their objective—and the objective here—is a modest one: to have a clearer vision, or understanding, of what factors will dominate the future maritime competition in a mature precision-strike regime.

Our understanding of the characteristics of this regime will, of course, need to be updated as circumstances change and as our picture of the future becomes clearer. This requires creating a "virtuous circle" consisting of a baseline vision of the competitive environment that is then refined through informed debate among the professional military through wargames, planning exercises, and, ultimately, field (or fleet) exercises and high-fidelity simulations at the operational (i.e., campaign) level of war. The insights derived from these efforts can be used to update the vision and inform the development of doctrine and equipment. The process is constant and iterative. This is

10 Lord John "Jackie" Fisher, *Memories and Records, Vol. 2* (New York: George Doran Company, 1920), p. 143.

11 Geoffrey Penn, *Infighting Admirals* (London: Leo Cooper, 2000), p. 96. Emphasis in the original.

12 See William Tuohy, *America's Fighting Admirals: Winning the War at Sea in World War II* (St. Paul, MN: Zenith Press, 2007), p. 39; and Clark G. Reynolds, *The Fast Carriers* (Annapolis, MD: Naval Institute Press, 1968), p. 1.

13 The first U.S. carrier built from the keel up, the USS *Range*r, did not join the fleet until 1934.

what President Dwight Eisenhower meant when he declared, "Plans are worthless but planning is everything."[14] Since the United States' ultimate objective is to establish and sustain a favorable military balance relative to its competitors and since the competition is dynamic and interactive, planning must also take into account the paths rivals are pursuing to gain advantage in the maritime competition.

The Competitive Environment: Key Assumptions

To bound the assessment, provide transparency, and facilitate further analysis of key variables affecting the competition, it is important to present its key assumptions regarding the environment that will shape the mature maritime precision-strike regime. Some of these assumed characteristics have a high probability of occurring; others are far less certain. Their common characteristic is that they all have the potential to affect the future maritime competition in a significant way.

This assessment's fundamental assumption is that over the next ten to fifteen years the proliferation of guided weaponry will accelerate such that major powers, minor powers, and even non-state entities possess them, though in varying quantities and levels of sophistication. We assume advanced competitors will also employ sophisticated battle networks, with minor powers fielding more modest versions. Each competitor, however, would follow its own path in developing and fielding these capabilities.

We also assume that the emergence of a mature maritime precision-strike regime will find the United States and China remaining the world's two principal economic powers, with Great Britain, France, Germany, Japan, and South Korea occupying the second tier. Among the other principal economic powers will be Brazil, Canada, India, Italy, and Russia. All of these countries are assumed to be technologically advanced and heavily dependent on maritime trade to sustain their economic health. Economic might and technical proficiency, while enabling those countries to field sizable and sophisticated maritime forces, does not necessarily mean they will do so.

We further assume that the overwhelming majority of trade continues to move by sea, including the Persian Gulf energy trade, and that shipping continues the trend toward ever-larger cargo ships (e.g., "Malaccamax" ships).[15] Given the breakthroughs in natural gas extraction technology, such as through "fracking," it appears reasonable to believe that the seaborne trade in liquefied natural gas (LNG) will increase significantly, along with the infrastructure needed to support this trade.

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14 David A. Nichols, *Eisenhower 1956* (New York: Simon & Schuster, 2011), p. 7. Should an emergency arise, Eisenhower counseled, "The first thing you do is to take all the plans off the top shelf and throw them out the window and start once more." Planning, he felt, prepared your mind "to do the normal thing when everybody else is going nuts" in a crisis, or period of stress.

15 The trend in shipping has been toward ever-larger container ships. The term "Malaccamax" refers to the maximum size a ship can be and still safely transit the Strait of Malacca, one of the world's key shipping chokepoints.

Importantly, this assessment assumes that the undersea economy, focused primarily on energy extraction, includes the South China Sea, Southern Atlantic Ocean (Brazil), Eastern Mediterranean Sea, Gulf of Mexico, and Gulf of Guinea, among others. As countries develop these undersea resources, they will likely seek to expand the authorities granted to them under international law in their EEZs, in part to protect their economic assets, but also for military purposes as well. Toward this end, we assume that undersea sensor grids have become increasingly widespread as a means of monitoring and defending EEZs, particularly in areas where advanced powers have substantial undersea infrastructure, such as communications cables and gas and oil production and distribution systems. The undersea economic infrastructure issue is so integral to the competition in a mature maritime precision-guided weapons regime that it will be elaborated on later in this assessment.

Given this assessment's focus, assumptions relating to military-technical developments are perhaps the most important. We assume that a range of PGMs are widely available in significant numbers to major military powers (e.g., China, India) and lesser powers (e.g., Iran), and that short-range PGMs—that is, guided rockets, artillery, missiles (to include anti-ship cruise missiles), and mortars, or G-RAMM—are available to minor powers and irregular proxy forces.

This assessment further assumes that first-tier economic powers that choose to compete as a first-class maritime power have battle networks capable of targeting both fixed and mobile targets, including major surface combatants at extended distances (i.e., 500 to 1,000-plus nm). Lesser powers will likely have more modest battle networks. Advanced battle networks are highly dependent on space-based systems against mobile targets in non-permissive environments. Moreover, these space-based systems in low Earth orbit are highly vulnerable to "mission kills"—for example, unable to perform their C4ISR functions owing to non-kinetic activities such as cyber attacks, jamming, "blinding" of their sensors by lasers, and physical damage inflicted by lasers. At present some major powers have either the ability or the potential to destroy satellites, such as through direct ascent missile attacks.[16] In brief, the space competition heavily favors the offense.

Consequently, owing in part to the relatively high vulnerability and expense of space-based systems, in a mature maritime precision-strike regime, major powers will likely have invested in significant numbers of unmanned systems to perform C4ISR functions as well as to support (and in some cases conduct) strike operations. In this way unmanned systems will serve as a hedge against the loss of space-based assets. Terrestrial-based systems also provide capabilities that space cannot, such as the ability to focus on a particular target, to employ sensors that cannot function effectively from space (e.g., sonar), to fuse data from multiple sensors (e.g., electronic intelligence [ELINT] and imagery intelligence [IMINT]) that could not all be located or accomplished on one

16 Minor powers or even non-state entities may be able to procure ASAT capabilities such as lasers, though in modest form.

satellite, or to provide cueing and tracking data at long ranges, such as by linking land-based over-the-horizon (OTH) radars and passive ELINT collection systems.

In addition to unmanned air-breathing systems, we can expect many competitors to field an array of UUVs and AUVs, as well as mobile, relocatable, and fixed underwater sensors.[17] The assessment assumes that minor powers will have these systems, but in relatively small numbers and at lower levels of sophistication. Non-state actors such as drug cartels and proxy forces such as Hezbollah could have them as well, albeit in relatively modest numbers and technical sophistication.

This assessment further assumes that advanced "smart" anti-ship mines are widely available to any government that can afford them, and to their non-state proxies. Importantly, just as UUVs and AUVs have taken on more of the characteristics of submarines, blurring the distinction between the two, so have smart mines taken on some of the attributes of unmanned and autonomous systems. Although not currently as mature as PGMs, UUVs and AUVs along with the munitions they carry will likely be capable of serving as integral parts of the mature precision-strike regime.[18]

It also seems increasingly likely, and is assumed here, that directed-energy weapon (DEW) systems would provide significant enhancements to kinetic defenses against cruise missiles and aircraft, but not against ballistic missiles (owing to their high speed and hardened warheads). This is a significant development. Current projections find solid-state laser interceptor "shots" cost far less than their kinetic interceptor counterparts (ranging tens of dollars to less than $1 a shot compared to up to $3 million per SM-6 missile).[19] Moreover, the assessment assumes that electromagnetic rail guns could offer some limited ballistic missile terminal defense capability, and at far less cost per shot than contemporary kinetic interceptors.[20] It is particularly significant for maritime combatants, which are capable of generating high power levels compared to their mobile land (ground combat vehicles) and air force (combat aircraft) counterparts. And as at least some maritime combatants (nuclear-powered submarines or carriers) have long-lasting power supplies (i.e., nuclear reactors), they can "rearm" their DEW magazines repeatedly, which is not currently the case with conventional, "kinetic" rounds.

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17 Unmanned underwater vehicles require data links to a remote controller in order to perform their mission with minimal effectiveness, whereas autonomous underwater vehicles are capable of doing so even if their data links are broken. The U.S. Navy now fields relocatable underwater systems that can be connected to fixed systems that provide power and enable communication.

18 For a general overview of mines, see Truver, "Taking Mines Seriously."

19 Ronald O'Rourke, *Navy Shipboard Lasers for Surface, Air, and Missile Defense: Background and Issues for Congress*, R41526 (Washington, DC: CRS, 2014), p. 2.

20 The U.S. Navy is hoping to field an electromagnetic rail gun (EMRG), a 32-megajoule weapon, in 2017. It is designed to have the ability to defeat cruise missiles and possibly ballistic missiles as well. As opposed to kinetic interceptors like the SM-3, which cost roughly $3,000,000 per missile, a shot from the EMRG would cost around $25,000, or less than 1 percent the cost of an SM-3.

Similarly, there are notable advances being made in the area of high-powered microwave (HPM) weaponry. A recent test conducted by the Counter-electronics High-powered Microwave Advanced Missile Project (CHAMP) produced impressive results.[21] This suggests that over the next ten to fifteen years—the time frame of this assessment—it may be possible to neutralize an enemy's electronic systems (e.g., radars and computers) with a form of miniature electromagnetic pulse (EMP) that produces little direct collateral damage.

One key aspect of the maritime competition that is assumed to not change dramatically is stealth, although significant effort will have to be made to sustain it at roughly its current level of effectiveness. This assessment assumes that new generations of aircraft, both manned and unmanned, will generally be capable of surviving in defended air space through the combination of passive signature reduction (i.e., stealth) and advanced electronic warfare capabilities. Nevertheless, stealthy aircraft will be challenged by the emergence of out-of-band detection capabilities, such as S-band, high-frequency (HF) and very high-frequency (VHF) radars, and infrared search and track (IRST)-like[22] sensor systems. The same holds for submarines. Modern boats like the U.S. *Virginia*-class nuclear attack submarines are assumed to remain very difficult for ASW forces to detect, track, and engage. What is less clear is how the growing practice of embedding sensors undersea, particularly along the world's continental shelves, will affect subsurface operations. This issue is elaborated upon briefly later in this assessment.

Perhaps the area of greatest uncertainty when it comes to military capability concerns is cyber warfare. Here we assume that all major powers, many minor powers, and a few non-state entities (e.g., terrorist groups) have a broad cyber warfare capability—that is, the ability by itself to inflict significant damage on a rival military's C4ISR systems and battle network, and to inflict substantial, although not catastrophic, damage on an enemy state's critical infrastructure. We make a similar assumption with respect to these groups' relative proficiency in biological warfare.

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21 The test, undertaken by Boeing's Phantom Works, shut down the targeted electronic systems (computers and their monitors) along with the cameras put in place to record the results. The systems were down for only a matter of seconds, but depending on how the computer network is configured and the kind of computers and peripherals employed, a CHAMP-like weapon generating a larger electromagnetic pulse could disable the system for a far longer period, perhaps even permanently. Liam Stoker, "Electromagnetic Pulse Weaponry: Boeing CHAMP Video and Jammer Grenades," *Army-Technology.Com*, November 27, 2012, available at http://www.army-technology.com/features/featureelectromagnetic-pulse-weaponry-boeing-champ-jammer-grenades/; and Devin Coldewey, "Boeing's New Missile Takes Down Electronics Without Touching Them," *NBC News*, October 24, 2012, available at http://www.nbcnews.com/technology/boeings-new-missile-takes-down-electronics-without-touching-them-1C666618.

22 Infrared search and track (IRST) is a passive, long-range sensor system that employs infrared technology to search for, detect, and track airborne systems. It is reputedly immune to efforts at electronic deception. Moreover, because the system is passive, unlike radar systems it does not emit radiation, making it difficult to detect. See "IRST Sensor System: Providing Warfighters the See First, Strike First Advantage," Lockheed Martin, n.d., accessed at http://www.lockheedmartin.com/content/dam/lockheed/data/mfc/pc/irst/mfc-irst-pc.pdf.

The assessment further hypothesizes that the nuclear trump card will remain in force in a mature maritime precision-strike regime. Unfortunately, from a U.S. perspective, the number of nuclear-armed actors will likely increase over the next ten to fifteen years, while the types of nuclear weapons will likely grow as well. We assume that some nuclear powers will follow the path of Russia and introduce into their arsenals very low-yield nuclear weapons, thereby blurring the distinction between precision-guided and nuclear weapons.[23] This has the potential to complicate greatly the competition within a mature maritime precision-strike regime.

Finally, as in the case of every military revolution over the past century or so, the mature maritime precision-strike regime that emerges ten to fifteen years from now will find that the principal maritime competitors *will retain many of the systems and capabilities they have today,* as well as those that are currently in production or under development. Simply stated, while many of the new capabilities described above are hypothesized to have worked their way into the maritime competition, there will remain large numbers of legacy systems as well.

Given these assumptions, this assessment explores the characteristics of a mature precision-strike regime in the maritime domain and offers some of its strategic implications from a U.S. perspective. Following this introduction, Chapter II describes the major developments in the history of the modern maritime competition, including six historical case studies—maritime operations in the Eastern Mediterranean during World War II; the impact of Japanese kamikazes, arguably one of the first precision-guided weapons, on the U.S. Navy in the Pacific theater of World War II; the advent of rudimentary no-go zones in the Eastern Mediterranean during the Cold War; the Falklands War and the use of anti-ship missiles; the U.S. Navy's outer air battle concept with respect to Soviet A2/AD capabilities in the latter stages of the Cold War; and the First Gulf War and the problem of mines. After examining these historical antecedents, Chapter III combines insights from these cases with trends in the maritime competition to describe a mature maritime precision-strike regime's characteristics. Chapter IV assesses how some maritime missions may be altered as we shift from the current regime to the mature regime. Chapter V turns to what might enable competitors to restore freedom of maneuver in the maritime domain in an environment where major competitors have long-range scouting and precision-strike capabilities, and where even minor competitors have these capabilities, although in more modest forms. Chapter VI presents some findings and insights regarding the characteristics of a mature maritime precision-strike regime, along with some suggestions for future analysis.

[23] For a detailed discussion of this issue, see Barry D. Watts, *Nuclear-Conventional Firebreaks and the Nuclear Taboo* (Washington, DC: Center for Strategic and Budgetary Assessments, 2013).

THE PAST AS PROLOGUE: CASE STUDIES OF THE MARITIME COMPETITION

The only new thing in the world is the history you don't know.

President Harry S. Truman[24]

Victory will smile upon those who anticipate changes in the character of war, not upon those who wait to adapt themselves after changes occur.

General Giulio Douhet, *The Command of the Air*[25]

The challenge of assessing the characteristics of a mature maritime precision-strike regime is exacerbated by a lack of experience regarding the competitive dynamics of such a regime. We have no experience as to how the systems, munitions, and sensors fielded by the various competitors in such a regime will perform. History suggests that a significant proportion of them will perform either substantially better or worse than expected, while some may perform quite well, but in accomplishing tasks for which they were not originally designed. Simply put, the technology associated with the maritime competition has changed dramatically since the last major clash of first-class navies almost seven decades ago. Consequently, those militaries intending to compete in a mature maritime precision-strike regime must make important decisions that will greatly affect their competitive posture for decades to come in the absence of detailed and accurate information regarding the prospective effectiveness of new military systems and operational concepts. Similarly those seeking to define a mature maritime precision-strike regime's characteristics are also hamstrung by the relatively high level of ambiguity regarding the path major maritime powers are pursuing toward fielding the capabilities that would mark their entry into such a regime.

24 Samuel W. Rushay, Jr., "Harry Truman's History Lessons," *Prologue*, Spring 2009, available at http://www.archives.gov/publications/prologue/2009/spring/truman-history.html, accessed on January 4, 2013.

25 Giulio Douhet, *The Command of The Air*, translated by Dino Ferrari (Washington, DC: Air Force History and Museums Program, 1998).

Defense planners have confronted this problem in the past. In many instances, they have relied in part on the scraps of data gleaned from even the smallest maritime conflicts.[26] For example, in the years leading up to World War I contemporary maritime analysts engaged in exhaustive examinations of the few engagements (most notably the Battle of Tsushima) during the 1904–05 Russo-Japanese War. The reports of these battles were dissected in the greatest detail by analysts starved of data following nearly half a century of peace between the major maritime powers at the very time when an unprecedented revolution in maritime capabilities was occurring.

Today's planners face a similar problem. There has not been a major war at sea between great maritime powers in over sixty-five years to provide what arguably would be reliable data on the relative effectiveness of military capabilities associated with the current maritime competition. Thus those attempting to assess the competition in a mature maritime precision-strike regime confront far greater uncertainty than their predecessors on the eve of the two world wars. When combined with the rapid advance of technology and the diffusion of the maritime competition to military forces operating in all domains, the task of declaring with a high degree of confidence how all these uncertainties will play out challenges even the best military analysts. The problem is particularly acute for U.S. military planners, who must address a wider array of contingencies with varying geography, wartime objectives, forces, and adversaries than any other maritime power.

This does not mean the situation is hopeless. It *does* mean we should understand both the opportunities and limitations inherent in exploring the characteristics of a mature maritime precision-strike regime. The opportunity is not to eliminate uncertainty, but to reduce uncertainty where possible, developing clear operational concepts based on well-informed judgments of what we do know, and developing hedges or capability options that can be exercised if our best assessment fails to prove out.[27] A useful first step in this effort involves conducting a military archeological dig of sorts. We begin with a brief discussion of the early period of the so-called maritime Machine Age, followed by examination of a select number of historical case studies in the hope that they will shed some light on where the competition may be headed.

The Advent of the Machine Age

The maritime competition has evolved over several millennia, marked by occasional periods of disruptive change or military revolutions. The incidence of these disruptive periods has become more frequent since the advent of what Bernard Brodie called

[26] An example is the work done by Wayne Hughes. See Wayne P. Hughes, Jr., *Fleet Tactics and Coastal Combat*, 2nd ed. (Annapolis, MD: Naval Institute Press, 2000).

[27] In addressing this challenge, see Andrew F. Krepinevich, *Defense Investment Strategies in an Uncertain World* (Washington, DC: Center for Strategic and Budgetary Assessments, 2008).

the "Machine Age," which had its origins in the Industrial Revolution.[28] Leading up to that period the maritime competition had been dominated over a protracted period by ships of the line of battle, or "battle ships," often classed in terms of the numbers of cannon they carried. For most of history, a state could achieve command of the maritime domain by defeating the fleet of its enemy, either through direct fleet engagement, such as at the Battle of Trafalgar, or by bottling it up in port through close blockade, as the Royal Navy had undertaken along the Dutch coast in 1653. This view is summed up well in the Royal Navy's position that:

> The primary object of the British navy is not to defend anything, but to attack the fleets of the enemy, and by defeating them to afford protection to British Dominions, supplies and commerce. This is the ultimate aim … The traditional role of the Royal Navy is not to act on the defensive, but to prepare to attack the force which threatens—in other words to assume the offensive.[29]

Once the seas had been swept of enemy warships (or if the enemy fleet refused to sally forth from its bases), the victorious fleet could operate with impunity up to the coastline of its rivals. During the early period of the Machine Age maritime powers had naval mines, but they were primitive and did not occupy a major place in calculations of the maritime balance. Shore-based forces, such as forts armed with cannon, also exercised minimal influence over maritime affairs, as the range of their guns was exceedingly modest. At the dawn of sea power in the Machine Age, the "gray zone" between land and sea was a thin three-mile strip along a country's littoral established as its territorial waters, a ruling first advanced in the 1702 publication of Cornelius Bynkershoek's *De Dominio Maris (On the Rule of the Seas)*. There is evidence that this "three-mile limit" may well have derived from the limits of contemporary cannon range, that is, the distance shore-based weaponry could exert influence over the seas.[30]

The onset of the Machine Age triggered a series of changes that, when combined with the Information Revolution in the late twentieth century, reverberates to this day.

The onset of the Machine Age triggered a series of changes that, when combined with the Information Revolution in the late twentieth century, reverberates to this day. By the mid-nineteenth century the world's two principal maritime powers, Great Britain and France, were transforming their battle fleets from wooden vessels powered by sail to ironclad warships driven by steam propulsion. The use of coal to fuel warships' steam

28 Bernard Brodie, *Sea Power in the Machine Age* (New York: Greenwood Press, 1969). Originally published in 1941 and 1943 by the Princeton University Press.

29 Geoffrey Till*, Seapower: A Guide for the Twenty-First Century* (New York: Routledge Press, 2009), p. 61. The Admiralty advanced this view in preparation for the 1902 Colonial Conference.

30 See H. S. K. Kent, "The Historical Origins of the Three-Mile Limit," *The American Journal of International Law*, October 1954, pp. 537–53. This established limit has been referred to as the "cannon-shot" rule. Were one to apply this rule today, states could logically claim sovereignty over waters much farther off their coasts. This could represent an important precedent for maritime competitors in a mature precision-strike regime who also have an undersea economic infrastructure along their continental shelf. Given both the considerable economic value of this infrastructure and the ability to defend it from land-based forces, competitors with these capabilities may assert that their sovereignty now extends far out to sea. This issue will be elaborated upon later.

boilers required major navies seeking to operate on a global scale to create a worldwide network of coaling stations.

Progress across a range of technologies, including metallurgy, propulsion, and explosives, produced a rapid turnover in warship classes as rival navies sought to exploit the ongoing improvements in armor, firepower, and engines. The broad march of military technology compelled a rethinking of the capital ship, or battleship. This led to what has been termed by some as the *Dreadnought* Revolution, in reference to the Royal Navy's construction of the first modern battleship, HMS *Dreadnought*, launched in 1906. The *Dreadnought*, inspired by the Royal Navy's First Sea Lord, Admiral "Jackie" Fisher, employed turbine engines in lieu of the standard reciprocating engines of the time. Along with enhanced reliability, this capability gave it unprecedented speed. Advances in metallurgy enabled the construction of ever-more powerful guns to the point that by World War I the range of naval artillery employing 15-inch guns extended to 20,000 yards, or nearly 10 nm.[31] This enabled the British to arm the *Dreadnought* uniformly with large-caliber guns, which permitted the ship to engage with far greater firepower than its predecessors at unprecedented ranges.

But the big-gun battleship was only part of the story in the new century's first decade. At the time, great strides were being made in terms of communications in the form of undersea telecommunications cables and wireless.[32] Together these advances provided an orders-of-magnitude leap in maritime forces' strategic situational awareness. Submarines, torpedoes, and mines, while military novelties for much of the nineteenth century, were also rapidly maturing as effective weapon systems. While mines were employed with some success in the Crimean and American Civil wars, it was not until the late nineteenth century that many countries began employing them as their primary coastal defense weapon. Along with mines, small craft armed with torpedoes known, appropriately, as torpedo boats made it increasingly risky for a rival's battle fleet to attempt a close blockade. Torpedo boat destroyers—the forerunners of the destroyer—were designed to address the problem, but failed to do so as the risks of mounting a close blockade skyrocketed with the introduction of contact mines. Mines proved their value during the 1904–1905 Russo-Japanese War when they destroyed one Russian battleship, two Japanese battleships, and one Japanese cruiser.[33]

The proliferation of new military capabilities at the dawn of the twentieth century greatly complicated thinking about the maritime competition. Even operations associated with the traditional line of battle were thought to be outdated and in need of reevaluation.

31 John T. Kuehn, *Agents of Innovation* (Annapolis, MD: Naval Institute Press, 2008), p. 79. Between the world wars, the U.S. Navy explored modifying the turrets of World War I-era battleships, like those of the USS *Florida* and USS *Utah*. By increasing their main guns' elevation to 30 degrees, the Navy concluded their range could be more than doubled to over 33,000 yards, or over 16 nautical miles.

32 The term "wireless" was common at that time. The more familiar term today is "radio."

33 "Naval Mine," available at http://en.wikipedia.org/wiki/Naval_mine#Early_20th_century, accessed on December 11, 2012.

By 1909 one of Admiral Fisher's acolytes, Rear Admiral Reginald Bacon,[34] was moved to declare that:

> The battleship as now known will probably develop from a single ship into a battle unit consisting of a large armoured cruiser with attendant torpedo craft. Line of battle, as we now know it, will be radically modified…The tactics of such units open up a vista of most exhilarating speculation.[35]

Bacon proved right. By the time of the Battle of Jutland in 1916, battle fleet maneuvers to battleships, or "dreadnoughts," but also included battle cruisers and destroyers, with the ships relying on wireless to impose some degree of command and control amid the chaos of battle. The Royal Navy was also at the vanguard of naval aviation during World War I and had a seaplane tender at the battle to provide aerial reconnaissance as well as airships, although they did not see action. More broadly, the Royal Navy modified ships to carry aircraft and conducted strike operations from them. HMS *Argus*, completed in September 1918, was the first true aircraft carrier.

The naval revolution was not limited to the battle line. Submarines transformed the commerce-raiding and blockade missions, operations once reserved for cruisers and the battle fleet.

The naval revolution was not limited to the battle line. Submarines transformed commerce-raiding and blockade missions, operations once reserved for cruisers and the battle fleet, respectively. When combined with torpedo boats and mines, submarines made it highly risky for surface warships to enter coastal waters. Thanks to their stealth, increased range, and great advances in torpedoes, they were able to menace commerce at sea, and in so doing created a new form of blockade.

The proliferation of submarines, mines, and torpedoes aided inferior maritime competitors, enabling them to field what might be described as a proto maritime A2/AD force.[36] Britain, the dominant naval power of the time, also recognized the defensive benefits of these instruments of war. As one senior official in the British Admiralty put it,

> The introduction of [the submarine and torpedo]…will strengthen our position. We have no desire to invade any other country; it's important that we ourselves are not invaded. If the submarine proves as formidable as some authorities think is likely to be the case, the bombardment of our ports, and the landing of troops on our shores will become absolutely impossible.[37]

At the outset of World War I in 1914, the combination of German mines, torpedo boats, and modern submarines made it too hazardous for the Royal Navy to approach Germany's naval bases and major ports. Consequently, the Royal Navy was compelled to abandon its traditional operation of close blockade when confronted by Germany's A2/AD threat. Yet

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34 Fisher chose Bacon to be the first captain of the *Dreadnought*.

35 Reginald Bacon, "The Battleship of the Future," *Transactions of the Institute of Naval Architects*, 1910, pp. 1–9.

36 For the purposes of this paper, anti-access (A2) capabilities are defined as those associated with denying access to major fixed-point locations, especially large forward bases, whereas area-denial (AD) capabilities are those that threaten mobile targets over an area of operations, principally maritime and air forces, including those beyond the littorals.

37 Lambert, *Sir John Fisher's Naval Revolution*, pp. 49–50.

fortune smiled on the British fleet in the form of geography, which enabled it to adopt a distant blockade stretching from Britain to Scandinavia and across the English Channel.

The Rise of Aviation and Radar

Following World War I, navies of the major maritime powers experimented with operational concepts and new warship designs within the confines of the Washington Naval Treaty arms limitations to exploit the opportunity that arose with the advent of the Dreadnought Revolution and extended-range gunnery. This advantage in range could be fully realized only if it could be brought to bear accurately. Prior to the war, the Royal Navy had attempted, with mixed success, to improve gunnery accuracy with systems such as those proposed by Arthur Pollen and Sir Frederic Dreyer.[38] Following the war, the leading navies found that rapid advances in aviation technology enabled aircraft to be used as spotters, greatly enhancing the accuracy of long-range gunnery.[39]

The sustained rapid pace of advances in aviation technology enabled carrier-borne aircraft to increase their range, endurance, and payload. As this occurred, attack aircraft operating off carriers provided an order-of-magnitude leap in maritime forces' effective striking range, from tens of miles to hundreds of miles. Their bomb payload also increased substantially. Beginning in the late 1920s, U.S. carrier aircraft began evolving beyond reconnaissance and spotting missions in fleet exercises (known as "fleet problems") to conduct strike operations as well. Moreover, through experimentation the U.S. fleet determined that its strike aircraft had a remarkably high likelihood of successfully striking their targets via dive bombing and torpedo bombing—if they could penetrate enemy defenses.[40] Consequently, by the late 1930s some argued the carrier's strike arm provided the fleet with a potential means of destroying or neutralizing capital ships at far greater ranges than was possible with naval gunfire.

38 For a detailed treatment of this issue, see John Tetsuro Sumida, *In Defence of Naval Supremacy: Finance, Technology and British Naval Policy, 1890–1914* (Boston: Unwin Hyman, 1989).

39 In March 1919 the U.S. Navy battleship USS *Texas* conducted a main-battery gun exercise employing air spotting. The results were "many times better than was done by ship's spotters." Highly impressed with the results, the captain of the *Texas*, N. C. Twining, stated flatly that "the Fleet that neglects aviation development will be at an enormous disadvantage in an engagement with a modern enemy fleet." Suddenly, aircraft assumed great importance, as did the aircraft carrier, since it was the carrier alone that had the potential to provide the necessary numbers of aircraft. Commanding Officer, USS *Texas*, letter to Commander in Chief, Atlantic Fleet, March 10, 1919, read into the record of General Board Hearings (GBH), 1919, p. 926, cited in Charles M. Melhorn, *Two-Block Fox* (Annapolis, MD: Naval Institute Press, 1974), p. 37.

40 The U.S. Navy developed dive-bombing techniques in the 1920s. By the late 1930s the Navy had fielded a radio-controlled drone aircraft that could simulate a dive-bombing attack. Tests soon revealed fleet defenses against this form of attack were "quite inadequate." See Thomas C. Hone, Mark D. Mandeles, and Norman Friedman, *The Introduction of Carrier Aviation into the U.S. Navy and Royal Navy: Military-Technical Revolutions, Organizations, and the Problems of Decision* (unpublished paper: May 12, 1994), pp. 103–4; Thomas Wildenberg, *Destined for Glory* (Annapolis, MD: Naval Institute Press, 1998), p. 194; and Thomas C. Hone, Norman Friedman, and Mark D. Mandeles, *American and British Aircraft Carrier Development, 1919–1941* (Annapolis, MD: Naval Institute Press, 1999), p. 164.

Of course, the greater an aircraft's range, the greater the area over which strikes could be conducted. Searching this greatly expanded area for attractive targets became a challenge in itself. For example, by extending the strike range of both sea- and land-based forces from roughly 20 nm (the distance that the most powerful naval guns could reach, such as those of Japan's *Yamato*-class 18.1-inch guns and the United States' *Iowa*-class sixteen-inch guns) to some 300 miles (the furthest reach of 1940s-era carrier strike aircraft) the prospective search area increased, not by a factor of fifteen, but by a factor of over two hundred. Naval commanders now confronted the formidable problem of locating the enemy fleet over such an expansive area.[41]

Thus it became that in the Pacific theater during World War II, U.S. and Japanese sea-based and land-based patrol and scouting[42] aircraft were used principally to find the enemy fleet, not to guide fires from their own fleet's battle line, and to direct strike aircraft to the enemy's location. The ability to strike at greatly extended ranges combined with the ability to scout over vast areas represented, in a crude form, what Soviet military theorists would later refer to as a "reconnaissance-strike complex."[43]

The absence of an effective early warning system consisting of radar and long-range radio detection finding in the year after.[44] The competition favored the offense. As such, locating the enemy fleet to enable a first strike was the top priority at battles such as the Coral Sea and Midway. In the latter battle, cryptanalysis provided critical information to the Americans regarding Japanese intentions and the likely location of their fleet, which

41 Of course it is often possible to anticipate an enemy fleet's likely general position or path of approach, making the search problem more manageable. However, as in land and air warfare, this gives the enemy an incentive to take an unexpected route where possible.

42 As used in this assessment, the term "scouting" is as defined by Wayne Hughes: "Scouting is information gathered by any and all means—reconnaissance, surveillance, cryptanalysis, or any other type of what some call information warfare. But the scouting process is not complete until the information is delivered to the tactical commander." Wayne P. Hughes, Jr., "Naval Tactics and Their Influence on Strategy," *Naval War College Review*, January–February 1986, p. 8.

43 First Soviet and later American military theorists used the term "reconnaissance-strike complex" to describe system-of-systems capable of locating and accurately striking distant targets more or less independent of range. Ogarkov, "The Defense of Socialism: Experience of History and the Present Day," p. R19. This theme was picked up in, among other American writings, Andrew F. Krepinevich, *The Military-Technical Revolution: A Preliminary Assessment* (Washington, DC: Center for Strategic and Budgetary Assessments, 2002). The latter document originally appeared in July 1992, produced by the Defense Department's Office of Net Assessment.

44 U.S. carriers and battleships did have primitive air search radars, but their range was quite limited. This, combined with the approach speed of enemy attack aircraft, precluded the reinforcement of any friendly combat air patrol aircraft or the massing of anti-aircraft assets on other ships to aid in the defense.

greatly eased the U.S. scouting problem, thereby increasing the chances of a successful U.S. first strike against the opposing carriers. The result was a decisive U.S. victory.[45]

Between the world wars, advances in radio and the invention of radar provided a starting point for further advances during World War II. Once the United States incorporated radar, radio, and thick layers of air defense guns into the fleet, the situation in the Pacific theater was reversed. Radar enabled the U.S. fleet to develop an effective early warning system against Japanese air attack, and progress in radio operations enabled improved coordination between interceptor aircraft and the U.S. fleet's Combat Information Centers (CIC) that vectored combat air patrol (CAP) fighter aircraft to intercept incoming aircraft. The U.S. commander's ability to wait until the approach of enemy aircraft before vectoring and reinforcing defensive combat air patrols greatly enhanced fleet defense. To exploit these advantages, U.S. commanders substantially increased the number of fighter aircraft relative to strike aircraft in the carrier air wing.[46] Dense anti-aircraft batteries on ships further enhanced the fleet's protection from air attack.[47]

As the case studies that follow further demonstrate, the dramatic advances in maritime military capabilities between the two world wars greatly altered the competition. Moreover, the pace of change remained brisk after World War II, in no small measure because of the intense competition between the United States and the Soviet Union during the Cold War.

Case Study: Mediterranean Operations in World War II

Advances in military capabilities since World War II have created the potential to shrink the world's oceans to what we might call "Mediterranean size." These capabilities range from satellites to sensors; long-range ISR; strike platforms and missiles;

45 While U.S. cryptologists greatly eased the fleet's scouting problem, it did not eliminate it. There was more than a trivial amount of chance associated with the U.S. strike aircrafts' locating the Japanese carriers. While aircraft from *Enterprise* and *Yorktown* were successful, the *Hornet's* scouting effort failed entirely to locate the enemy carriers.

46 See Hughes, *Fleet Tactics and Coastal Combat*, pp. 107, 114–16, 117–44. Between 1942 and 1944 the percentage of fighter aircraft making up a U.S. carrier air wing increased from roughly 25 percent to 65 percent. Hughes shows how "good sensing and scouting could overcome better firepower." In particular, he demonstrates how radar, radio, and communications intelligence, when properly combined with other elements of the maritime force (including land-based systems), represented a major source of competitive advantage. This shift in the carrier air wing's composition was also due to the decline of the Imperial Japanese Navy's carrier forces following the Battle of Midway. With fewer Japanese carriers on the prowl, there was less need to maintain as strong a strike arm on U.S. carriers. The Americans placed greater emphasis on providing close air support to Army and Marine Corps ground forces ashore, which also involved fighter aircraft flying escort for the attack aircraft. I am indebted to my colleague Bryan Clark for this observation.

47 Of particular importance was the United States' introduction of anti-aircraft munitions with radio-frequency (RF) proximity fuses, which by at least one estimate produced a sevenfold increase in the effectiveness of American anti-aircraft defenses. Vannevar Bush, *Pieces of the Action* (New York: William Morrow and Company, Inc., 1970), p. 109.

advanced battle networks to filter, organize, analyze, and transmit high volumes of data and information; and more accurate munitions along with the ability to deliver them along increasingly compressed timelines. Thus the maritime competition in the Mediterranean, from Italy's entry into the war in June 1940 until the collapse of the Axis position in North Africa in the spring of 1943, may represent a kind of "precursor" war, providing useful insights regarding maritime operations where the challenge of finding enemy surface combatants and transports is small compared with what it was in the Atlantic or Pacific theaters of operations at that time.

Between the two world wars, *land-based* air power began exerting a significant influence on thinking about the maritime competition. For the first time, weapon systems operating in and striking from a different domain (land and air, respectively) became important in assessing the maritime balance. Land-based air power was generally less expensive than sea-based air power. Land-based systems were also less constrained in their size. They could operate from much larger bases and off much longer runways than a carrier "base," which meant they could fly longer ranges, have greater endurance, and carry heavier bomb loads.

For the first time, weapon systems operating in and striking from a different domain (land and air, respectively) became important in assessing the maritime balance.

The long range of land-based aircraft meant they could scout targets over greater distances and areas. Advances in radio technology enabled them to report sightings of enemy ships almost instantaneously to their command elements. Finally, code breaking could, and did, at times significantly enhance the "scouting" efforts of the warring powers.[48]

The combination of land-based air power with enhanced scouting and command and control by exploiting the radio frequency (RF) spectrum exerted a major influence on the maritime competition, nowhere greater perhaps than in the Mediterranean theater. Indeed, a major feature of World War II maritime operations in the Mediterranean centered on the difficulty surface warships and cargo ships had in avoiding detection.

The challenges of operating in the Mediterranean in the wake of rapid advances in aviation and radio technology were anticipated by navies, most notably Great Britain's Royal Navy, long the region's dominant naval power. Prior to the war, the Admiralty grew increasingly concerned over its ability to conduct effective operations in the event of war with Italy. Admiral Dudley Pound, the commander-in-chief of the Mediterranean Fleet from 1935 to 1939, observed that "with present-day communications and long-range aircraft the Mediterranean has become a very small place." He forecast that, in the event of war, even "the movement of a single auxiliary from, say, Malta to Alexandria will become a major operation."[49]

Once Italy entered the war against Britain, the combination of Italian and (later) German reconnaissance and strike aircraft with submarine patrols made movement

48 Norman Friedman, *Network-Centric Warfare: How Navies Learned to Fight Smarter through Three World Wars* (Annapolis, MD: Naval Institute Press, 2009), pp. 10–11, 27–29.

49 Christopher M. Bell, *The Royal Navy, Seapower and Strategy Between the Wars* (Stanford, CA: Stanford University Press, 2000), p. 120.

by surface warships or transports a risky business. This was particularly the case in the central Mediterranean, where Britain's island base at Malta was sandwiched between Axis forces in Italy and Libya. The Axis powers also laid down mine belts extending from Sicily to Tunisia, further complicating Royal Navy surface ships' efforts to interdict supplies moving from Italy to support Italian and German forces in North Africa, and to move supplies from Gibraltar or Alexandria to Malta. This compelled the British to rely increasingly on aircraft and submarines for interdiction.[50] Consequently, the overwhelming majority of Axis merchant shipping sunk during Italy's involvement in the war resulted from attacks by allied aircraft and submarines. During the climactic battles in North Africa from January through May 1943, Allied air and submarine forces were responsible, either by themselves or in combination, for over 96 percent of Axis transports sent to the bottom, whereas attacks by surface warships were responsible for less than 4 percent of the losses (see Table 1).

TABLE 1: AXIS MERCHANT SHIPPING SUNK, JANUARY–MAY 1943[51]

Ships Sunk/ Tonnage Sunk	By Surface Ships	By Aircraft	By Submarine	Shared	Total
Ships	8	87	52	25	172
Tonnage	19,070	297,825	159,448	77,016	553,359
Percentage of Total Tonnage	3.4%	53.8%	28.8%	13.9%	

Note: The percentages do not total 100, due to rounding to one decimal place.

While the British relied heavily on submarines and aircraft for strike operations, their own supplies and troops could only be moved by transports. The handful of critical Allied convoys that had to move across the Mediterranean, often between Gibraltar and Malta, and between Malta and Alexandria, were compelled to use deception and night movement in attempting to avoid being detected by enemy aerial reconnaissance. Even assigning carriers to escort the transports offered no guarantee of success against land-based reconnaissance and strike aircraft. In January 1941 the British carrier *Illustrious* was severely damaged by German Junkers Ju-87 "Stuka" dive bombers while convoying.[52]

50 Britain's successful breaking of Germany's Enigma code was crucial in enabling aircraft and submarines to locate their targets.

51 Vincent P. O'Hara, *Struggle for the Middle Sea* (Annapolis, MD: Naval Institute Press, 2009), p. 207.

52 John Weal, *Junkers Ju 87: Stukageschwader of North Africa and the Mediterranean* (Oxford: Osprey Publishing Ltd., 1998), pp. 7–9.

According to maritime scholars, "[T]he fate of the *Illustrious* suggests that the role of carriers as both power projectors ashore and fleet-defense vessels was sharply circumscribed when confronted by [comparable] land-based airpower."[53] Carriers experienced particular difficulty in protecting either themselves or the ships around them from determined dive-bombing attacks. Given the risks involved, many British convoys heading for Egypt were routed around Africa owing to the high risk of running the Mediterranean gauntlet.

On more than one occasion code breaking enabled one side to gain a major "scouting" advantage. The British were at times able to leverage their cryptanalysis—the breaking of German Enigma codes through Ultra decryptions.[54] For example, in March 1941 Ultra code breakers informed the Royal Navy of planned Italian fleet movements. This enabled Admiral Cunningham to intercept the Italian fleet at the Battle of Cape Matapan off the southwest coast of Greece on March 27–29, 1941. In the battle, the Italians lost three heavy cruisers and two destroyers, and had one battleship heavily damaged at the cost of only minor damage to four Royal Navy light cruisers.

The battle, which produced Italy's greatest at-sea defeat[55] in the war, revealed its deficiency in air "reconnaissance-strike" operations. Vice Admiral Angelo Iachino, who served as the *Regia Marina*'s fleet commander from December 1940 through April 1943,[56] saw the battle as revealing Italy's "inferiority in aero-naval cooperation and the backwardness of our night-battle technology [i.e., radar]."[57] In the wake of its defeat, the *Regia Marina* was directed "not to venture outside land fighter aircraft range, and…to avoid night clashes until…equipped with radar."[58]

53 Lisle A. Rose, *Power at Sea: The Breaking Storm, 1919–1945* (Columbia, MO: University of Missouri Press, 2007), p. 369. The term "comparable" is key here. Obviously if the naval force comprises many carriers and the land force has but a few obsolescent aircraft, the balance will favor the former. The rationale for choosing the period from June 1940 to May 1943 is that the military balance was arguably roughly equal during that time.

54 In June 1941 the British military intelligence adopted "Ultra" as the designation for signals intelligence obtained by breaking high-level encrypted enemy radio and teleprinter communications at the Government Code and Cypher School (GC&CS) at Bletchley Park. The designation was subsequently adopted by western Allies and used throughout the remainder of the war for all such intelligence. F. H. Hinsley, *Codebreakers: The Inside Story of Bletchley Park* (Oxford: Oxford University Press, 2001), p. xx.

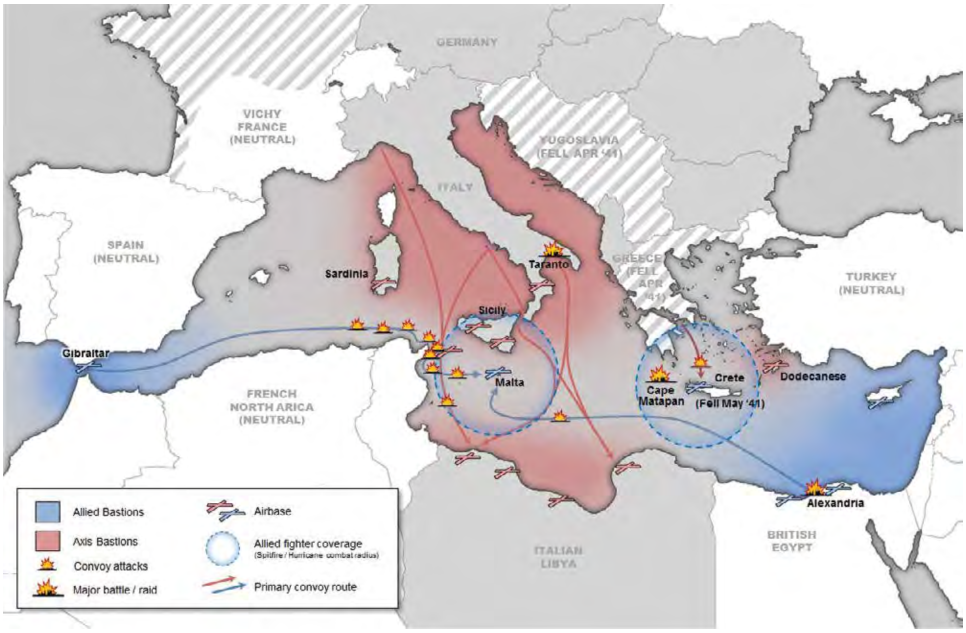
55 It bears noting that the Italian losses suffered from the British air attack on its naval base at Taranto in November 1940 were far greater.

56 Italy was at war from June 1940 until September 1943.

57 The Italian air force and navy, although in some ways possessing equipment superior to that of the British, proved incapable of establishing effective coordination during the war. The problem was highlighted at the Battle of Cape Matapan, when little of the air support expected by the Italian fleet commander arrived. Angelo Iachino, *Tramonto di una grande marina* [Sunset of a great navy] (Verona: Alberto Mondadori, 1966), p. 245, cited in O'Hara, *Struggle for the Middle Sea,* p. 98.

58 Iachino, *Tramonto di una grande marina*, p. 245; cited in O'Hara, *Struggle for the Middle Sea*, p. 98.

FIGURE 1: SELECTED MARITIME OPERATIONS IN THE MEDITERRANEAN THEATER



Traditional naval power in the form of surface warships also proved incapable of fending off an island invasion against an enemy that controlled the air, even when supported by naval aviation forces. When German airborne forces assaulted Crete in May 1941 they paid a high price in casualties. But the Royal Navy paid an even higher price. Forced to concentrate near Crete to oppose the German assault, the British greatly eased the *Luftwaffe's* scouting problem. Admiral Cunningham, who commanded British naval forces in the Mediterranean during the critical stage of the war in that theater from 1940 to 1943, concluded that in a "trial of strength between the Mediterranean Fleet and the German Air Force . . . [the] enemy command of the air unchallenged by our own air force in these restricted waters with Mediterranean weather is too great odds for us." He also concluded that:

> The experience of three days in which two cruisers and four destroyers have been sunk and one battleship, two cruisers and four destroyers severely damaged shows what losses are likely to be [should the fleet be ordered to maintain control of the seas around Crete without the benefit of sufficient air cover]. Sea control in the Eastern Mediterranean could not be retained after another such experience.[59]

[59] Rose, *Power at Sea*, p. 374. The British suffered these losses even though intercepts of the Luftwaffe's Enigma codes gave the Royal Navy two weeks' advance notice of Germany's intention to assault Crete with paratroopers.

As noted above, the vulnerability of surface ships, even carriers, against air forces led both the British and the Italians to resort to other forms of maritime power, such as submarines and mines. Moreover, the Italians also employed torpedo boats along with their submarine forces to good effect, particularly in narrow waters. Italian special operations forces undertook several raids with impressive results, including an attack by frogmen on the British naval base at Alexandria in December 1941 in which they sank the Royal Navy battleships *Queen Elizabeth* and *Valiant*.[60]

What insights might we derive from an examination of the maritime competition in the Mediterranean regarding the prospective characteristics of a mature maritime precision-strike regime? Several suggest themselves.

First, in a mature maritime precision-strike regime the dramatic improvements in land- and space-based scouting systems (and in undersea sensor arrays) will "shrink" the oceanic maritime domain to "Mediterranean-size," and in so doing make operating surface combatants and transports within these systems' effective range a risky proposition (see Figure 2). This is not to say that all surface ships and shipping will be swept from the seas, but that those ships operating in such an environment will likely experience attrition more comparable to that suffered by the Royal Navy and the *Regia Marina* in the Mediterranean during World War II than the U.S. Navy has suffered in the major regional conflicts since that war.

The aphorism "A ship's a fool to fight a fort" applies here. While the term originated in the age of cannon and sail, it held true during the Mediterranean campaigns in World War II and seems likely to hold true in a mature maritime precision-strike regime. A land-based fort could mass greater firepower and stock a deeper magazine than a man-of-war, and a land-based "reconnaissance-strike" complex made up of scouting and strike aircraft could best a surface fleet. Similarly, the extended ranges and high accuracies of the missiles that will characterize a mature maritime precision-strike regime will find surface ships vulnerable to shore-based weaponry at distances ranging from hundreds to perhaps to a thousand miles or more.[61] While some land-based strike forces will operate from fixed "forts" (e.g., air bases) and be relatively easy to locate and strike, others, such as mobile missile launchers and their complement of missiles, may prove far more difficult to find and engage successfully than a major surface warship at sea.[62]

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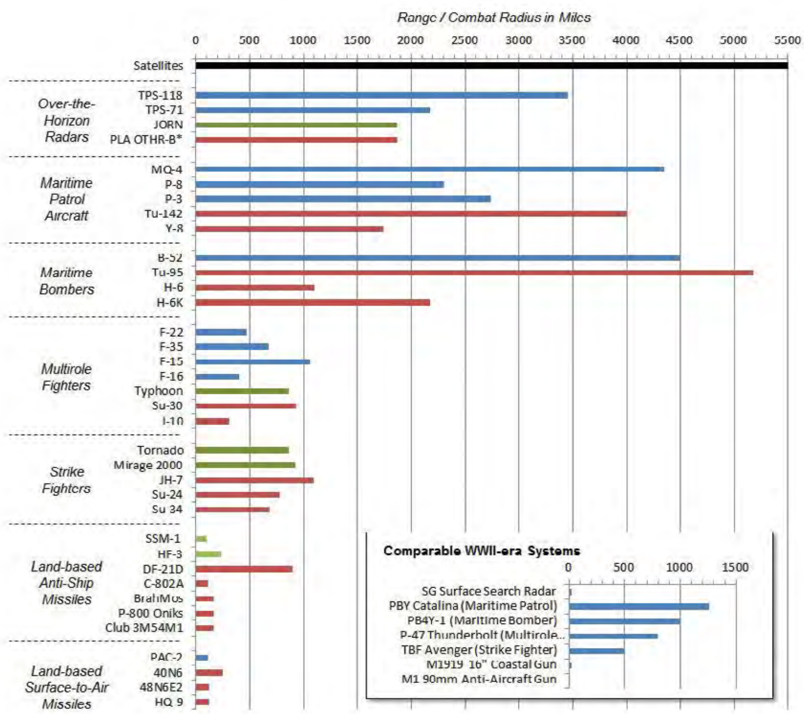
60 Rose, *Power at Sea*, p. 377. These ships were later raised.

61 Again, the statements here regarding the character of the competition assume that both sides have roughly equal resources. Obviously a large fleet could defeat a weakly armed and defended "fort," or minor military power. The ability to leverage technology could also play an important role. For example, since magazine size is to a significant degree the basis of the fort's advantage, this could change if a fleet were to introduce directed-energy systems (lasers and rail guns) unavailable to its land-based rival. Such an asymmetry could do much to redress the magazine imbalance. Yet one also suspects that land-based directed-energy systems could be made far more powerful than those based on surface warships, and that a monopoly in such systems would be difficult to sustain over a protracted period. Moreover, a fort could almost certainly be "hardened" against directed-energy attacks far more easily and cheaply than a surface warship.

62 Land air bases can be hardened to a much greater degree than a surface ship, and their runways can typically be more easily and rapidly repaired than a ship's superstructure or a carrier's flight deck.

FIGURE 2: COMBAT RADIUS AND RANGE OF MODERN LAND-BASED SYSTEMS



In a mature maritime precision-strike regime, major powers may have a strong incentive to increase significantly the ratio of undersea to surface striking capacity.

Second, as a direct result of land-based forces and the relatively small size of the Mediterranean, surface warships essentially "sat out" much of the Mediterranean campaign owing to the high risk of operating within an enemy's land-based air scouting and strike elements. When they did not, surface ships were often badly bloodied even in those rare cases where they brought their own carrier-based air with them. Translating this insight to the time frame of this assessment, absent a breakthrough in active defenses, asymmetries in the magazine depths between shore bases and surface warships will likely make it difficult to project power against a first-class military power's land-based scouting and strike forces, especially if they are dispersed and mobile, even if the fleet possesses its own extended-range air and missile forces. Undersea forces, however, would be far less exposed to land-based ISR and strike elements. In a mature maritime precision-strike regime, therefore, major powers may have a strong incentive to increase significantly the ratio of undersea to surface striking capacity.

While surface warships may have the option of not steaming in harm's way, the option may not present itself for transport ships that provide badly needed supplies, military or otherwise, to critical destinations located within an enemy's A2/AD threat range. While the British employed novel tactics in some cases to slip their convoys through to Malta, at times they simply had to route them around Africa if they wanted to reach

Suez from Britain, though at a considerable cost in materiel, cargo capacity, and time. As with surface warships the threat stemmed not only from land-based air but from submarines and mines as well. And while Britain was able to win the Battle of the Atlantic against Germany's commerce-raiding submarines and employ "workarounds" in the Mediterranean, the favorable weight of resources the Royal Navy enjoyed in the former theater and the geographic advantage it had in the latter theater (the ability to take a safe alternate route around Africa) may not be available to those relying on seaborne trade in a mature maritime precision-strike regime.

Indeed, with the range of scouting and strike systems (including nuclear-powered submarines) having increased so dramatically since World War II, geography may offer little if any advantage save perhaps at greatly extended (1,000 nm-plus) ranges. Should commerce protection prove difficult, or perhaps even impractical in a mature maritime precision-strike regime, a competitor's level of autarky could represent a major advantage, especially in a protracted conflict. Those competitors who are relatively self-sufficient may be incentivized to posture themselves for protracted war, and be content to remain outside an enemy's effective scouting and strike ranges. Those who are not may posture themselves to achieve victory in a short campaign, or undertake a major (and costly) program to stockpile strategic materials.

Then there is the matter of maritime "outposts"—including countries—that are behind an enemy's A2/AD lines. Britain proved unable to defend the island of Crete against German assault in May 1941. Despite its great advantage in naval power, Britain could not prevent a successful German airborne assault on the island, enabled by land-based *Luftwaffe* air support. Conversely, Britain's ability to maintain sufficient land-based air power on the island of Malta helped prevent its falling to the Axis powers despite its close proximity to Sicily, Italian and German land-based air, and the *Regia Marina*'s local (though short-lived) predominance. It may be that not just islands but countries, even major island countries (like Japan and Taiwan), risk becoming "outposts" within range of an enemy's maritime scouting and strike forces. Against a major adversary, these outposts may be difficult if not impossible to defend in the event of war.

As the Italians discovered, the ability to scout at great range and to engage at great range is of far less value—especially against mobile targets at sea—if the scouting information cannot be quickly communicated. Just as radio communications proved of key importance to effective scouting, and by extension fighter vectoring and maritime strike operations, the ability to communicate along similar lines will be important in a mature maritime precision-strike regime, particularly in areas where the scouting and strike distances are far greater than they were in the Mediterranean.

At first blush this would appear to put a premium on engaging with missile forces, as opposed to munitions carried by air platforms, given that missiles—particularly ballistic missiles—can travel substantially faster than any aircraft or submarine employing homing torpedoes. However, given the high cost of long-range missiles, the need to minimize the delay between identifying a target and striking it, and reductions in PGM size and weight, militaries will likely find it increasingly attractive to *combine* the scouting and striking function on the same platform where possible, as the U.S. military has done by placing munitions on its Predator scouting drone.[63]

Given the importance of communications, just as Ultra at times provided a major scouting advantage for the allies in the Mediterranean theater, cryptanalysis and cyber warfare may prove important—and perhaps decisive—in a mature maritime precision-strike regime where operations must be coordinated over vast distances and at times along very tight timelines (e.g., in engaging surface combatants at very long range).

Case Study: The Kamikazes

Since the mature maritime precision-strike regime is defined in part by the widespread proliferation of precision-strike munitions and delivery systems, it may be useful to examine the first (and to this point, only) extensive use of munitions that possessed many of these characteristics by one major maritime power against another. Interestingly, these weapons fused both the "scouting" and the munitions on one platform. We refer, of course, to Japan's employment of its kamikaze forces against the U.S. fleet in the Pacific theater of operations in World War II.

By 1944 American forces had effectively crippled Japan's fleet air arm. As the U.S. Navy moved closer to Japan's home waters, however, Japan's defense perimeter correspondingly contracted. Consequently Japan's reconnaissance problem was alleviated significantly as its depleted scouting forces had far less area to search for the approaching U.S. fleet, especially since the American campaign centered on seizing Japanese-held islands to use as bases for future U.S. operations.

With its air strike capabilities depleted following defeats in a series of battles and campaigns stretching back to the Battle of Midway, in desperation the Japanese employed "precision-guided" weaponry in the form of its kamikaze pilots. The Kamikazes, from the Japanese for "divine wind," were pilots who used their aircraft to conduct suicide attacks on allied warships during the closing months of World War II. These aircraft were among

63 Many submarines can employ both anti-ship missiles and homing torpedoes, which should also be regarded as precision-guided weapons. If ships are close enough to be engaged with torpedoes, the scouting-to-shooting lag time is not likely to be a significant issue, although diesel submarines (and, to a lesser degree, their nuclear counterparts) must get into proper firing position relative to the target in order to have a high-probability-of-hit shot. Conversation with Captain (U.S. Navy, retired) Jan van Tol, March 15, 2014.

the earliest precision-guided weapons, but at the price of sacrificing their human pilots. One could thus describe the kamikazes as human-guided cruise missiles. Japan conducted some 2,800 kamikaze attacks toward the end of the Pacific War in 1944–45.[64]

The U.S. (principally) and British fleets put up strong defenses against kamikaze attacks. They included a picket line of destroyers on the periphery of the fleet. These radar pickets typically comprised several destroyers and some support ships. They provided the outermost part of a defense-in-depth that included radar detection and cuing, airborne interception and attrition, and massive anti-aircraft barrages. Despite these defenses during the Philippines Campaign and at Okinawa, roughly fourteen percent of kamikaze fighters survived to score a hit on a ship.[65] Of those ships hit, forty-seven vessels, or roughly 8.5 percent, sank, whereas over 300 ships suffered significant damage.[66] In the opinion of Admiral Raymond Spruance, who commanded U.S. forces at both the Philippines in 1944 and at Okinawa in 1945, the kamikazes were the ultimate guided weapon.[67] The ability of allied ships to absorb hits and survive is a tribute to their crew's damage-control training and equipment, and the quality of their construction, including the ability to incorporate lessons learned earlier in the war.[68]

The lightly armored ships along the picket line bore the brunt of the kamikaze attacks. There were only thirty-seven kamikaze attempts on battleships and forty-two attempts on cruisers; none of these more heavily armored ships that were hit sunk. There were 303 attempts on destroyers and 428 on auxiliary and landing ships. The preference for attacks on these ships may have been because the Japanese encountered the picket line ships first, or because they believed striking such ships offered the greatest chance of creating a mission kill or actually sinking their target. With respect to destroyers, ninety-two kamikazes made successful hits, sinking twelve ships. There were 121 successful

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64 Richard P. Hallion, "Military Technology and the Pacific War," in Jacob Neufeld, William T. Y'Blood, and Mary Lee Jefferson, eds., *Pearl to V-J Day: World War II in the Pacific* (Bethesda, MD: Air Force History and Museums Program, 2000), p. 85.

65 Difficulty in obtaining data on the kamikazes has produced some significantly differing estimates regarding their operation and performance. For example, a postwar assessment concluded that roughly one-third of all kamikaze fighters that left their bases succeeded in hitting a ship—a success rate seven-to-ten times that of a conventional sortie, but also more than twice the rate cited in other assessments. Nicolai Timenes, Jr., *Defense Against Kamikaze Attacks in World War II and Its Relevance to Anti-Ship Missile Defense Volume I: An Analytical History of Kamikaze Attacks Against Ships of the United States Navy During World War II*, Operations Evaluation Group Study 741 (Washington, DC: Center for Naval Analyses, November 1970), pp. 60–64, cited in Ronald H. Spector, *At War, At Sea* (New York: Viking Press, 2001), p. 312.

66 Timenes, *Defense Against Kamikaze Attacks in World War II and its Relevance to Anti-Ship Missile Defense*, p. 78.

67 Hal M. Friedman, "The Quiet Warrior Back in Newport: Admiral Spruance, the Return to the Naval War College, and the Lessons of the Pacific War, 1946–1947," *Naval War College Review*, Spring 2011, p. 122.

68 Most of the U.S. Navy's ships were not particularly well armored, the fast battleships being an exception. The latter's heavy armor was a result of their being designed and built just prior to the war when it was still envisioned that they would have to absorb punishment from the heavy shells fired by enemy battleships in a traditional battle-line engagement.

kamikaze strikes on auxiliary and landing craft, with twenty-five sinking.[69] Most of the ships that were sunk by kamikazes were not sunk by the impact, but rather by the fires they created.

Given their significant role in the Pacific theater, it is worth noting that three U.S. escort carriers were sunk by kamikaze fighters. Their demise largely resulted from their lack of armor.[70] Not only were no heavily armored U.S. warships sunk, but British aircraft carriers with their armor-plated decks proved highly resilient to such attacks, especially compared to their wood-deck U.S. counterparts. When a kamikaze struck the Royal Navy carrier *Indefatigable*'s deck, the ship suffered only a three-inch dent in its armor plate. In contrast, attacks on the U.S. carriers *Bunker Hill*, *Franklin*, and *Enterprise* knocked them out of the war.[71] As a U.S. naval liaison officer aboard the *Indefatigable* reported,

> When a kamikaze hits a U.S. carrier it means six months of repair at Pearl [Harbor]. When a kamikaze hits a Limey [British] carrier it's just a case of "Sweepers, man your brooms."[72]

One can arguably view the kamikaze attacks as precursors to the kind of attacks surface warships can expect from modern guided ASCMs.

How might our thinking about the characteristics of a mature maritime precision-strike regime be informed from an examination of the kamikaze attacks in the closing days of the Pacific campaign in World War II?

As the preceding narrative suggests, one can arguably view the kamikaze attacks as precursors to the kind of attacks surface warships can expect from modern guided anti-ship cruise missiles (ASCMs). For example, one aircraft used for kamikaze attacks, the Ohka Model 11, had a maximum dive speed of 576 mph (927 km/h) and carried a 1,200 kg warhead.[73] This is comparable to an SS-N-2 Styx, which has a speed of Mach 0.9 (1,103 km/h) and a payload of about 500 kg.[74]

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69 These data are derived from Timenes, *Defense Against Kamikaze Attacks in World War II and Its Relevance to Anti-Ship Missile Defense*, p. 78.

70 The large, fast U.S. carriers of the *Essex* class were not particularly well-armored either, as they were not expected to be engaged by enemy surface ships, and emphasis was placed on active air defenses (i.e., radar-vectored combat air patrols and large numbers of anti-aircraft artillery firing radio-frequency-fused rounds. These carriers' lack of armor (especially the flight decks) is what made many of the kamikaze hits on CVs so devastating, putting the carriers out of action for long periods.

71 Arthur Herman, *To Rule the Waves* (New York: Harper Collins, 2004), pp. 546–47.

72 Kenneth Wheeler, *The Road to Tokyo* (Chicago: Time-Life Books, 1979), p. 153.

73 Chris Bishop, *The Encyclopedia of Weapons of WWII: The Comprehensive Guide to Over 1,500 Weapons Systems, Including Tanks, Small Arms, Warplanes, Artillery, Ships, and Submarines* (New York: Metrobooks, 2002), pp. 326, 394.

74 Thomas G. Mahnken, *The Cruise Missile Challenge* (Washington, DC: Center for Strategic and Budgetary Assessments, March 2005), p. 9. Of course there is a trade-off between warhead weight, missile range, and missile speed. The Styx's warhead size could be increased to match more closely that of the Ohka 11's at the expense of reducing its speed advantage over that aircraft.

That said, warhead designs have improved dramatically since World War II, enhancing their kinetic effects.[75] Moreover, dramatic improvements in ASCM performance may be in the offing. For example, the BrahMos ASCM being developed by India and Russia is projected to have a speed of Mach 3 (3,675 km/h) and a payload of 300 kg, enabling it to deliver a significantly more powerful hit than a kamikaze.

Then there is the matter of range. The Missile Technology Control Regime prohibits the export of missiles with ranges exceeding 300 km (186 miles). It is believed that the BrahMos missile could easily have incorporated greater range, but that it was intentionally limited to facilitate exports. According to the Project 2049 Institute, China is developing the HN-2000 ASCM with a much longer range.[76]

There is no inherent barrier to simply building an extended-range ASCM carrying more fuel and a larger warhead, while still achieving high speed. The Soviet SS-N-12 Sandbox and Soviet SS-N-19 Shipwreck, two of the fastest ASCMs fielded, achieved Mach 2 speeds and carried warheads exceeding 1,000 kg and 750 kg, respectively. The ASCM's size, however, can limit its deployment on certain platforms (surface combatants, submarines, and aircraft). This might find such missiles being based primarily on land, at least until naval and air delivery platforms could be modified to accept the larger missiles.[77] It also costs more to build such a weapon, a reminder that while precision guidance provides accuracy independent of range, it does not provide range independent of cost. All other things being equal, this could reduce the number of long-range ASCMs in a competitor's inventory. Another factor that should not be ignored is scouting. It makes little sense to have a missile capable of engaging targets—particularly mobile targets such as surface ships and transports—at ranges exceeding 300 miles without the ability to locate these targets and track them. These ASCMs would likely require more scouting resources (because their engagement area would be far greater than short-range ASCMs) and more costly scouting forces (as they would need to scout over greater distances, and closer to the enemy's own scouting and strike forces).

Finally these missiles still must hit the "right" target in what may be a cluttered environment, either in reality or because the defender has created false signatures.[78] The problem of dealing with enemy attempts at deception was greatly attenuated in the case

75 Ibid., p. 11.

76 Ian Easton, *The Assassin Under the Radar: China's DH-10 Cruise Missile Program* (Washington, DC: Project 2049 Institute, October 1, 2009), available at: http://project2049.net/documents/assassin_under_radar_china_cruise_missile.pdf, accessed on January 12, 2013.

77 Both U.S. SSGNs and the *Virginia*-class nuclear-powered submarine (SSN) Payload Module (VPM) provide for larger ASCMs. Email exchange with Captain (Ret.) Karl Hasslinger, March 3, 2013.

78 The U.S. Navy, for example, fielded a 250-nm Tomahawk Anti-Ship Missile (TASM) in the 1980s, but withdrew it from service because the targeting problem proved too challenging. Indeed, even targeting the shorter-range Harpoon missile can be a challenge. Philip Ewing, "Research begins on new anti-ship missile," *Navy Times*, July 13, 2009, available at http://www.navytimes.com/news/2009/07/navy_missile_071309w/, accessed on February 12, 2013.

of the kamikazes, as human pilots solved the problem that is now given to sensors and artificial intelligence. Assuming a competitor is willing and able to pay the additional cost (and has access to the requisite technology), producing a stealthy missile that can loiter for an extended period in a target area with less risk of being engaged successfully could enhance the attacker's efforts to defeat attempts at deception. These missiles could also employ multiple means to find targets and discriminate among them. All this suggests that the competition will be dynamic given the pace of advances in stealth, sensor, and deception technologies.

If the cost of fielding large numbers of such ASCMs is sufficiently high, they may only be procured in relatively small numbers. This could significantly influence how a military organization might go about designing its surface combatants and defenses to deal with the threat within the overall context of operational concepts designed to accomplish key maritime missions (e.g., sea control, sea denial, commerce defense, and presence). This suggests there *may* be value in increasing surface ship staying power, or resilience against the ASCM threat. These defenses could be passive (such as a ship's single- or double-hull armor, automated battle damage control, and electronic countermeasures) or active (such as kinetic and directed-energy interceptors). Given the rapid advances being made in DEW, a key part of the competition may require that ASCMs be hardened to offset enhanced DEW defenses. This may be a losing proposition, however, if DEW enhancements, such as in power and beam control are both significant and sustaining (i.e., the advances persist over an extended period of time, similar to the advances in aviation between the world wars or the advances in computer processing power associated with Moore's Law).[79]

A combination of enhanced armor protection and advanced damage control, along with widely distributed internal sensors, weapons, and propulsion systems could enable surface ships operating at extended ranges to absorb ASCM attacks with a significantly greater chance of avoiding either being sunk or becoming a victim of mission kill. This being said, there are a lot of "ifs" associated with assuming that surface combatants can reverse the long trend in which the competition increasingly favors the attacker.[80]

As with the Mediterranean case study, the kamikaze example drives one's thinking toward the need to explore the ASCM-surface ship competition within the broader con-

79 See Mark Gunzinger and Chris Dougherty, *Changing the Game: The Promise of Directed-Energy Weapons* (Washington, DC: Center for Strategic and Budgetary Assessments, 2012). Moore's Law was stated by Gordon E. Moore in 1965. It asserts that the number of transistors on integrated circuits doubles every two years. Moore's Law was based on his observation that since their invention in 1958, the number of transistors on integrated circuits had, in fact, doubled roughly every two years. His prediction that this would continue has proven remarkably accurate for nearly fifty years.

80 Many ship sensor and communications antennas and waveguides are located on its superstructure and are quite fragile. It is not clear how they could be effectively hardened against kinetic and nonkinetic forms of attack. Nor it is clear that, assuming these items could be replaced quickly following an attack, spares could be purchased and maintained at acceptable cost.

text of an overall operational concept involving specific prospective adversaries. We will address the issues of competitor paths, specific contingencies, and operational concepts later in this assessment.

Case Study: The Cold War and the Mediterranean No-Go Zone

Following his experience in World War II, Admiral Spruance concluded that although the U.S. Navy's principal mission in wartime was exercising sea control where needed, accomplishing it would become increasingly difficult. He believed this to be true primarily because submarines and aircraft were making forward naval bases increasingly vulnerable to attack and because of the growing range and sophistication of aircraft, submarines, and mines.[81] In brief, Spruance can been understood as expressing concerns over the ongoing development of what today are referred to as anti-access/area-denial forces.

With the onset of the Cold War, the Soviet Union emerged as the pacing threat in nearly all areas of the military competition, including the maritime domain. Reflecting Spruance's concerns, a series of U.S. Navy fleet exercises beginning in the mid-1950s can be seen as an attempt to solve the problem first confronted by the British and Italian navies operating in the Mediterranean during World War II, when aircraft and submarines emerged as the principal ship killers in the maritime competition.

Just as parts of the Mediterranean had been a virtual no-go zone for the Royal Navy's surface fleet during World War II, a similar problem emerged for the U.S. Navy during the Cold War. Locked in a bloodless struggle with the Soviet Union, the United States sought to contain Soviet influence around the globe, including in the Eastern Mediterranean. To this end, the U.S. Navy's Sixth Fleet maintained a presence in the region. Should war erupt, one of the fleet's principal missions involved launching air attacks on the Soviet Union, including strikes with nuclear weapons. Given the range of U.S. carrier strike aircraft, the Sixth Fleet was compelled to maneuver into the Eastern Mediterranean to launch its attacks. This would bring U.S. carriers within range of Soviet land-based strike aircraft far more capable than those encountered by the Royal Navy during World War II. In addition to the threat of land-based aircraft, the U.S. Navy had to consider the Soviet Union's submarine force, which by the latter half of the 1950s had begun to challenge the Sixth Fleet's dominance of the Middle Sea. A key issue emerged for the U.S. Navy: Could the fleet sortie far enough into the Eastern Mediterranean long enough to launch its attacks, recover its aircraft, and depart before the Soviets could locate and engage it?

Just as parts of the Mediterranean had been a virtual no-go zone for the Royal Navy's surface fleet during World War II, a similar problem emerged for the United States Navy during the Cold War.

81 Hal M. Friedman, "The Quiet Warrior Back in Newport: Admiral Spruance, the Return to the Naval War College, and the Lessons of the Pacific War, 1946–1947," *Naval War College Review*, Spring 2011, p. 132.

From 1956 to 1972, the U.S. Navy experimented with a number of concepts designed to answer this question. Two of these concepts—Haystack and UPTIDE—are summarized here.[82] These experiments enabled the Navy to adapt new modes of operation to reduce the threat imposed by Soviet advances in land-based aviation and submarines. The exercises resulted in the Navy fundamentally altering its tactics by adopting dispersed operations under emission control (EMCON) and employing acoustic decoys. The lessons from the Navy's efforts offer insights as to how major maritime powers can respond to adversaries' emerging A2/AD capabilities, such as China's anti-ship ballistic missiles and information warfare tactics, as they pertain to the maritime competition.

Haystack

Beginning in 1956 the Sixth Fleet conducted a series of exercises involving experiments designed to increase the survival time of its carriers in the event of war with the Soviet Union. The exercises were stimulated by the work of a young Navy lieutenant and an operations analyst who believed the fleet's strike mission could best be accomplished by complicating the Soviet's most difficult challenge in preventing it: detecting the U.S. carriers. They asserted this could be achieved by dispersing fleet elements, operating more autonomously, employing deception methods, and minimizing communication. Applied in concert, these tactics, techniques, and procedures constituted a concept dubbed "Haystack," a reference to the adage "as difficult as finding a needle in a haystack."

The fleet began testing the Haystack concept in 1957. Three major exercises took place: Haystack Charlie, Delta, and Echo. Two aircraft carriers, their escorts, and their logistics support ships participated against an "enemy" force of conventional submarines, and land-based attack and ISR aircraft. In contrast to their practice of forming task groups, which characterized carrier operations toward the end of the Pacific campaign in World War II, the carriers operated 250 miles apart. They launched simulated nuclear strikes while enemy forces undertook to find and engage them. In the first exercise, Haystack Charlie, the carriers were able to launch roughly thirty strikes before they were located and engaged. The exercise showed that the fleet's use of cruisers and destroyers as decoys was partially successful in diverting the enemy; however, when ships were in the general proximity of the carriers, their presence aided the enemy in locating the carriers. These lessons were incorporated into Haystack Delta.

Haystack Echo found the fleet exercising amid the many small islands in the Aegean Sea. The idea was to exploit the islands' potential to confuse enemy forces and complicate their efforts to distinguish major surface combatants from the islands. The results were

82 The summary of Haystack and UPTIDE presented here is based on a more detailed discussion in Robert G. Angevine, "Hiding in Plain Sight: The U.S. Navy and Dispersed Operations under EMCON, 1956–1972," *Naval War College Review*, Spring 2011. See also Operations Evaluation Group (EOG), *The Sixth Fleet Concept and Analysis of Haystack Operations*, OEG Report 77 (Washington, DC: Office of the CNO, 24 January 1958).

discouraging. Enemy forces easily intercepted tactical air navigation (TACAN) electronic emissions during night operations, facilitating their efforts at detecting the carriers.[83] Thus the Navy concluded this approach represented a dead end.

The series of exercises helped refine the Haystack concept and aided the fleet's efforts to extend the time before the carriers were detected and engaged. Prior to the exercises, carriers operating in the Eastern Mediterranean were projected to avoid detection for two hours. By the end of the exercises, the carriers operating in fleet task forces employing the refined Haystack concept were avoiding detection for at least eight hours; half were avoiding detection for fifteen hours.

UPTIDE

The maritime competition between the United States and the Soviet Union was dynamic, as each side sought to gain or maintain the upper hand against the other. By the early 1960s the Soviets began deploying nuclear-powered submarines (SSNs), adding to the threat posed by their land-based aviation forces. Nuclear submarines presented a fundamentally greater threat than did the handful of Soviet conventional submarines that patrolled the Mediterranean in the 1950s. Soviet SSNs were armed with SS-N-3A ("Shaddock") ASCMs with a range of 250 nm, whereas the Sixth Fleet's carrier battle group defense perimeter extended only some hundred nautical miles from the carrier. Yet while Soviet submarines appeared to have the advantage in strike range, they had a "scouting problem:" finding and identifying their targets while avoiding being detected themselves.

Despite the Soviet SSN scouting problem, it was clear the Haystack concept of defending the carriers was, by itself, no longer sufficient. The U.S. Pacific Fleet took the lead in addressing the challenge through a series of exercises known as UPTIDE (Unified Pacific Fleet Project for Tactical Improvement and Data Extraction). As with Haystack, UPDTIDE's objective was to exploit the Soviet SSNs' scouting problem rather than attempting to engage and destroy them. Put another way, the measure of effectiveness (MOE) employed by the U.S. fleet was to reduce the Soviet SSNs' detection rate of American surface ships—the carriers in particular. This indirect approach was seen as the best way to counter the threat of Soviet submarine missile and torpedo attacks. To accomplish this, the fleet emphasized acoustic deception.

The U.S. Navy conducted Project UPTIDE in three phases from 1969 to 1972. The first two phases pitted an aircraft carrier and its associated aircraft and a destroyer squadron against a combined force of nuclear and conventional submarines. The final iteration, Phase III, introduced additional capabilities for both sides. The battle group received

83 Operating among the Aegean islands proved more of a hindrance to the fleet than to "enemy" aircraft. This was likely due to the limited operating areas, navigation hazards, and many coastal vessels in the area.

land-based patrol aircraft, towed passive sonar arrays, and helicopter-equipped destroyers, while its "enemy" received integrated surface, subsurface, and air forces. As with Haystack, UPTIDE's Phase I set the time to detection as the metric for success. It established a baseline of nine hours, on average, before a carrier was located and engaged. New forces and tactics employed in Phase II enabled the fleet to lengthen this period to *seven full days* by employing dispersion, acoustic and electromagnetic emission control, and active acoustic deception techniques.

The results of the first Phase II exercise, which lasted seven days, were striking. The carrier avoided all efforts to detect it. A new acoustic deception device introduced during the second exercise proved effective, and enabled the carrier to survive undetected for eighty-seven hours despite the "enemy's" efforts to apply "lessons learned" from its experience in the earlier exercises. During the fourth exercise the U.S. Navy reverted to its "standard" tactics to reestablish a baseline between it and the gains made in Phase I of UPTIDE. The aggressor force detected the carrier within five hours.

The final phase, Phase III, introduced a new metric: miles safely traveled. The results of Phase III were impressive: acoustic deception devices coupled with UPTIDE tactics enabled the carrier to avoid detection except when many of the acoustic deception devices broke down.[84]

Like the Haystack exercises before it, and like the series of Fleet Problems conducted between the world wars, the UPTIDE series enabled the U.S. Navy to adapt and, in some cases, radically transform its methods of operation to address an emerging challenge to its dominant maritime position.[85]

One of the biggest challenges confronting the U.S. Navy during both the Haystack and UPTIDE exercises centered on commanding and controlling widely dispersed forces operating under EMCON. Although workarounds were identified, such as communicating with signals, using aircraft to carry messages, and relying on line-of-sight ultra-high-frequency (UHF) transmissions, these alternatives often delayed communi-

84 Angevine, "Hiding in Plain Sight," p. 88.

85 The U.S. Navy continued to build on the findings of Haystack and UPTIDE, through exercises and wargames. See, for example, James F. Murphy, *Report of War Game IV: Cover and Deception* (Arlington, VA: Office of Naval Research, July 1977). The game, a Pacific scenario involving five U.S. carrier task groups against Soviet forces in East Asia, was conducted in two phases—Seadog I and Seadog II. The results confirmed the growing importance of cover and deception. They found that, *"The decoys, assumed to be functioning, reliable, and correctly manned, helped the users significantly*. In no excursion, did any task group with the devices suffer damage to its carrier," [emphasis in the original]. Experiments and exercises focusing on detection avoidance continued until the Cold War's end. In 1986, for example, the U.S. carrier *Ranger* battle group steamed from San Diego to the Western Pacific under EMCON, while successfully avoiding detection by Soviet forces. Later that year, in August and September the carrier *Carl Vinson* steamed through Japanese waters, the North Pacific, the Bering Sea, the Sea of Okhotsk, and the Sea of Japan/East Sea while also avoiding detection by the Soviets. Edward J. Marolda, *Ready Seapower: A History of the U.S. Seventh Fleet* (Washington, DC: Naval History & Heritage Command, 2012), p. 96.

cations, necessitating extensive pre-exercise planning. This planning enabled the fleet to maintain radio silence when necessary as directions and movements had been predetermined. It also reduced commanders' abilities to alter their plans to better fit the situation. Moreover, to the extent the fleet has come to rely on a battle network for its effective operation, EMCON may be a losing proposition over the long term unless new forms of secure communication (e.g., laser communications) can be fielded.

Haystack and UPTIDE focused on the challenge of surface naval forces operating in a progressively more hostile environment enabled by advances in extended-range scouting and strike forces. In so doing, they offer insights on the character of the competition in a mature maritime precision-strike regime. Although the maritime competition's character may change over time, a fundamental challenge—particularly for surface warships—remains the same: How can naval forces conduct effective operations while dispersing widely and minimizing communications to avoid detection and attack? Under EMCON, information exchange is inherently inefficient but other communication methods may be employed to mitigate the problem.[86] Most important, however, is that faced with an increasingly non-permissive environment, the fleet preserved its ability to execute its mission with respect to carrier strike operations. Its ability to sustain this capability in a mature maritime precision-strike regime may depend a great deal on its willingness to persistently engage in the kind of thinking and experimentation characterized by Haystack and UPTIDE.

Although the maritime competition's character may change over time, a fundamental challenge—particularly for surface warships—remains the same: How can naval forces conduct effective operations while dispersing widely and minimizing communications to avoid detection and attack?

One key to operating surface ships effectively in a mature maritime precision-strike regime may require adapting the methods used by the Sixth Fleet in the Mediterranean as a point of departure. In wartime a surface fleet may spend most of its time operating outside the enemy's A2/AD maritime systems, conducting periodic short-duration dashes inside the A2/AD perimeter to launch strikes and execute other missions. If this is the case, then the MOEs chosen by the U.S. Navy as indicators of success in its planned operations in the Eastern Mediterranean may be relevant in a mature maritime precision-strike regime. One of the two dominant metrics is the length of time a surface strike system can operate within the enemy's A2/AD defenses *before detection*. This assumes that the combination of high-speed, precision-guided enemy missile forces and the absence of effective missile defenses creates a situation where to be seen is to be subjected to disabling attack. The second metric, miles steamed before detection, is likely the preferred metric, as the maritime surface strike platforms will need to move within range of their targets, and thus transit a certain distance to do so. Moreover, the greater the distance that can be traveled within an enemy's A2/AD zone, the greater the

86 Ships operating under total EMCON can *receive* communications without revealing their location. For example, U.S. carrier strike groups sometimes operate this way, employing their E-2D airborne early warning aircraft, both to operate its radar and to transmit information. Over time a fleet may be able to exploit advances in aerostats, unmanned aerial vehicles, and laser communications to transmit priority information in sufficient quantity and at the necessary speed to accomplish the mission while denying the enemy a scouting advantage.

area that can be subjected to maritime strikes. This suggests that distance traveled (or "depth of penetration") into the enemy's A2/AD zone may be a more useful MOE than time spent within it. Of course, the longer the range of the strike elements (i.e., aircraft and missiles) on U.S. surface warships, the less time or distance these ships will have to transit in order to accomplish their missions.

Another insight derived from the Haystack and UPTIDE efforts is the importance of ship "signatures" in the hider-finder competition. A ship's radiated signature can be described as a set of signals, usually electromagnetic or acoustic, generated by a source (the ship or, in the case of a carrier, its aircraft as well). These signals can be emitted unintentionally, such as noise onboard, or intentionally, such as sonar pings, radar energy, or radio communications. Prospective adversaries can collect these signals passively to locate and track ships. In addition, both passive sensors (such as visual and infrared) and active sensors (such as radar) can detect the ship and its wake.[87]

Given the plethora of ways that maritime combatants can now be detected, the "finder" seems to have the upper hand in the competition relative to the "hider."

With this information, an opponent can determine not only the type of ship, but often its speed and direction as well. If, in a mature maritime precision-strike regime, the success of a mission depends heavily on the ability to avoid detection, reducing ship signature is critical. Given the plethora of ways that maritime combatants can now be detected (e.g., from space, manned and unmanned aircraft, underwater sensors, and shore-based over-the-horizon radars), the "finder" seems to have the upper hand in the competition relative to the "hider" (the surface ship). To reduce some of the "finder's" advantage, a maritime force might profitably experiment with various methods of "hiding" its fleet's signature. Drawing on the insights of the UPTIDE project, the fleet may consider employing active jamming and deception to delay or completely prevent the detection of its surface ships. As the U.S. Navy's experience with the Soviet threat indicates, such efforts would not be new, as they were commonplace for the fleet in the latter stages of the Cold War. What appears likely is the reemergence of these kinds of operations, though on a more sophisticated level, with the rise of a mature maritime precision-strike regime.

In addition to exploring sophisticated solutions to the problem of masking surface ship signatures, navies might also consider low-tech options, including constructing smaller surface vessels. While carriers possess the U.S. fleet's greatest combat potential, unless the range at which they can project that potential increases dramatically, thanks in large part to their enormous size (both the *Nimitz* and *Ford* classes of carriers have a displacement of roughly 100,000 tons) they will run a relatively high risk of detection and destruction in a mature maritime precision-strike regime.

87 "Signatures and Silencing: An Overview," *Global Security*, available at http://www.globalsecurity.org/military/library/report/2002/mil-02-03-wavelengths01.htm, accessed on December 21, 2012.

Depending on the level of risk one is willing to accept, however, a combination of *smaller surface platforms armed with missiles whose range greatly exceeds those of carrier-borne aircraft may be an attractive proposition for a fleet in a mature maritime precision-strike regime*. During the interwar period, for instance, carriers were able to conduct effective strikes at ranges far greater than could the other ships in the order of battle. The advent of the missile age, particularly the rise of precision-guided missiles, however, has significantly altered—if not reversed—the situation: *some missiles can now outrange the aircraft on today's American carriers*. Moreover, as long as submarines retain their relatively high level of stealth, their ability to penetrate an enemy's A2/AD defenses to launch attacks will enable them to employ relatively short-range (and inexpensive) missiles.

Depending on the level of risk one is willing to accept, however, a combination of smaller surface platforms armed with missiles whose range greatly exceeds those of carrier-borne aircraft may be an attractive proposition for a fleet in a mature maritime precision-strike regime.

These conditions appear likely to persist over the foreseeable future, especially with respect to *manned* aircraft.[88] Thus it may be that relatively greater emphasis may need to be accorded to increasing the range of carrier scouting and strike systems and to maritime missile forces—particularly those deployed on undersea platforms—than has heretofore been the case. This suggests that further conceptual development and experimentation with respect to the fundamental design of fleets may be in order.[89]

The Outer Air Battle

Competition in the North Atlantic

The Cold War competition between U.S. and Soviet maritime forces was not limited to the Mediterranean or Soviet efforts to preclude U.S. Navy carrier strike operations. The two superpowers engaged in vigorous competition in undersea warfare, nuclear strike operations, and commerce raiding. A key element of this maritime competition centered on the United States' need, in the event of war, to ship reinforcements to Europe across the Atlantic.[90]

Recognizing the importance of U.S. reinforcements to the NATO-Warsaw Pact military balance, the Soviets sought to enhance their sea-denial capabilities beyond the Greenland-Iceland-United Kingdom (GIUK) line into the North Atlantic Ocean. Toward this end, the progressive buildup of Soviet maritime forces that transformed the competitive

88 The range of at least some anti-ship ballistic and cruise missiles will likely continue to exceed that of carrier-based manned aircraft for the foreseeable future. Whether the same situation is true for *unmanned* systems, however, remains to be seen. Of course, missiles can also be fired from platforms other than surface ships, including submarines, aircraft, and locations ashore.

89 For an example of this kind of conceptual development, see Hughes, *Fleet Tactics and Coastal Combat*, pp. 266–309.

90 See Jeffrey I. Sands, *On His Watch: Admiral Zumwalt's Attempts to Institutionalize Strategic Change* (Alexandria, VA: Center for Naval Analyses, 1993), pp. 11–18.

environment in the Mediterranean during the 1950s had, by the 1970s, enabled the Red Navy to pose a serious threat to U.S. shipping in the Atlantic. Not only was Moscow's fleet substantially larger than its 1950s incarnation, but more technologically advanced as well.

The basic character of the maritime competition between the Soviet Union and the United States in the Atlantic centered on U.S. Navy planning to operate its carrier battle groups forward, with the Soviet Navy and naval air forces attempting to stop them through a combination of wide-area sensors for cueing and vectored conventional (and, potentially, nuclear) armed ASCMs. The conventional wisdom held that whichever side won "the battle of the opening salvo" would gain a significant advantage. Both sides also understood that winning the scouting competition would be essential to winning the battle of the opening salvo.

The Soviets Look to Create a Maritime No Man's Land

With that in mind, the Soviets went to work in building a battle network that would enable them to create a maritime no man's land not only in the Arctic Ocean north of the GIUK line, but into the North Atlantic as well. Reflecting the dynamic character of the maritime competition between the two superpowers, the Soviets sought to overcome the problems posed to their scouting efforts through the U.S. Navy's use of EMCON, decoys, and other tactics developed through the Haystack and UPTIDE exercises to frustrate Soviet passive detection efforts.

By the 1970s, the characteristics of this competition had evolved substantially, with an increasing reliance on satellites for wide-area surveillance and communications, and an emphasis on compressing the time between "sensor and shooter," that is, between the time a target is detected and the time that information reaches the maritime force's strike element. The Soviets responded to the U.S. Navy's efforts at EMCON and its shift to satellite communications[91] by developing active and passive space-based wide-area cueing, known as the Radar Ocean Reconnaissance Satellite (RORSAT) and the ELINT Ocean Reconnaissance Satellite (EORSAT). EORSAT provided the Soviets with an adjunct to their land-based direction-finding systems that could detect a broader range of emissions. Relying on satellites also meant that there would be periodic gaps in the

91 As noted earlier, Haystack and UPTIDE had shown that by maintaining strict EMCON, carriers could evade detection for days at a time. However, when radios, and particularly HF communications, were used, the carriers became highly vulnerable to being located by Soviet surface vessels (known as "tattle-tales") or by land-based bombers. Over time the lack of HF communication hampered the U.S. fleet's command and control, particularly as the threat of ASCMs with tactical nuclear warheads pushed surface forces into increasingly dispersed formations. The fleet's dispersion, combined with limits on early warning radar emissions, created potential gaps in coverage, leaving the fleet even more vulnerable. To mitigate the problem, the U.S. Navy looked to space. In the 1960s, the Navy began to develop shipboard satellite communications through the Defense Satellite Communications System (DSCS) and the Fleet Satellite Communications System (FLTSATCOM). By the 1970s, work had progressed sufficiently to enable the fleet to reduce its dependence on HF communications, as the narrow-band UHF communications with satellites were far more difficult to intercept.

coverage over areas of interest, such as the North Atlantic. Given the satellites' predictable orbits, the U.S. fleet could employ EMCOM when EORSATs were overhead. Each RORSAT, on the other hand, used a small onboard nuclear reactor to power a synthetic aperture radar array to identify surface warships. Although RORSAT did not rely on a ship's emissions for detection, it too suffered from gaps in its coverage. These gaps were made worse by the satellite having to operate in very low orbit. This significantly limited both the RORSAT constellation's coverage area and its satellites' operational lifespans, which were measured in days.[92]

In addition to these satellite constellations, the Red Navy's scouting efforts were supported by the Soviet Ocean Surveillance System (SOSS), which used radio direction-finding for wide-area surveillance to cue its interception forces. Despite their limitations, these satellites—in conjunction with the rest of the SOSS—provided the Soviets with sufficient wide-area cueing for surface targets at long range without the use of high-frequency direction finding (HF/DF). Combined with radar targeting data provided by Soviet Tu-95R and Tu-22R reconnaissance aircraft, this scouting architecture enabled the Soviet Navy and naval aviation forces to attack the carriers at significantly greater ranges than had previously been possible in the North Atlantic.

As for the "shooters," the Soviets introduced the long-range, supersonic Tu-22M "Backfire" bomber and the Kh-22 (designated by NATO as the AS-4) and Kh-15 (AS-16) long-range supersonic ASCMs.[93] The combination of the bombers' range along with the extended ranges of their ASCMs enabled the Soviets to orient forces rapidly based on cueing data and strike extended ranges beyond the U.S. Navy's existing combat air patrol (CAP) defending the carrier. In brief, the Soviets were looking to gain the upper hand in the scouting competition and, in so doing, enable their strike forces to engage the U.S. fleet—its carriers in particular—by launching their ASCMs outside the range of its defenses. This last factor was critical. Although the U.S. Navy had enhanced its defenses by developing the Aegis Combat System and the Close-In Weapons System, their ability to intercept significant numbers of Kh-22s or Kh-15s remained limited. Put another way, modern scouting forces and cruise missiles were shifting the balance that had favored the defense at Okinawa back to the offense.

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92 While the Soviets had difficulty maintaining persistent broad-area RORSAT coverage, it was believed that in a crisis or in preparing for war they would have launched additional RORSAT satellites. See Norman Friedman, *Seapower and Space: From the Dawn of the Missile Age to Network-Centric Warfare* (Annapolis, MD: Naval Institute Press, 2000), p. 196.

93 These missiles traveled at extremely high speeds—the Kh-15 was capable of achieving a terminal speed of approximately Mach 5. Also, the accuracy of the missiles' targeting data and their inertial guidance systems meant that they did not need to use their terminal seekers until very late in their approach to the target, which made jamming less effective as a means of defense. Additionally, some variants of the Kh-15 had antiradiation seekers designed to target the radars on the carriers.

Shooting the Archer

The U.S. Navy had been grappling with defending the fleet from air-launched ASCMs since the 1950s. This included incrementally improving the range of its surface and airborne radars, increasing the effectiveness of the CAP and pushing it a greater distance from the carrier, and liberally using decoys and deception. Yet the Soviet effort to create a maritime no man's land rendered these efforts inadequate. Consequently, the U.S. Navy decided to alter its approach to the competition. Rather than attempting to persist in an unfavorable competition—defending itself against ASCM attacks—the U.S. fleet would focus its efforts on attacking the Backfire bombers themselves. In Navy parlance this became known as "shooting the archers, not the arrows." Not only was it easier to hit the much larger and relatively slower bomber, but shooting down one bomber also eliminated multiple ASCMs and valuable crew. If successful, what became known as the Outer Air Battle would both protect the carrier battle group and cripple the striking power of Soviet naval aviation, thereby restoring the fleet's freedom of maneuver (see Figure 3).

This was easier said than done. The arrival in the fleet of the F-14 Tomcat and the long-range AIM-94 Phoenix missile in the 1970s gave the carrier battle group the theoretical ability to intercept aircraft as far as 600 nm from the carrier.[94] At this range, however, the CAP of F-14s would have little time on station. The Navy's tactical solution was referred to colloquially as "the chainsaw" (see Figure 4). It called for the carrier's F-14s to fly near the limit of their combat range before turning back or rendezvousing with an aerial tanker orbit to be refueled, then pushing out again in a constant cycle.[95] Upon inspection, this tactic was incredibly resource-intensive, as it required arranging the carrier and its entire air wing to support Outer Air Battle operations. The result was to create a kind of "self-licking ice cream cone," where the carrier's sole purpose was to defend itself. According to Norman Friedman,

> By 1982 it was possible to envisage Outer Air Battle tactics using the F-14s, but it was clear that they would be difficult to carry out. It would take hours to configure a carrier's aircraft to support the Outer Air Battle; for example, the carrier would not be able to conduct air strikes (among other things, all her tankers would be occupied supporting F-14s on distant CAP stations). Even so, the Outer Air Battle stations could not be maintained for long. Moreover, much depended on estimating the direction from which the raid would approach.[96]

94 This is the combined combat radius of the F-14 and the maximum range of the AIM-94. Robert Work and Thomas Ehrhard suggest that the F-14/Phoenix combination was not stretched this far with, "F-14 CAP(s) out to 400 nm from the carrier, allowing missile engagements out to 500 nm." Thomas P. Ehrhard and Robert O. Work, *Range, Persistence, Stealth, and Networking: The Case for a Carrier-Based Unmanned Combat Air System* (Washington, DC: Center for Strategic and Budgetary Assessments, 2008), p. 88.

95 Conversation with Captain (U.S. Navy, retired) Jan van Tol, March 15, 2014.

96 Friedman, *Seapower and Space*, p. 238–39.

FIGURE 3: THE OUTER AIR BATTLE OF THE 1980s

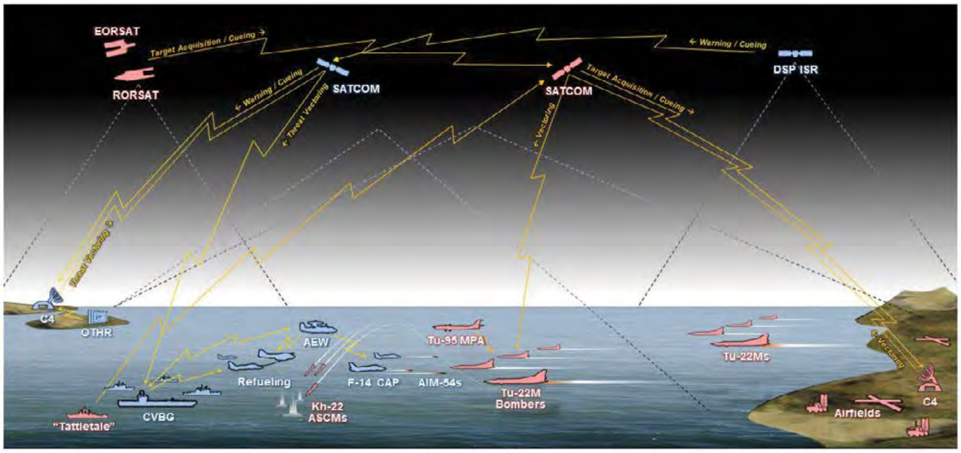
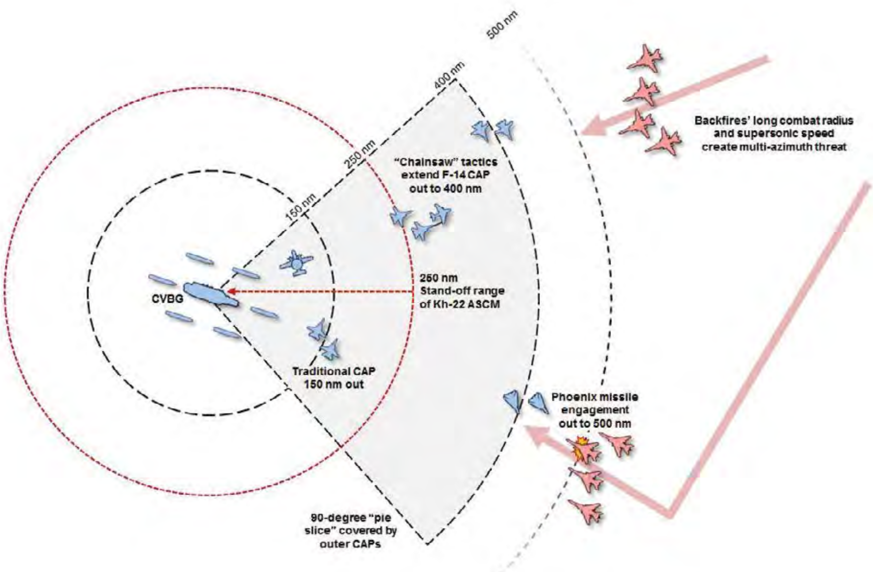


FIGURE 4: THE OUTER AIR BATTLE AND THE "CHAINSAW"



Friedman's last point demands explanation. Simply put, even the "chainsaw" tactic would require the fleet to make a difficult choice as to where to allocate its aircraft. In order to counter a major Soviet attack, the carrier's strike aircraft would need to mass at the point of attack. But where was the point of attack? The range at which the F-14s were expected to operate would be well beyond the sensor range of the battle group's E-2 aircraft, its primary long-range sensor. Making matters worse, the Backfires, with their long range and high supersonic dash speed, expanded the Soviet's possible attack approaches, taking indirect, unexpected azimuths of attack while still reaching their ASCM launching point (between 150 nm for the Kh-15s or 250 nm or more for the Kh-22s) before the carrier's interceptors could respond.[97] The Outer Air Battle would therefore require sensors capable of detecting the approach of Backfires at the earliest possible moment. This meant the U.S. Navy would need to compete with its Soviet counterpart into wide-area over-the-horizon cueing to win the all-important scouting battle.

The Navy had made some forays into space-based ISR over the preceding decades with the canceled Clipper Bow space radar and the White Cloud ELINT system, but the Outer Air Battle was going to require a system capable of persistent coverage of key areas such as the Kola Peninsula. Despite increased funding for the Navy, Secretary John Lehman decided that a Navy space radar to support the Outer Air Battle would be too expensive, and instead decided to install ground-based Re-locatable Over the Horizon Radar (ROTHR) stations in Scotland and the Aleutian Islands.[98] The ROTHR could provide a rough track of the Backfires once they were airborne, but the battle groups required even more warning.

Fortunately for the Navy, the Defense Support Program (DSP) had a geostationary satellite constellation designed to detect Soviet missile launches from space using sensitive infrared sensors. These satellites could also detect afterburning Backfire engines, which the DSP had come to refer to as "slow walkers." The name stuck, and the Slow Walker program began feeding its information to the fleet through the Slow Walker Reporting System.[99] This information, combined with tracks from the ROTHR, would be fed into the battle group's Tactical Flag Command Center (TFCC), correlated with other data sources, and used to vector the battle group's F-14s to meet the incoming Backfires. This information could also be passed between the carrier, the E-2s, and the F-14s via the Joint Tactical Information Distribution System (JTIDS, Link-16). The responsiveness and total system speed of this battle network—consisting of ROTHR, Slow Walker, TFCC, JTIDS, E-2s, F-14s (and their sensors), and AIM-94s (and their terminal sensors), as well as the personnel operating these systems—were absolutely critical.

97 Ibid., p. 169.

98 Ibid., p. 239.

99 As opposed to satellites, which they called "fast walkers." Ibid., p. 242; and Friedman, *Network-Centric Warfare: How Navies Learned to Fight Smarter through Three World Wars*, p. 215; and Jeffrey T. Richelson, *America's Space Sentinels: DSP Satellites and National Security* (Lawrence, KS: University of Kansas, 1999), pp. 104–6.

Endgame

By the mid-1980s, the U.S. and Soviet navies had developed two superficially similar approaches to finding, fixing, and striking mobile targets over long ranges on or above the open ocean. These two battle networks never interacted during combat; therefore it is difficult to ascertain which side would have "won" if the Outer Air Battle had been put to the test. From the strategic perspective of the United States, the Outer Air Battle could be considered a success in that it was part of a larger, more aggressive military strategy that applied pressure to the ailing Soviet system. Although these two networks did not clash during war, the nature of their peacetime competition and development suggest some interesting insights for the maritime warfare precision-strike regime, as will be elaborated upon presently.

Case Study: The Falklands War

On April 2, 1982, Argentina invaded the Falkland Islands, seeking to resolve in its favor a 150-year territorial dispute with Great Britain. The military junta ruling Argentina at the time believed the British would not respond militarily.[100] They were mistaken.

In an operation code-named "Corporate," British forces mobilized to retake the Falklands. By April 12 there were over one hundred British ships en route to the islands. A few days later the majority of the force converged at Ascension Island, the halfway point between Britain and the Falklands. This task force consisted of two small aircraft carriers; three modern destroyers; three modern frigates; six submarines, of which three were nuclear-powered; and numerous other destroyers, frigates, and transport ships.[101] The Royal Navy, however, was hardly optimized to conduct operations close to a country possessing a substantial land-based air arm. Influenced by thirty years of Cold War, the British maritime force had been shaped to counter the Soviet maritime threat, which, at the time, was principally centered on the Red Navy's submarine fleet.

Argentina, on the other hand, looked to present the Royal Navy with a difficult challenge. The Argentine air force represented a seemingly formidable foe, counting over one hundred fighter jets in its inventory, including Mirage III interceptors, Israeli-made Mirage 5 fighters (Daggers), American-made A-4 Skyhawks, and French-built Super Étendards.[102] The Argentines also possessed a substantial number of missiles, although apart from some Étendards equipped with the French-built, radar-homing, sea-skim-

100 Harry D. Train, "An Analysis of the Falkland/Malvinas Islands Campaign," *Naval War College Review*, 41, No. 1, Winter 1988, p. 36.

101 Max Hastings and Simon Jenkins, *The Battle for the Falklands* (New York: W. W. Norton & Company, 1983), p. 83. The two aircraft carriers were the *Invincible* and the *Hermes*; the three Type 42 destroyers were the *Coventry*, the *Glasgow*, and the *Sheffield*; and the three Type 22 frigates were the *Battleaxe*, the *Broadsword*, and the *Brilliant*.

102 James S. Corum, "Argentine Airpower in the Falklands War: An Operational View," *Air & Space Power Journal*, 16, No. 3, Fall 2002, p. 3.

ming, Exocet anti-ship missiles, few were precision guided. Thus the Argentine air force was constrained in its ability to execute precision attacks, relying instead primarily on unguided "dumb" bombs in its strike operations. Moreover, to conduct operations around the Falklands its aircraft would have to operate at the limits of their combat ranges.[103]

In some respects the situation resembled Britain's experience in the Mediterranean theater during World War II, especially in its defense against the German airborne assault on Crete, and the U.S. Navy's experience at Okinawa. In both cases the enemy's scouting problem was greatly eased by the presence of an island that was the objective of a major operation. The Germans knew the Royal Navy would have to concentrate its fleet near Crete to oppose its assault, just as the Japanese knew the Americans had to concentrate their fleet in order to assault Okinawa. Similarly the Argentines were confident the British would need to concentrate their forces near the Falklands, effectively denying the Royal Navy the ability to exploit the "scouting problem" to its advantage.

Having declared a 200-mile maritime exclusion zone around the Falklands on April 7, the Royal Navy employed its three SSNs to enforce it. Once these submarines were in position, the British planned to establish air and sea superiority, rolling back any Argentine maritime defenses, thereby laying the groundwork for an amphibious assault to retake the islands.

As noted above, out of necessity dumb iron bombs dropped by low-flying, fast aircraft were the Argentines' weapons of choice. They enjoyed some success, sinking more ships through these means than by employing the more sophisticated Exocet missiles. Again, this was due in large measure to the fact that the Argentines had a very small inventory of Exocets—fewer than ten—and similarly few delivery platforms capable of carrying them.[104]

Nevertheless, the handful of Exocets was able to greatly disrupt and complicate British planning. Unsure of how many Exocets the Argentines possessed, the British had to prepare their defenses accordingly. In reality, however, rather than confronting a formidable threat like the German *Luftwaffe* in the Mediterranean, the Royal Navy was now facing a much inferior adversary with an almost insignificant missile inventory and an obsolescent (by NATO standards) navy.

In fact, it was the British, not the Argentines, who first employed air-to-surface missiles (ASMs). On May 3, 1982, two British Lynx helicopters from HMS *Coventry* and HMS *Glasgow* attacked the Argentine patrol boats *Alférez Sobral* and *Somellera*.[105] The helicopters were equipped with the untested Sea Skua missiles that had been hastily installed on them as the task force sailed south from Ascension Island. Each helicopter

[103] The distance between the Argentine mainland and the Falklands is roughly 400 miles.

[104] France cooperated with British efforts to deny Argentina from acquiring any more Exocets on the world's arm market and also advised the British on ways to counter the missiles.

[105] Hastings and Jenkins, *The Battle for the Falklands*, p. 151.

fired two missiles at the patrol boats, sinking the Somellera and inflicting heavy damage on the *Alférez Sobral*.

The British fleet's defenses were somewhat similar to those employed by the U.S. fleet at Okinawa. The Royal Navy employed a layered approach made up of a series of five concentric rings with the aircraft carriers and amphibious assault ships at the center. Moving outward, the second ring consisted of Type 22 frigates, with older ASW destroyers and frigates beyond them in the third ring. The fourth ring included the newer Type 42 destroyers armed with the Sea Dart air defense system, which were capable of intercepting missiles. Like the picket line of U.S. Navy destroyers at Okinawa, these ships stood to take the most damage. Beyond them were Harrier aircraft.

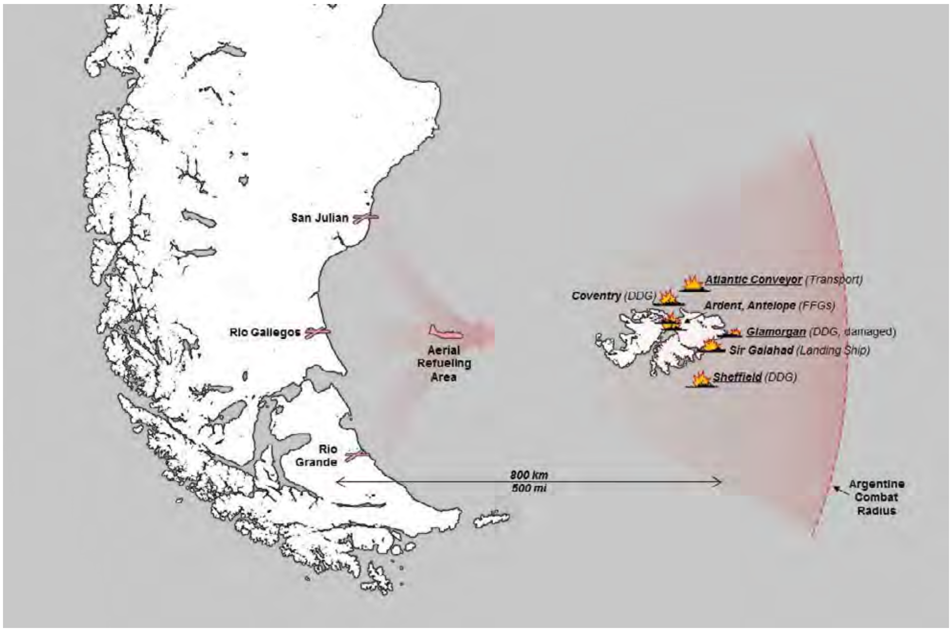
The Royal Navy's first major loss occurred when the HMS *Sheffield*, one of Britain's three modern Type 42 destroyers, was sunk. On the morning of May 4, two Argentine Super Étendards each fired an Exocet missile at the British fleet, hoping to hit one of the two aircraft carriers. One missile, fired from point-blank range (around six miles), managed to hit the *Sheffield* but failed to detonate.[106] The impact of the blast, however, was powerful enough to ignite a fire, ultimately forcing the crew to abandon ship.[107] Due to the lack of early warning, the *Sheffield* did not take any countermeasures against the incoming Exocets. Moreover, Type 42 destroyers were only equipped with the Sea Dart, which, while it did post a few kills against low-flyers, was supported by an old Type 965 radar that had trouble picking up low-flying aircraft.[108]

106 Ibid., p. 153.

107 The other missile failed to acquire a target.

108 Hastings and Jenkins, *The Battle for the Falklands*, p. 152.

FIGURE 5: ROYAL NAVY LOSSES IN THE FALKLANDS



(Ships underlined were lost to ASCMs)

Another major event involving the use of Exocet missiles led to the sinking of the *Atlantic Conveyer*, a British merchant navy ship requisitioned during the war. On May 25, the Argentinians launched a major air assault against the British naval force guarding the entrance to the Falkland Sound near San Carlos where the British had made their amphibious landing a few days earlier. Flying A-4 Skyhawks and Super Étendards, the Argentinians hoped to deal a devastating blow to the Royal Navy by sinking one or both of its aircraft carriers. While the Skyhawks attacked the picket ships, the Étendards penetrated the outer layers of the defense in attempting to strike the main British fleet. At first sight of a large target, the HMS *Ambuscade*, the two Argentine pilots each fired one Exocet missile. Detecting the incoming Exocet before impact, the crew of the *Ambuscade* fired off chaff radar decoys, which diverted the missiles. Unfortunately, the Exocets then acquired a new target—the defenseless *Atlantic Conveyer*.[109] One of the Exocets hit the ship, causing extensive damage, including the destruction of most of its cargo of eleven helicopters and fourteen aircraft, and in so doing significantly compromising British plans for the land campaign.[110]

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109 Hughes, *Fleet Tactics and Coastal Combat*, p. 153.

110 Hastings and Jenkins, *The Battle for the Falklands*, p. 227.

The last Argentinian air-launched Exocet missile was fired on May 30 when an Argentine Étendard attacked British ships, including the HMS *Avenger*. In a remarkably quick response, the *Avenger* shot down the missile with its 4.5-inch gun, thus rendering the attack unsuccessful. Having exhausted its supply of air-launched Exocets, the Argentine Air Force was without its most formidable weapon for the remainder of the war.

In addition to air-launched Exocet missiles, the Argentinians had two shore-based Exocets, firing one at the HMS *Glamorgan* on the morning of June 11. The Exocet detonated near the helicopter hangar, killing thirteen sailors and wounding many others. The damage to the ship, however, was minimal and within thirty-six hours the *Glamorgan* was back in action. A few days later, on June 14, 1982, the Argentinians surrendered.

As with the other case studies, any conclusions drawn from the Falklands War regarding the maritime competition should be qualified. Although the Royal Navy was still a significant maritime force at the time, it was hardly a maritime power of the first rank, whereas its opponent, Argentina, barely registered on the scale.

Caveats aside, there are a number of important insights that may be derived from the Falklands War. First, while the Argentines' Exocet ASCMs inflicted a remarkable level of damage on Royal Navy ships, their effectiveness was aided significantly by the particularly favorable circumstances in which they were employed. The Argentines' scouting problem could have been far worse than it was.[111] The situation for the Argentinians was enhanced considerably by their knowledge that the British had to concentrate their fleet near the Falklands. The absence of integrated British air defenses also worked in the favor of the Argentine Exocets.[112] This suggests that the Argentine military might have been able to greatly enhance its performance if it had given priority to improving its scouting forces and to investing in a large ASCM arsenal prior to the conflict. While the Argentine air force inflicted more damage on British ships with unguided bombs than ASCMs, it suffered catastrophic losses in the course of doing so.[113] Thus the shift that occurred in 1943–44 in which air defenses seized the advantage in the maritime competition was sustained in the Falklands War. Yet in both cases—the United States against Japan and Great Britain against Argentina—the defenders faced adversaries who were significantly weaker than they. Moreover, missile forces, either in the form of the Exocets or Japan's kamikazes, stressed fleet defenses, even when employed by the weaker side. In situations where the rivals were comparable (Great Britain against Germany and Italy in the Mediterranean during World War II and the United States against the Soviet Union during the Cold War), the offense appears to have enjoyed the

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111 The official British history of the war finds that Argentina's "reconnaissance effort continued to be frustrating: they could find neither the carrier battle group nor the amphibious force and were having difficulty with the serviceability of their surveillance aircraft." Lawrence Freedman, *The Official History of the Falklands Campaign, Volume 2: War and Diplomacy* (London: Routledge, 2005), pp. 264–65.

112 Wayne P. Hughes, Jr., *Fleet Tactics: Theory and Practice* (Annapolis, MD: Naval Institute Press, 1986), p. 7.

113 Hughes, *Fleet Tactics and Coastal Combat*, pp. 154–55.

upper hand. Finally, this case study reinforces the assessment that the principal threat to surface warships has long since ceased to be other surface warships, but rather submarines and aircraft, in this case aircraft armed with missiles.

Case Study: The First Gulf War and Mines

We have lost control of the seas to a nation without a navy, using pre-World War I weapons, laid by vessels that were utilized at the time of the birth of Christ.

Rear Admiral Allen E. Smith[114]

Nearly lost amid growing concerns over the major changes nuclear-powered submarines and anti-ship cruise missiles were imposing on the maritime competition was the growing importance of anti-ship mines, even though mines have exerted a significant and growing influence on war at sea for over a century. For example, at the turn of the twentieth century mines played a significant role in convincing the Royal Navy that its preferred close-blockade operation was no longer viable. During World War I, Turkish mines in the Dardanelles stopped the initial British and French attempts to force the strait in February 1915. During World War II, mine belts stretching from Sicily to North Africa exacerbated British efforts to operate in the Central Mediterranean Sea. The only four U.S. naval vessels sunk during the Korean War were the result of enemy mines.[115] When it undertook tanker escort operations in the Persian Gulf in 1988 during the Iran-Iraq War, the U.S. Navy frigate *Samuel Roberts* suffered over $100 million in damage when it struck a mine employing a design dating back to World War I.[116]

Nearly lost amid growing concerns over the major changes nuclear-powered submarines and anti-ship cruise missiles were imposing on the maritime competition was the growing importance of anti-ship mines, even though mines have exerted a significant and growing influence on war at sea for over a century.

The advent of sophisticated countermine operations, however, has done little to diminish the advantages of mines. During the First Gulf War, two U.S. Navy warships—the USS *Princeton* and USS *Tripoli*—struck mines despite extensive mine reconnaissance operations both prior to the war's outbreak and during the war.[117] The U.S. Navy intended to map these minefields and avoid them when conducting maritime operations, including a possible amphibious assault, but was unable to do so. In the two decades since, the U.S.

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[114] Tamara Moser Melia, *"Damn the Torpedoes": A Short History of U.S. Naval Mine Countermeasures, 1777–1991*, Contributions to Naval History, No. 4 (Washington DC: Naval Historical Center, 1991), p. 76, cited in Truver, "Taking Mines Seriously," pp. 30–31. Admiral Smith was referring to the laying of mines by North Korean forces during the Korean War.

[115] Edward J. Marolda, "Mine Warfare," *Naval History & Heritage Command*, available at http://www.history.navy.mil/wars/korea/minewar.htm, accessed on December 21, 2012. During the war, UN mine countermeasure forces constituted only 2 percent of its naval forces, but suffered 20 percent of the casualties. Truver, "Taking Mines Seriously," p. 31.

[116] Truver, "Taking Mines Seriously," p. 31.

[117] All but four of the eighteen U.S. ships sunk or damaged by enemy ordnance since World War II have been the result of mines. U.S. Navy Department, *21st Century U.S. Navy Mine Warfare: Ensuring Global Access and Commerce* (Washington, DC: PEO LMW/N85, June 2009), pp. 7–8. The *Princeton*, an Aegis cruiser, suffered a "mission kill" from a multiple-influence mine that cost roughly $25,000.

Navy appears to have made little progress in addressing this challenge. Although China, Italy, and Russia sell such advanced mines on the open market, and there are concerns that buyers may have further modified these mines to enhance their effectiveness, the U.S. Navy has traditionally viewed countermine operations as "an inconvenience, or in many cases ignored [them] during fleet exercises and routine deployments."[118]

The lessons to be derived from mine warfare are less about U.S. losses in the First Gulf War than about the progression of mine technology over the course of the last century or so, and the successful use of mines in littoral waters to impose substantial costs on surface warships. Modern mines are far more sophisticated than those that inflicted damage on the world's most advanced navy in 1991.[119] Over time it seems increasingly likely that the distinction between mines and UUVs will blur, making mines even more formidable. At the same time, the cost of the most advanced "smart" mines is only a small fraction of that for a modern warship. This suggests that mines will become an increasingly important part of a maritime competitor's A2/AD force, particularly if they can be emplaced in deep waters or move either continuously or periodically. Either approach would severely complicate minesweeping operations.

Modern mines are far more sophisticated than those that inflicted damage on the world's most advanced navy in 1991.

The Changing Maritime Geography: Undersea Economic Infrastructure

The Admiralty should never engage itself to lock up a single vessel even—not even a torpedo boat or submarine—anywhere on any consideration whatever. The whole principle of sea fighting is to be free to go anywhere with every d—d thing the Navy possesses. The Admiralty should…reserve entire freedom of action.

Admiral John "Jackie" Fisher, First Sea Lord, Royal Navy[120]

Shortly after the end of World War II, a growing number of countries, led by the United States, began developing offshore energy fields along their continental shelves and in other areas where shallow waters permitted such construction. The ever-growing demand for energy fueled the undersea economic infrastructure's continued expansion

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118 James D. Bahr, *Damn! The Torpedoes: Coping with Mine Warfare in the Joint Maritime Environment* (unpublished paper: May 10, 2007), pp. 2, 7. On an encouraging note, the U.S. Navy's attitude may be changing. In recent years, the fleet has conducted two international mine warfare exercises and is investing in upgrades to its mine countermeasure capabilities as well as in new unmanned mine warfare systems. The Navy's new class of Littoral Combat Ships (LCSs) has been designed with mine countermeasure operations as one of their principal missions.

119 Contact mines were among the most widely used mines in the two world wars. As the name indicates, they detonated when they came in contact with a ship's hull. Magnetic mines were developed by both Germany and Great Britain during World War I, with improvements made between the two world wars. As their name suggests, these mines detonated when a passing ship's magnetic force repelled a magnet in the mine, detonating it. During World War II, both acoustic and pressure mines were employed as well. The former relied on detecting a passing ship's propeller noise to trigger a detonation, while the latter detonated based on the change in water pressure from a ship passing above.

120 Till, *Seapower: A Guide for the Twenty-First Century*, p. 351.

to the point where U.S. offshore capital assets (oil rigs, production platforms, subsea pipelines, and related production assets) are now valued at roughly $150 billion.[121]

The growth of a global undersea economy and its associated infrastructure motivated many states to establish sovereign economic rights over these areas. These rights were codified in the United Nations Convention on the Law of the Seas (UNCLOS), which established EEZs extending 200 nm out to sea from a state's coastline.[122] Part III of the treaty, UNCLOS III, lists several categories of waters, along with their states' associated sovereign rights (see Table 2 for a summary).

TABLE 2: PRINCIPAL ELEMENTS OF UNCLOS—VARIOUS ZONES AND ASSOCIATED RIGHTS & LIMITS

Type of Water	Definition	Rights
Internal Waters	Waters on the landward side of the baseline (e.g., bays and rivers)	Full sovereignty as they are treated like land territory
Archipelagic Waters	The waters inside the baseline of a country deemed an archipelago under UNCLOS requirements	The rights are a combination of those of internal waters and the territorial sea (i.e., there exists the right of innocent passage); however, archipelagic states have the right to establish archipelagic sea lanes
Territorial Sea	Waters that extend up to 12 nautical miles from the baseline	Complete sovereignty with the exception of the right of innocent passage for foreign vessels
Contiguous Zone	A zone that is contiguous to the territorial sea extending no more than 24 nautical miles from the baseline	Limited control for the purpose of: 1) preventing the infringement of customs, fiscal, immigration, or sanitary laws and regulations within a state's territory or territorial sea and 2) punishing infringement of the aforementioned laws and regulations within the a state's territory or territorial sea
EEZ	Waters that extend 200 nautical miles from the baseline	Sovereign rights to explore, exploit, conserve, and manage living and non-living resources (i.e., rights that are resource-related)

Extension of EEZs: *A state has the right under UNCLOS to extend its EEZ (up to 350 nautical miles) if its continental shelf extends beyond 200 nautical miles. The continental shelf is composed of the seabed and subsoil of the submarine areas that extend beyond its territorial sea. Submissions to extend EEZs must be supported by science and research.*

High Seas: *High seas derive from maritime law and include all parts of saltwater that are not part of the territorial sea or internal waters of a state. These are outside the jurisdiction of any one nation.*

Landlocked States: *Also, under UNCLOS, landlocked states are granted rights of access to and from the sea without taxation by transit states.*

121 Based on a conversation with a representative from Douglas-Westwood, a leading provider of energy business strategy, research, and commercial due-diligence services.

122 For UNCLOS definitions, see "United Nations Convention on the Law of the Sea," United Nations, available at http://www.un.org/Depts/los/convention_agreements/texts/unclos/unclos_e.pdf, accessed on January 4, 2013.

Since the treaty came into force in 1994, over 160 states have signed the convention. Notably absent from the signatories is the United States, the world's dominant maritime power. The establishment of EEZs under UNCLOS was seen as a major achievement in identifying and protecting the economic potential of maritime states both large and small. Even some small island states have claimed areas exponentially greater in size than their territory for their exclusive economic benefit.

Yet some assertions made by states citing UNCLOS have met with fierce resistance. For example, consider the case of the Paracel and Spratly Islands in the South China Sea, where sizable energy resources are believed to be located.[123] China, the Philippines, and Vietnam have claimed sovereignty over islands in those seas, as have Brunei, Malaysia, and Taiwan. This has led to friction in the relations between the latter two states and China. The problems associated with competing offshore economic claims may be even more acute in the Eastern Mediterranean and Persian Gulf where for decades instability and hostility between states has been the exception rather than the rule. Similar tensions may arise over time in the Arctic Ocean as a consequence of global warming. The melting of Arctic ice caps could make its waters more navigable, and the resources in the seabed below more accessible, resulting in several countries already positioning themselves to lay claim to sovereignty in preparation to exploit those resources.

The growth of an undersea economic infrastructure for the purpose of extracting valuable resources has not only led to a growing competition between states that have competing claims to these resources, but to concerns about the infrastructure's security. These concerns stem in part from the ability of major maritime powers to inflict damage on the infrastructure, much as they have traditionally done in wartime against economic targets on the surface, in particular, cargo shipping. The diffusion of both manned and unmanned underwater systems (autonomous underwater vehicles, or AUVs, and unmanned underwater vehicles, or UUVs) is giving even non-state actors the potential to attack the infrastructure.[124] Given the increasing capabilities of advanced ("smart") mines that have enabled them to take on some of the attributes of AUVs and UUVs, they also could emerge as a major threat to the undersea infrastructure.[125]

The growth of an undersea economic infrastructure for the purpose of extracting valuable resources has not only led to a growing competition between states that have competing claims to these resources, but to concerns about the infrastructure's security.

123 "Q&A: South China Sea Dispute," *BBC News*, available at http://www.bbc.co.uk/news/world-asia-pacific-13748349, accessed on January 4, 2013.

124 Center for Strategic and Budgetary Assessments, *The Future of Undersea Warfare: Trends, Vulnerabilities and Opportunities* (unpublished paper: April 2008), p. 91.

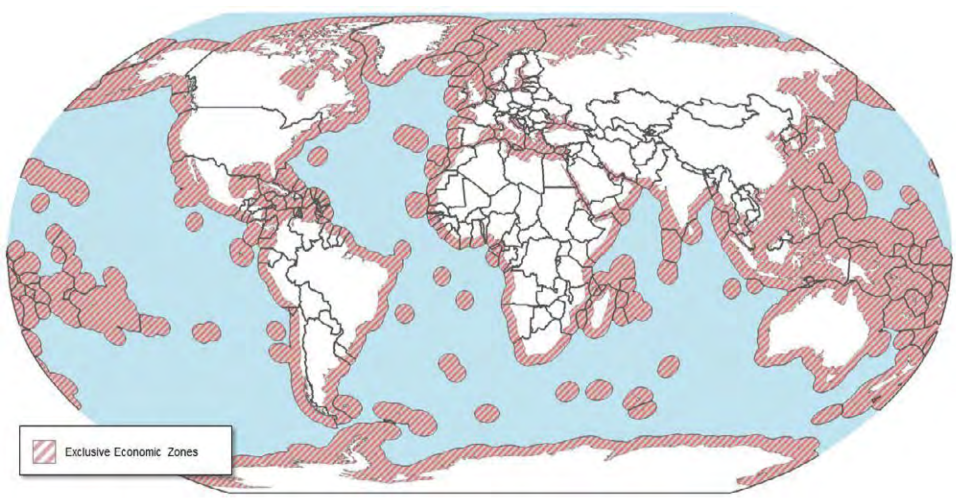
125 Ibid., pp. 88–89.

In a mature maritime precision-strike regime an extensive and expensive undersea economic infrastructure may be a lucrative target for its owner's enemies, ranging from major maritime powers to radical terrorist groups.

In a mature maritime precision-strike regime an extensive and expensive undersea economic infrastructure may be a lucrative target for its owner's enemies, ranging from major maritime powers to radical terrorist groups.[126]

Some states are arguing that UNCLOS does not go far enough in securing their sovereign rights over the seas off their shores. These states are looking to prevent foreign militaries from conducting operations within their EEZ. As can be seen in Figure 6, if this movement succeeds, it would greatly limit major maritime powers' freedom of maneuver in peacetime, and perhaps in war as well.

FIGURE 6: WORLD EXCLUSIVE ECONOMIC ZONES



What are we to make of these trends in the maritime competition? What insights can they offer regarding the characteristics that will define a mature maritime precision-strike regime? The following chapter sheds some light on these two issues.

[126] While the undersea infrastructure is vast, there are some high-leverage targets (e.g., narrow channels like the Houston Channel; locations where methane is injected into big pipelines as at Port Fourchon; large oil-drilling platforms; and the growing number of key undersea components, such as large wellhead manifolds) that are the product of greater integration of the undersea infrastructure. To the extent that there are relatively few undersea targets that, if destroyed, will result in disproportionate destruction of the undersea infrastructure, it may increase the number of competitors able to present a major threat to the infrastructure. See Center for Strategic and Budgetary Assessments, "The Future of Oil & Gas Exploration in the GOM: The Regulators Perspective," Gulf of Mexico Wargame PowerPoint Presentation, NORTHCOM HQ, Peterson AFB Colorado Springs, CO, September 17–20, 2007.

THE FUTURE MARITIME COMPETITION: CHARACTERISTICS

As the preceding discussion reveals, the ongoing maturation of the precision-strike regime in the maritime domain is but the latest in a series of disruptive changes affecting war at sea stretching back over a century. It is no exaggeration to say that the last century or so has witnessed profound changes in maritime affairs driven to a large extent by advances in technology. Given the current pace of technological change, it seems reasonable to assume that the emergence of a mature maritime precision-strike regime is likely, if not inevitable, over the next decade or so. Before outlining the prospective characteristics of such a regime, it is useful to review these trends.

Complexity

The complexity of maritime operations has increased dramatically since the onset of the Machine Age. The maritime competition has long since expanded beyond naval forces operating on the ocean's surface. An adequate assessment of today's maritime balance must include a range of systems and capabilities operating in all domains—land, air, sea, undersea, space, and cyber space. Any net assessment of the maritime balance must account for all of these forces and capabilities. Moreover, while a century ago maritime powers were only beginning to envision the "combined arms" battle line that included cruisers and destroyers in addition to various types of dreadnoughts, today the possible combinations of military systems that can be brought to bear on the maritime competition are far greater than those of a century ago, further complicating efforts to assess the balance—or to describe in detail the characteristics of the competition several decades from now.

Operational Concepts

The military effectiveness of this increasingly wide range of capabilities will depend, to a great extent, on how they are employed through operational concepts that over time are established as a new way of fighting, that is, as doctrine. Integrating naval aviation, nuclear-powered submarines, satellites, autonomous and semi-autonomous vehicles, and cyber warfare to create new operational concepts that confer competitive advantage in a mature maritime precision-strike regime will be no small feat for military planners. Since the combinations of these capabilities ensure a wide range of possible operational concepts, contemporary planners may find it extremely challenging to blend them together to find the "right" mix. Given the availability of many options, many competitive paths are open to maritime powers seeking competitive advantage in a mature maritime precision-strike regime. This, along with other factors that influence the development of operational concepts— for example, geography, state and scale of economic development, and the technical competence of the manpower base—also imposes substantial limits on efforts to define with accuracy a mature maritime precision-strike regime's characteristics.

The Shrinking—and Expanding—Maritime Domain

Over the past century the world's oceans and seas have "shrunk" thanks to the ability of military forces to scout and strike at progressively greater ranges. In the nineteenth century a surface ship could often hide at sea with little prospect of being detected. As the Cold War competition between the United States and Soviet Union demonstrated, this has become increasingly difficult to accomplish against a major maritime power. "Hiding" will likely be more difficult still in a mature maritime precision-strike regime, even allowing for the stealth associated with the new-technology *Zumwalt*-class destroyer and quiet submarines. Correspondingly, the area ashore that can be scouted and attacked by maritime forces has also expanded, and will likely grow larger as the precision-strike regime matures. Yet, as noted above, land-based forces will likely enjoy advantages relative to maritime forces in this competition.

Moreover, over the past sixty years the world has witnessed the rise of a large-scale undersea infrastructure of great economic value, both in terms of the capital stock making up the infrastructure and the resources extracted by it. Given that economic assets at sea have been legitimate targets in war, it seems reasonable to assume that the undersea economic infrastructure will likely emerge as a prime target in a conflict waged by adversaries in a mature maritime precision-strike regime.

Evading Detection

Electromagnetic means for scouting were introduced in the early twentieth century. Over time scouting has become progressively more dependent on computer-aided processing, automation, and coordination. Computer-aided dissemination of scouting information on targets has emerged to coordinate the actions of widely distributed strike elements, be they platforms, munitions (e.g., missiles), or cyber weapons. This evolution opened up new possibilities for influencing the scouting process through both wireless and wired means.

Just as scouting has become an increasingly vital factor in assessing the maritime competition, frustrating the enemy's scouting efforts has assumed greater importance as well. Passive tactics such as dispersing friendly forces, employing decoys, or employing electronic emission controls seem likely to assume greater prominence in maritime operations. The ability of stealth aircraft and submarines to avoid electronic detection has increased their value relative to non-stealthy aircraft and surface warships, for the simple reason that owing to their reduced probability of detection, stealthy platforms are less likely to suffer high attrition rates during scouting and strike operations. Similarly, operations aimed at destroying, degrading, or corrupting enemy C4ISR forces (such as satellites, radars, and sensors) to win the scouting competition will likely remain a core element of maritime warfare.

Just as scouting has become an increasingly vital factor in assessing the maritime competition, frustrating the enemy's scouting efforts has assumed greater importance as well.

Range Costs

As Italian naval officer Lieutenant Romeo Bernotti noted a century ago, "A weapon, the action of which cannot be repeated except at considerable intervals of time, and of which the supply is very limited, must be employed only under conditions that assure notable probability of hitting."[127] Long-range precision-guided weapons fit Bernotti's description, as range exacts a cost in both resources and time.

The range at which maritime engagements can occur has increased by orders of magnitude over the last century, from the horizon to the globe—from direct-fire engagements between surface warships, to long-range strikes far beyond visual range by aircraft, to prospective missile strikes at intercontinental range (see Table 3).[128] The greater the range at which strikes can occur, the greater is the area that can be subjected to such strikes. The greater the area that can be subjected to attack, the greater is the area that can, and (assuming the enemy has a comparable capability) *must* be scouted. As noted above, this places a premium on scouting effectively, and avoiding detection. Simply stated, the "hider-finder" competition is a central part of the overall

127 Romeo Bernotti, *The Fundamentals of Naval Tactics* (Annapolis, MD: Naval Institute Press, 1912), p. 14, cited in Hughes, *Fleet Tactics and Coastal Combat*, p. 83.

128 American and Russian SSBNs can do this today. The missile technology is well established. There is nothing to preclude changing the warheads on these missiles and deploying conventional munitions in lieu of nuclear warheads.

maritime competition, and will almost certainly remain so in a mature maritime precision-strike regime.[129]

TABLE 3: GROWING NAVAL STRIKE RANGE[130]

Period	Range
Age of Sail	Less than half a mile
Dreadnought Era	8-10 miles
Aviation Regime	300-plus miles
Missile Age	7,000-plus miles

Accuracy: Precision Strike

The ability to strike at ever-greater range has been an important characteristic of the maritime competition over the past century or so. As it does little good to have such a capability if the ordnance cannot be delivered accurately, especially as one pays a premium to attack at extended distances, the early years of the twentieth century also saw an increased emphasis on accuracy, including range finding and gunnery. The accuracy at which fires could be applied improved by an order of magnitude between 1900 and the end of World War II, as witnessed by the first use of precision-guided weaponry such, as the kamikazes, German weapons,[131] and the maturation of dive bombing.

129 See Krepinevich, *The Military-Technical Revolution: A Preliminary Assessment*, pp. 14–15. Krepinevich argued that "targets that can be identified and tracked (if they are mobile) will run a high risk of being destroyed, not only at or near the forward edge of the battle areas (a term which itself may be on the verge of becoming an anachronism), but over the entire breadth and depth of an enemy state or coalition." This aspect of the competition has become increasingly important over time. In the Age of Sail, for example, a fleet had to close within visual range of its enemy's fleet in order to engage it. Although one fleet might be at a disadvantage (e.g., with respect to the weather gage), it could still engage the enemy fleet. This has not been the case since at least the early years of World War II, when aircraft enabled the engagement of a fleet without the opposing fleet's ships being at risk of attack by surface warships (e.g., at Taranto in November 1940, Pearl Harbor in December 1941, Coral Sea in April 1942, and Midway in June 1942).

130 This chart's "Aviation Regime" reflects that of World War II era carrier-based aircraft. Today's F-18E/F and F-35C aircraft have somewhat longer ranges, whereas the A-6E (which is no longer in service) had considerably greater range. Note that many World War II-era land-based bombers used for maritime patrol and attack (e.g., Condors, Betties, B-24 Liberators, and B-25 Mitchells) also had considerably greater ranges. In the Missile Age, ballistic missiles became capable of far outranging any unrefueled aircraft. As noted earlier in this assessment, most cruise missile ranges are considerably more modest.

131 See Barry D. Watts, *Six Decades of Guided Munitions and Battle Networks: Progress and Prospects* (Washington, DC: Center for Strategic and Budgetary Assessments, 2007), pp. 3–4.

PGMs were not employed in large numbers until the United States used them during the Vietnam War. Since then, in conflicts such as the First Gulf War, PGMs have been used extensively. Their increased popularity can be attributed to their effectiveness. The number of "dumb bombs" required to accomplish a given mission relative to PGMs can be an order of magnitude or more.[132] Obviously, this greatly reduces the number of delivery systems required as well.

Speed

No aspect of the maritime competition has experienced more change than the role of speed. A little over a century ago, at the time of Admiral Jackie Fisher, the value of speed was seen primarily in terms of warships. In this he echoed Corbett's observation that "the fleet that sails the fastest has much the advantage, as they can engage or not as they please, and so always have in their power to choose the favorable opportunity to attack."[133]

Hence Fisher's view that:

> The desideratum of all…is Speed!…You don't go into the Battle to be safe! No, you go into the Battle to hit the other fellow in the eye first so that he can't see you. Yes! You hit him first, you hit him hard and you keep on hitting. That's your safety! You don't get hit back!…Because you want to fight when you like, where you like, and how you like! And that only comes from speed—Big Speed.[134]

But over time the value of naval combatant speed has become much less important compared with other forms of speed. As Corbett noted, "With the advent of wireless in the early twentieth century, the speed of conveying naval intelligence has increased in a far higher ratio than the speed of sea transit."[135] The ability to strike at extended distances and the increased importance of scouting were closely associated with the ability to move the information discovered by scouting to the strike element. (At times, of course, they can be one and the same.)

Simply stated, the time has long since passed when a ship's speed was decisive in setting the terms of engagement.

The manner in which speed is viewed in the maritime (indeed, military) competition has also changed owing to the speed of engagement. Aircraft can close on an enemy fleet far more quickly than any ship, and missiles further boost the speed of engagement. Fisher could argue for ship speed, but what happens when the speed of information and munitions platforms (e.g., aircraft) far exceeds the speed of the ship? Simply stated,

132 Thomas A. Keaney and Eliot A. Cohen, *Gulf War Air Power Survey: Summary Report* (Washington, DC: U.S. Government Printing Office, 1993), pp. 243–44.

133 Corbett, *Principles of Maritime Strategy*, p. 124.

134 Jon Tetsuro Sumida, "British Capital Ship Design and Fire Control in the Dreadnought Era: Sir John Fisher, Arthur Hungerford Pollen, and the Battle Cruiser," *Journal of Modern History*, June 1979, pp. 226–27.

135 Corbett, *Principles of Maritime Strategy*, p. 124.

the time has long since passed when a ship's speed was decisive in setting the terms of engagement. Rather, the ability to scout effectively, to move scouting information quickly, and to strike both quickly and at great distances have become a key competition in the maritime domain, offering a far better set of metrics by which to judge the side that enjoys the speed advantage. This is what Russian military theorists were describing in their discussions of a "reconnaissance-strike complex."[136]

An alternative way to leverage speed is by increasing the speed of the strike element, such as by firing hypervelocity projectiles (from rail gun-type weapons) or employing hypervelocity missiles that fly faster than combat aircraft. Still another way is to pre-position strike elements, capable of surviving inside an adversary's A2/AD threat ring, such as submarines armed with short-range missiles. Finally, the ultimate way to leverage speed is to fuse the scouting and strike elements together, as has been done, for example, with the U.S. Predator and Reaper unmanned aerial vehicles.

Scouting

Effective scouting that enables one side to maneuver to a position of advantage and to strike the first blow has often provided an important advantage in maritime warfare. At the time of Fisher, great value was attached to identifying the enemy fleet's location so that the friendly fleet could maneuver to maximize its firepower advantage (i.e., "crossing the T") and engage first, thanks to the all-big gun armament of Britain's dreadnoughts and battle cruisers. The advantage increased between Jutland and Midway, where a combination of scouting and luck enabled U.S. naval aircraft to locate and attack the Japanese carriers first. The Haystack and UPTIDE exercises reflected the importance of the Sixth Fleet getting in the first blow before its carriers could be located and attacked by the Soviets. This trend seems likely to continue in a mature maritime precision-strike regime. Even a modest degradation of an enemy's scouting capabilities could produce disproportionate advantages to the attacker as one side maintains its ability to "see" the other while the other side's "vision" is poor or lacking entirely, at least for a time. This is particularly true in a regime where the offense has the advantage.[137]

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136 Speed may still matter in maritime actions such as evading torpedoes (i.e., outrunning or exhausting the torpedo's fuel before it can reach the ship), or for deploying special operations forces covertly into position. Speed may also offer some marginal advantage when conducting "dash-and-strike" operations within an enemy's A2/AD defensive zone.

137 When two competitors have roughly the same resources, and it is more advantageous to invest in offensive capabilities than in defensive capabilities, the regime is "offense dominant." For example, the nuclear competition is offense dominant in that it requires far more in the way of resources to defend successfully against an attack by nuclear-armed ballistic missiles than it does to field nuclear forces capable of defeating such defenses. Land warfare on the Western Front in World War I can be viewed as defense dominant. Some competitive regimes (e.g., the nuclear competition) are highly stable, whereas others (e.g., submarine commerce raiding versus commerce defense in World War II—the Battle of the Atlantic) are dynamic, with advantage shifting back and forth, from offense to defense.

As the author observed over two decades ago, in a mature precision-strike regime,

> Warfare will become more of a competition between "hiders" and "finders." Targets that can be identified and tracked (if they are mobile) will run a high risk of being destroyed, not only near the forward edge of the battle area… but over the entire breadth and depth of an enemy state or coalition.[138]

That being said, the longer a strike platform's or munition's (e.g., missile's) range, the higher its cost, thus the increased premium on accuracy. The ability to strike at extended range also implies a much larger search area and the need for good scouting. If, in an era of precision warfare, to be seen is to be hit, then it becomes important to find the enemy before he finds you. In an environment where the speed of engagement may be highly compressed (particularly in the case of mobile targets), the ability to understand and act quickly upon the information provided by scouting forces, including code breaking and cyber warfare, may be critical—hence the high desirability of fusing the scouting and strike elements on a single platform or munition. Combining scouting and strike capabilities in this manner is far preferable to relying on potentially vulnerable data links to enable scouting systems to trigger strike elements with a significant time of flight.

If, in an era of precision warfare, to be seen is to be hit, then it becomes important to find the enemy before he finds you.

Yet in some instances, such as when scouting information is provided by a satellite, or via cyber operations, combining scouting and strike elements may not be feasible. There may also be cases where it is not clear where strike forces should be concentrated. For example, at times scouting forces may have to be dispersed in an effort to find the enemy's main assets of interest. Only after scouting elements identify these targets can strike assets be massed. Depending upon the ability to mass the fused strike/scout force relative to other means of bringing the necessary volume of fires to bear, the latter approach—involving the separation of scouting and strike elements—may prove preferable. This suggests that, as with fleet design, there is much in the way of profitable analysis that might be undertaken to identify and assess the future types and relative mix of maritime scouting and strike systems.

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138 Krepinevich, *The Military-Technical Revolution: A Preliminary Assessment*, p. 14.

Bombs, Missiles, and Staying Power

The evolution of increasingly impressive striking power has led to relatively little emphasis over the past hundred years or so[139] on what Wayne Hughes has described as a ship's "staying power," which he defines as "the number of hits that a unit or force can absorb before being placed out of action."[140] This is a function not only of a ship's armor, but also of other factors such as its capacity to conduct effective damage-control operations. Jackie Fisher, for example, was willing to sacrifice much of his capital ships' armor protection to increase their firepower and, of course, their speed. And despite the Royal Navy carriers' superior ability to remain operational even when suffering kamikaze hits, the U.S. Navy's leadership never regretted sacrificing its carriers' staying power in order to maximize their speed and offensive punch (i.e., their complement of aircraft) during World War II.[141]

Although the trend toward placing lesser value on ship speed and staying power[142] has characterized the maritime competition since World War II, it may be time to reassess the merits of investments in staying power as the precision-strike regime matures. As noted above, two major advantages of reduced armor have been to provide a ship with increased speed and firepower, as was the case with Admiral Fisher's battle cruisers. Speed was useful to enable ships to maneuver to gain positional advantage over the enemy's ships (e.g., "crossing the enemy's 'T'" in the line of battle). With the advent of long-range reconnaissance and strike, and aircraft and missiles, this advantage has come to count for less and less. Furthermore, with the advent of extended-range scouting and strike capabilities, we may have reached the point where, in the case of surface

139 The shift from sail to steam and from wooden to metal hulls in the mid-nineteenth century did spawn a spirited debate over whether a ship's staying power would trump advances in armament—that is to say, whether a ship's defenses would achieve the upper hand over its enemy's offensive capabilities. For example, the four-hour exchange at close range between the ironclads USS *Monitor* and the CSS *Virginia* (originally the USS *Merrimac*) at the Battle of Hampton Roads in March 1862 found both ships still afloat. This suggested to some that staying power would be more important than firepower. The Battle of Lissa in 1866 saw Austrian ironclads ramming their Italian counterparts owing in part to the ineffectiveness of gunfire against armor-plated ships. Thus it is not surprising that there was a healthy debate over whether the defense would achieve the upper hand. Brodie, *Sea Power in the Machine Age*, pp. 86, 172–73; and Hughes, *Fleet Tactics and Coastal Combat*, p. 64.

140 Michael D. Johns, Steven E. Pilnick, and Wayne P. Hughes, Jr., *Heterogeneous Salvo Model for the Navy after Next* (Monterey, CA: The Institute for Joint Warfare Analysis, Naval Post Graduate School, January 2001), p. 9.

141 This trend toward sacrificing staying power has continued into current times, and for good reason. The results of several independent studies suggest that the "kill curve" is relatively flat—that is, that modern warships are highly vulnerable to suffering a mission kill or even being sunk after suffering only a few hits from torpedoes, bombs, or missiles. Even capital ships such as carriers and battleships required only a few more hits than a cruiser, suggesting an unfavorable trade off between increased ship armor and enhanced staying power. For a fuller treatment of this issue, see Hughes, *Fleet Tactics and Coastal Combat*, pp. 157–68.

142 For nearly seventy years the U.S. Navy, by far the world's dominant maritime force, has emphasized weapon and sensor capacity in the absence of a serious maritime threat. This has increased its scouting and strike potential relative to its survivability.

combatants, we might consider trading off some of its speed in exchange for increased protection against PGM attack, in the form of either bombs or missiles. Put another way, is there a case for emphasizing greater staying power in the design of surface warships?

Emphasizing the fleet's staying power may be an important means of shifting the long-range strike competition in one's favor, either by reducing the effectiveness of the enemy's long-range strike element or by imposing costs on the enemy.

There is merit in at least identifying the conditions under which the value of a ship's staying power would increase significantly in the maritime competition. If, for example, the key engagements in a mature maritime precision-strike regime were to occur at greatly extended ranges—say, along the outer limits of where the competitors have a significant strike capacity[143]—then emphasizing the fleet's staying power may be an important means of shifting the long-range strike competition in one's favor, either by reducing the effectiveness of the enemy's long-range strike element[144] or by imposing costs on the enemy.[145]

Simply stated, could enhancements to staying power impose a high "tax" on the enemy's ability to conduct effective long-range engagements? The odds of this happening may increase if the enemy relies primarily on missile strikes rather than bombs or missiles delivered by aircraft. The longer the engagement range and/or the faster the missile, the more fuel it requires relative to its explosive warhead. If a larger warhead were required to achieve the necessary level of damage, then under these circumstances the enemy would need to make sacrifices in terms of either missile range, speed, or both. This could enable a surface fleet either to operate at its original range from the enemy at reduced risk of destruction, or to operate at reduced range to the enemy at current levels of projected damage.

There is, of course, a counterargument. An enemy whose primary long-range strike elements are based on land would likely be able to increase the size and capability of his strike element, whether aircraft or missiles, as he would not confront the problems of sea-based forces (e.g., smaller ship runways; and standard vertical launch system (VLS) tubes and the limits they impose on missile design). Realizing significant enhancements, such as active defenses, armor, and automated damage control in surface warship staying power will occur only over a long period of time as new ships enter the fleet. While this is not an absolute barrier to staying-power enhancements, should they be pursued

143 As will be elaborated upon presently, given the fielding of A2/AD defenses and the creation of a contested no man's land where they overlap, maritime freedom of maneuver may well be restored progressively in the form of a rollback strategy that finds one side seizing general control over no man's land by depleting the enemy's long-range strike forces. If this were to occur then, as described here, a ship's staying power could increase in importance relative to other design parameters.

144 This assumes the enemy would require a significantly greater strike element to achieve the same level of damage to friendly ships possessing enhanced staying power. This might be the case if one is comparing two surface fleets of comparable size and composition. It may not be the case when a surface fleet is going up against land-based maritime forces, or undersea forces (e.g., submarines).

145 Cost would be imposed if, for example, the enemy had to restructure much of his long-range strike force in order to redress the problem created as a consequence of enhancements to surface warship staying power—*and* if those costs were substantially greater than those incurred to achieve the improvements to staying power.

Since the U.S. military first conducted intensive precision-strike operations in the First Gulf War, its evolving battle networks have functioned solely in highly permissive environments, rarely being attacked and, even then, only feebly.

the full results may not be realized for several decades or longer. Then there is the matter of how the joint force plans to operate. It may be that friendly land-based long-range strike elements (e.g., bombers and forward-based strike aircraft operating from hardened bases) may damage the enemy's long-range strike forces with sufficient speed and effectiveness that the fleet can advance at acceptable risk without having to sacrifice speed and armament to enhance staying power.

Finally, there is the matter of active defenses. At present, the competition favors the offense. The U.S. Navy, for example, allocates significantly more resources to field and maintain the ships, battle network, aircraft, and missiles intended to defend a carrier strike group in an area in which access is contested than an enemy would require to field offensive forces to penetrate these defenses. Simply put, in the missile attack/missile defense competition, the attacker has the advantage. Will this persist in a mature maritime precision-strike regime? Perhaps. Yet the U.S. fleet is exploring first-generation DEWs that offer the promise of shifting the competition in favor of the defense. Should DEWs prove out over the next decade or so, they could greatly influence the character of the maritime competition.

In an era of rapid and rich technological change, these factors should be subjected to rigorous analysis, persistent wargaming, and frequent fleet exercises to determine the future design, mix, and disposition of maritime forces as a component of the U.S. military.

Battle Networks

Both the importance and the challenge of informing, controlling, and coordinating maritime forces have increased over the past century. With maritime forces' growing ability to strike with precision at extended ranges, especially against time-critical mobile targets,[146] surface warships will likely need to disperse to complicate the enemy's scouting efforts while also retaining the ability to coordinate their actions effectively. Moreover, the limits of a competitor's ability to rely on artificial intelligence in the form of unmanned and autonomous systems will almost certainly be tested as enemies attempt to break or corrupt their command links.

Two critical questions emerge. First, can battle networks be defended sufficiently well to enable maritime forces to accomplish their missions? Second, can the battle networks be operated effectively in support of friendly scouting and strike operations in a manner that does not reveal the location of friendly forces to enemy scouts?

Since the U.S. military first conducted intensive precision-strike operations in the First Gulf War, its evolving battle networks have functioned solely in highly permissive environments, rarely being attacked and, even then, only feebly. Yet history strongly sug-

[146] Advances here seem to have come primarily with respect to high-value individual targets—for example, al-Qaeda leaders.

gests this happy state of affairs will not persist for long. For example, once the Royal Navy began capitalizing on its new technology—wireless communication—the German military worked tirelessly to jam the Royal Navy's system at the Battle of Jutland. The security that their codes afforded Imperial Japan and Germany in World War II disappeared when compromised, resulting in a major defeat for Japan at Midway and significant German and Italian losses in the Mediterranean theater and elsewhere. Today's battle networks have capabilities—and vulnerabilities—far beyond those of the comparatively primitive battle networks of the early twentieth century. Not only has cryptanalysis progressed (thanks in part to the rapid advances in information technologies), the creation of the Internet and associated networks have opened up an entirely new area of the competition in the form of cyber warfare. Particularly worrisome is that, as with the U.S. penetration of Japan's codes and the British breaking of the German codes during World War II, the victim may have no knowledge that such a break had occurred.

Robotics

Closely related to the issue of battle networks is the rise of robotic systems. The latter part of the twentieth century saw the advent of semi-autonomous and autonomous systems, whose development has accelerated in recent years with the introduction of unmanned air, ground, sea, and undersea vehicles.[147] With advances in artificial intelligence, unmanned systems directed remotely by humans could evolve into autonomous systems capable of performing relatively sophisticated operations independent of human control. These systems offer a number of potential benefits, including reducing the need to place humans at risk, lower cost, and greater performance. (Examples are drones that can maneuver in ways too stressful for the pilots of manned aircraft, as well as drones and undersea systems that have greater range and endurance since they do not experience fatigue and do not need to accommodate the weight of a human and the associated life support equipment.) Unmanned systems can also provide access to areas larger manned platform cannot reach due to navigational draft or vulnerabilities to mines or seabed sensors (because of the larger platform's higher signatures).

With advances in artificial intelligence, unmanned systems directed remotely by humans could evolve into autonomous systems capable of performing relatively sophisticated operations independent of human control.

In the past decade, the U.S. military's familiarity with and use of these systems has increased tremendously. During the Iraq War, Afghan War, and in operations against radical Islamist groups, drones have come to be viewed as important and effective platforms. Although remotely operated assets have proved their mettle on the battlefield, as with the battle networks that enable them they have done so in relatively benign environments. Their data links have rarely been attacked, and even then the attacks have been very modest in their sophistication, scale, and effectiveness.

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147 The U.S. Navy has been conducting some experiments with small surface vehicles. Department of the Navy, *The Navy Unmanned Surface Vehicle (USV) Master Plan* (Washington, DC: Department of the Navy, July 23, 2007), p. 89.

It is far from clear whether these systems will be able to function with anything approaching comparable effectiveness if the battle networks they rely on are subjected to intensive attack by an enemy with the resources of a nation-state at its disposal, let alone those of a major military power. Operating effectively in such non-permissive environments—such as those created by an A2/AD force—may require maritime powers to field far more sophisticated—and expensive—unmanned and autonomous systems. These costs may come in the form of incorporating stealth; enhanced or redundant command-and-control links; and improved defenses against cyber attacks, including closed supply chain development and manufacture of artificial intelligence software and the hardware on which it resides. In summary, while recent trends indicate an ever-greater reliance on robotic systems, there is no guarantee this will persist in a mature maritime precision-strike regime.

Lack of Data

Not only is the challenge of assessing the characteristics of a mature maritime precision-strike regime becoming more complex, it is also made more difficult owing to a lack of data. Data are lacking not only on the wide range of systems and capabilities that now exert a significant influence on the military balance, but also from actual warfare in the maritime domain. In the case of the former, detailed and accurate information regarding the characteristics and specifications of space-based systems, cyber weapons, battle network effectiveness, and autonomous systems, to name but a few, can be difficult if not impossible to come by. Divining the effectiveness of such systems operating as part of an integrated battle network is even more difficult.

Those seeking data from actual wartime operations to assess key trends in the maritime competition have had to work with the scraps of data gleaned from wars between major maritime powers and greatly inferior powers going back two decades or more (such as Britain and Argentina in the Falklands War, and the United States and Iraq in the two Gulf Wars). In the period leading up to World War I, the 1904–05 Russo-Japanese War provided a relative treasure trove of data to contemporary maritime analysts after nearly half a century of peace between the major maritime powers marked by the dramatic improvements in maritime capabilities cited earlier in this assessment. Yet even then there was considerable debate over the true “lessons of Tsushima.”

Now consider the current situation. There have been advances across an array of military capabilities affecting the maritime competition across multiple domains. Yet there has not been a major war at sea between great maritime powers in over sixty-five years to provide what arguably would be the best data—the greatest clarity—on the relative effectiveness of military capabilities in the current maritime competition, let alone on the competitive environment a decade or more in the future.[148] Thus those attempting to assess the competition in a mature maritime precision-strike regime confront far greater uncertainty than their predecessors on the eve of the last century's two world wars. This makes it especially difficult to state with a high degree of confidence how all these uncertainties will play out. This is especially true in the case of the United States, the world's dominant maritime power. This is because relative to other competitors, American analysts need to address a wider array of different contingencies, with varying geography and wartime objectives, against adversaries fielding forces that are different in scale, composition, positioning, and doctrine from their own.

Relative to other competitors, American analysts need to address a wider array of different contingencies, with varying geography and wartime objectives, against adversaries fielding forces that are different in their scale, composition, positioning, and doctrine from their own.

With this in mind, our goals in assessing the characteristics of a mature maritime precision-strike regime are necessarily modest. Yet history strongly suggests that even modest insights into this regime and the uncertainties surrounding it can offer significant competitive advantages. Put another way: the objective here should not be to develop a transparent picture of the mature maritime precision-strike regime; rather, it should be to ensure that one's picture is less cloudy than the competition's. It is this issue—the competition in a mature maritime precision-strike regime—to which we now turn our attention.

148 Indeed there have been no major conflicts involving large numbers of offensive missiles and kinetic missile defenses. Thus there is little empirical data concerning the effectiveness of some of the conventional weapon systems that have received a substantial share of defense investments since the 1950s.

MARITIME MISSIONS IN A MARITIME PRECISION-STRIKE REGIME

[F]orecasts for planning purposes and estimates which involve implicit estimates of military power beyond about four to five years in the future require an understanding of the decision-making behavior of military organization that we do not have.

Andrew W. Marshall[149]

One way of reducing the uncertainty associated with assessing the characteristics of a mature maritime precision-strike regime is to examine the paths the principal (or key) competitors are taking toward that regime. Maritime history strongly suggests that each competitor will pursue its own path. These paths will deviate to a greater or lesser extent from each other owing to important asymmetries between the competitors, including their geostrategic objectives, geography, economic might, technological sophistication, existing defense capital stock, and strategic culture.

Few countries have both the resources and the will to pursue all possible main paths at a high level of effort toward a mature maritime precision-strike regime.[150] Therefore, each will necessarily choose, either out of design or through some other mechanism, to emphasize some aspects of the competition while hedging against or ignoring other aspects.

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149 Marshall, *Problems in Estimating Military Power,* pp. 14–15.

150 For example, during the period leading up to and through World War II, competitors pursued various paths in exploiting the rapid advances in mechanization, aviation, and radio. The British developed an advanced integrated air defense battle network and long-range strategic bombing forces. The Japanese did neither of these; instead they developed carrier task forces. The Germans focused primarily on mechanized air-land operations, whereas the Japanese did not. The United States was able to compete in all of these emerging areas of military operations, save for integrated homeland air defenses (for which, it had no need). Of course the United States alone undertook the most ambitious and far-reaching effort of all: the development of nuclear weapons.

The path (or paths) a competitor chooses to pursue will oftentimes provide insight into how it plans to compete. For example, in the period between the two world wars, the German Army emphasized capabilities that would enable it to wage a war of mobility relying extensively on elite forces. To do this, they placed great emphasis on the ability of radio communications to coordinate the operations of mechanized land forces integrated with tactical air forces. Germany's principal rival, France, took a different path, emphasizing static defense and firepower over mobility. This led to several major asymmetries emerging between the two sides' approach to land warfare, which worked much in Germany's favor in 1940.[151]

Similarly, the world's three principal maritime powers at that time, Great Britain, the United States, and Japan, took different paths in exploiting the emergence of naval air power. The latter two powers took paths oriented on the Pacific theater of operations and, in so doing, came to emphasize offensive air power at the expense of both active and passive defenses for their carriers (i.e., "offense is the best defense"). The Royal Navy felt it had to prepare for war in the Pacific and Atlantic oceans, as well as the Mediterranean Sea. As the case study on maritime operations in the Mediterranean during World War II shows, the relatively small size of that theater made it risky to operate surface ships, as the scouting problem of enemy land-based aircraft and submarines was greatly reduced. This in part led the Royal Navy to emphasize active and passive defenses for its carriers at the expense of strike aircraft, among other things. For this and other reasons the path taken by the Royal Navy in developing naval aviation led to a British fleet that was sub-optimized for war in the Pacific, as events in 1945 would demonstrate.[152]

In attempting to identify the paths which the major maritime competitors are pursuing, one must know what kind of "tracks" to look for. Put another way, what are the key capabilities associated with a mature maritime precision-strike regime? The following set of capabilities is provided to serve as a point-of-departure for assessing the competition.

Fixed Targets

The first and most basic capability is that of striking *fixed* targets on the Earth's surface with precision at *extended ranges*. This can be viewed as an "entry-level" capability into the mature maritime precision-strike regime, as the level of technological sophistication and force integration required to do so is relatively modest. It requires only precision guidance and the coordinates of the target—as well as the ability to penetrate an adver-

151 See Ernest R. May, *Strange Victory: Hitler's Conquest of France* (New York: Hill and Wang, 2000), pp. 448–64. May notes not only the differences in the two sides' doctrine and equipment, but also in other factors such as intelligence, leadership, and surprise. Together these factors helped produce a rapid German victory not only over France's military but the militaries of France's Belgian, British, and Dutch allies as well.

152 Hone, Friedman, and Mandeles, *American and British Aircraft Carrier Development 1919–1941*, p. 198–99.

sary's defenses. An example of such a capability would be a ballistic or cruise missile, or an aircraft carrying PGMs, attacking ships or facilities at a naval base.

An important sub-element is the ability to execute such strikes at extended ranges. While such terms as "long range" and "extended range" are imprecise, as used in this assessment they are strikes conducted at distances exceeding 500 miles. As noted earlier in this assessment, long-range systems and munitions (e.g., cruise missiles like the U.S. Tomahawk Land Attack Missile, or TLAM) are quite expensive compared with their short-range counterparts, and thus more difficult for minor military powers to acquire in large numbers.[153]

Another important sub-element of this category is the ability to strike fixed *undersea* targets with precision. This ability enables a competitor to operate in the expanded geography of the maritime competition. Subsurface strike elements could include submarines, unmanned and autonomous underwater vehicles, and towed payload modules.[154] The ability to strike fixed undersea targets at extended range may impose costs similar to those incurred in striking fixed surface targets, thereby limiting the ability of all but the richest and most technically proficient competitors from doing so on a major scale.

Mobile Surface Targets

A second broad capability within a mature maritime precision-strike regime is the ability to strike *mobile* targets effectively with precision. The experience of the U.S. military—the leader in precision-strike warfare—in recent conflicts indicates that the

153 As of Fiscal Year (FY) 2013, the average unit cost of 4,201 Tomahawk Land Attack Missiles (TLAMs) and 4,951 Tactical Tomahawks procured by the U.S. military is over $1.6 million. The average unit cost of the 172,815 Joint Direct Attack Munitions (JDAMs) procured is roughly $25,000. The cost ratio of long-range missiles is nearly sixty-five times greater than that of short-range precision munitions. One also must consider the delivery platform. In this example, TLAMs and Tactical Tomahawks are typically delivered by expensive platforms—surface warships or submarines—whereas JDAMs are delivered by combat aircraft, which are also expensive. This need not be the case. For example, munitions can be delivered from a range of other platforms whose price could significantly influence the overall cost ratio. Barry D. Watts, memorandum to Andrew W. Marshall, "Some Broader Implications of the Maturing Precision-Strike Regime," September 30, 2012, pp. 6–7.

154 A Towed Payload Module (TPM) is a submarine hull section containing large-diameter tubes arrayed vertically. Each tube is capable of launching kinetic weapons as well as ISR payloads. As its name suggests, a TPM is unmanned and operates under sea. The TPM would ideally have both nose- and tail-cones to reduce drag. A TPM would function as an AUV in the sense that it could autonomously maneuver, communicate, and conduct automated damage control operations. It could be programmed to conduct automated launches of weapons, sensors, and other payloads if desired. As envisioned, the TPM would surface upon command to launch strikes with missiles or other weapons, initially against fixed targets ashore. Given its ability to carry a variety of payloads, it could also launch UUVs or long-range torpedoes, for example, to strike seabed infrastructure targets. Karl Hasslinger and Paul Everson, "Junior Officers Design the Submarine Force for the Next Hundred Years," *Undersea Warfare*, Summer 2000, available at http://www.navy.mil/navydata/cno/n87/usw/issue_8/future_force.html, accessed on December 11, 2012.

Despite investing enormous resources in developing and fielding forces capable of destroying time-critical mobile targets, the U.S. military has displayed this capability only against minor powers or non-state entities, and only in highly permissive environments.

ability to strike mobile, moving, emergent, or time-sensitive targets from extended ranges in near real-time represents a step-function increase in the ability to wage war in a precision-strike regime. Striking these targets requires a battle network capable of effective scouting, moving the information gathered by scouting quickly to strike elements, and guiding those strike elements sufficiently close to the mobile target before the scouting force loses track of it or the weapon's terminal homing guidance system acquires it. Alternatively, as illustrated by the weaponization of the Predator UAV prior to Operation Enduring Freedom followed by the introduction of the Reaper UAV, competitors may opt to combine the scouting and striking function into a common "armed scout" platform. The latter offers three significant advantages for engaging mobile and time-sensitive targets: increased responsiveness owing to a shorter time of flight; reduced reliance upon potentially vulnerable data links; and reduced cost (direct-attack munitions and short-range missile are less expensive than longer-range ones).

Finding, tracking, and engaging mobile surface targets requires a level of technical sophistication that may limit a competitor's ability to accomplish this task even if it is willing to invest the resources necessary to acquire the battle network's various "piece-parts." Moreover, the battle network must also be fielded on a scale sufficiently large to cover the search area. This suggests that only the most technologically advanced and wealthiest maritime powers[155] will field a force capable of striking mobile targets on the surface of the seas at extended ranges.[156]

Despite investing enormous resources in developing and fielding forces capable of destroying time-critical mobile targets, the U.S. military has displayed this capability only against minor powers or non-state entities, and only in highly permissive environments. Thus the resilience of a battle network, even one as advanced as the U.S. military's, against a major military power remains highly uncertain.

Third, there is the matter of *how* these strikes would be conducted. Precision-guided *kinetic* munitions can be delivered by a strike platform (aircraft or submarine), by a missile, or by a UUV or AUV.[157] The strike platform can be manned or unmanned (i.e., a

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155 Major, technically advanced maritime powers can provide these capabilities to lesser powers. Syria, for example, has the ability to passively detect surface ships at extended ranges off its shores and to engage them at ranges exceeding 150 miles with the Russian-built Yakhont ASCM. I am indebted to Robert Martinage for this observation.

156 A related capability involves a naval force's ability to strike mobile targets on land. Executing this mission would likely prove considerably more demanding than striking mobile targets at sea. Unlike targets at sea, targets on land benefit from a wide range of ground clutter, or terrain types—such as urban areas, jungles, and forests—that they can exploit to conceal their movement from attempts at visual, electronic (e.g., radar), or at times even thermal (infrared) detection. Note also that sea platforms do not generally do their own targeting at extended ranges. For example, TLAM targeting information comes from external sources. This again serves as a reminder that the maritime competition involves capabilities drawn from all domains.

157 With the blurring of the distinction between UUVs and mines, the latter could be viewed as a weapon carried by the former. At some point mines could also be a form of AUV, moving and operating autonomously.

UAV in lieu of an aircraft and a UUV in lieu of a submarine). In all cases, it is necessary for both the platform *and* the weapon to penetrate the adversary's defenses successfully. Given the diffusion and maturation of integrated air defense systems both on land and at sea, that challenge will intensify over time, placing a premium on signature reduction, advanced electronic attack, and deception. During the time frame under discussion in this assessment the maritime competition may also be characterized by precision strikes employing directed-energy weapons (e.g., chemical and solid-state lasers) and cyber munitions.[158]

Mobile Undersea Targets

If scouting and striking mobile targets on the surface of the world's seas, particularly at extended ranges, will test even the world's major dominant maritime powers, then conducting the same kinds of operations against mobile undersea systems is likely to prove even more challenging.

New technologies and greater commercial and scientific interest in the undersea will make finding mobile undersea systems easier, while offering opportunities to disperse undersea operations to more platforms. Given current trends, we will witness a large increase in both the number and variety of systems and sensors populating the undersea domain. Over the next several decades many companies, researchers, and military competitors are planning to field an array of unmanned underwater systems. Military efforts, in particular, may be expanded to defend undersea infrastructure such as communication cables and gas and oil distribution systems from attack. The United States, Russia, and now China all have acoustic sensors on the ocean floor and we can also expect to see the proliferation of mobile sensors. Moreover, even minor powers and more advanced non-state entities such as drug cartels and proxy forces (like Hezbollah) will likely have access to sophisticated underwater systems. Simply put, the undersea is destined to be a far more crowded domain than it is today, especially in extended coastal regions.

The undersea is destined to be a far more crowded domain than it is today, especially in extended coastal regions.

[158] Either directed-energy weapons or cyber weapons could induce major disruptions in the maritime competition should they realize the potential ascribed to them. For example, while "range costs" when it comes to striking with kinetic munitions, there is no variation in cost associated with range in cyber attacks. A full treatment of DEW and cyber weapons is beyond the scope of this assessment. That said, assuming this assessment provides a baseline for thinking about a mature maritime precision-strike regime, future assessments, wargames, etc., should undertake excursions to explore more fully how these emerging means of conducting strike operations (including these weapons' role in defense) might affect the competition. See, for example, Andrew F. Krepinevich, *Cyber Warfare: A "Nuclear Option"?* (Washington, DC: Center for Strategic and Budgetary Assessments, 2012); and Gunzinger and Dougherty, *Changing the Game: The Promise of Directed-Energy Weapons.*

Viewed from this perspective, especially if we are reaching the limits of acoustic quieting,[159] this, along with the proliferation of undersea sensors combined with UUV and AUV "scouts," could make even advanced submarines significantly more vulnerable to detection and engagement. It seems plausible that, given the cost disparity between a small UUV or AUV and a modern submarine, maritime competitors could arm and deploy them as undersea "kamikaze" devices or delivery systems for ASW munitions. This undersea competition would likely be most intense along the world's continental shelves, where sensor networks are most dense and where UUV and AUV scouting and strike operations could be best supported. Even under these circumstances, however, for a given amount of resources successfully locating and engaging mobile targets beneath the waves would present a significantly greater challenge than those on the surface, whether they are located in the littoral regions or in the open ocean.

Paths to a Mature Maritime Precision-Strike Regime

Given the range of plausible paths competitors might pursue in fielding maritime battle networks of varying capabilities, the characteristics of a mature maritime precision-strike regime will likely be influenced greatly by the paths they choose to follow in order to achieve their strategic objectives. What can we say about the paths key competitors are pursuing? Other than stating the obvious—that the United States has staked out a clear lead in sea-based precision-strike networks—what else can be observed from the actions of the major maritime powers? To identify the paths these powers may travel and the possible end-states of their efforts, this assessment employed the following metrics:

- Principal maritime missions emphasized;
- Mix of precision-guided munitions and delivery systems (e.g., bombs and missiles, aircraft, surface ships, submarines, ballistic and cruise missiles) that make up their forces;

[159] A submarine's ability to avoid detection is, to a significant extent, a function of its ability to minimize its acoustic signature. Many sources contribute to this signature. The noise from a submarine's machinery enters the water through the hull and radiates in all directions. A submarine's propeller vibrates when rotating. In so doing it offers anti-submarine warfare forces another acoustic source. At shallow depths or high speeds, the tips of the propeller blades also produce bubbles, or cavitation, which generates noise when the bubbles collapse. This provides still another source for ASW forces. And the turbulent flow of water around the ship can excite the hull itself. Each type of noise has a unique pattern, which can differ with speed, depth, and water conditions, and each can aid ASW forces to distinguish a submarine's noise from other sources, such as ambient noise from the motion of the ocean's surface, shipping, and sea life. While progress on quieting technologies continues, it appears to have slowed in recent years, especially when contrasted with developments in the ASW realm. See Federation of American Scientists, "Run Silent, Run Deep," Updated December 28, 1998, available at http://www.fas.org/man/dod-101/sys/ship/deep.htm. At the same time, detection techniques are improving that do not rely on the submarine's acoustic signature. These include low-frequency active sonar. See G. D. Tyler, "The Emergence of Low-Frequency Active Acoustics as a Critical Antisubmarine Warfare Technology," *John Hopkins APL Technical Digest*, January-March 1992; W. Garrett Mitchener, Gretta Bartels, and Fred Wang, *Using Ambient Noise Fields for Submarine Location*, Math Modeling Contest (unpublished paper: Duke Math Union, 1996), available at http://www.mitchenerg.people.cofc.edu/mcm96paper.ps.gz.

- Types of targets (fixed, mobile, undersea, surface) they intend to engage; and
- Characteristics of the battle network.

The further along a competitor is in developing its strategic objectives and doctrine (the maritime missions to which it accords high priority and how it envisions conducting them), and the capabilities to support them (systems, munitions, networks), the easier it is to have a sense of the path it is pursuing toward a mature maritime precision-strike force. Those competitors who have not moved very far along the path present a challenge in divining the characteristics of their mature maritime precision-strike force. Until such indicators emerge, defense analysts may gain insight into a competitor's thinking from the writing of its military theorists and personnel, much as Admirals Fisher and Sims laid out their vision of a disruptive shift in the maritime competition nearly a century ago, or as described by the authors in Peng and Yao's edited volume, *The Science of Military Strategy*.[160] But visions are not always pursued, let alone pursued to their completion. Finally, if history is any guide each competitor will likely arrive at a mature maritime precision-strike capability with many "legacy" systems. The question of how these systems will be combined with the new is an important issue, though one seldom addressed. Simply stated, it is impossible to ascertain in detail how existing and latent maritime powers will go about developing mature precision-strike complexes.

Reviewing the Bidding

How might the conduct of traditional maritime missions change in a mature maritime precision-strike regime? History suggests the changes could be profound. The following discussion explores possible answers to this question, after a brief review of the assessment's basic assumptions and preliminary observations about the overall competition. This assessment of the mature maritime precision-strike regime began by making two fundamental assumptions. First it assumes that in such a regime maritime precision-strike forces and capabilities are widely available to all major maritime powers, and to a lesser extent to minor powers and some non-state groups. The assessment also assumes that major competitors have advanced battle networks that enable them to engage both fixed and mobile targets on the surface at extended ranges, and that minor maritime powers have more modest battle networks limited at best to engaging these targets at relatively short-range.

160 Peng Guangqian and Yao Youzhi, eds., *The Science of Military Strategy*, English Version (China: Military Science Publishing House, academy of Military Science of the Chinese People's Liberation Army, 2005). *The Science of Military Strategy* is a compilation of essays by academicians at the Chinese Academy of Military Science (AMS). It examines Chinese military strategy from historical, cultural, and contemporary vantage points. The book's editors are major generals in the People's Liberation Army (PLA). The preceding is paraphrased from Timothy L. Thomas, "The Chinese Military's Strategic Mind-Set," *Military Review*, November-December 2007, pp. 47–55.

As noted above, given the range of possible paths competitors might pursue, and the number of potential competitors, the mature maritime precision-strike regime will likely produce major asymmetries between competitors.[161] This stems from a variety of factors. Given the great expense of fielding the capabilities described in this assessment that comprise the elements of a mature maritime precision-strike regime, cost will be a major limiting factor for most and perhaps all competitors. Long-range systems and stealthy systems will be in great demand; they are also expensive. This suggests (as does history) that even the wealthiest maritime competitors may be limited in their ability to field extensive extended-range scouting-strike forces linked by battle networks.[162] Moreover, the long life of much of the capital stock (ships, submarines, aircraft, satellites, etc.) means that a mature maritime precision-strike regime may have a low percentage of advanced scouting and precision-strike capabilities relative to the whole, particularly early in such a regime. Thus the competition will almost certainly be waged with a mix of old (or "legacy") and new capabilities.[163] In the case of the "old," these systems may undergo substantial modifications in order to emphasize their need to support different missions in different ways than those for which they were originally designed and built. Just as battleships in World War II were adapted to support the air defense mission rather than to establish sea control through their actions in the line of battle, tomorrow's carriers might place more emphasis on long-range unmanned scouting and strike systems as opposed to their long-standing emphasis on an air wing made up of comparatively short-range manned aircraft.

For less sophisticated maritime powers that must make do with modest resources, mines and short-range missiles may prove attractive—especially when one considers the prospective cost of countering them. The same might prove true for unmanned underwater systems and diesel submarines in lieu of large surface combatants and carriers.

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161 For example, the U.S. and Japanese fleets in World War II were symmetrical in that they had both made heavy prewar investments in battleships but quickly adjusted toward carrier-centric fleets after witnessing the lethality of aircraft against even battleships. By contrast, while the U.S. fleet remained centered around the carrier during the Cold War that followed, its principal rival, the Soviet Union, placed far greater emphasis on surface combatants, submarines, and land-based naval aviation. Thus the U.S.-Soviet maritime competition was much more asymmetric than was the preceding U.S.-Japan competition.

162 For example, consider the U.S. Navy's small scouting and strike elements at the time of the Japanese attack on Pearl Harbor in December 1941. At that time the Navy had only eight carriers out of a combined fleet strength of 790 ships. A year later it had sixteen carriers, still a tiny percentage of a fleet that had grown to 1,782 ships. "U.S. Navy Active Ship Force Levels, 1886–Present," *Naval History and Heritage Command*, available at http://www.history.navy.mil/branches/org9-4.htm#1917, accessed on January 2, 2013.

163 For example, the U.S. fleet that had transformed itself around fast carrier task forces in World War II still included warships built as far back as World War I. In the attack on the U.S. fleet at Pearl Harbor in December 1941, among the battleships damaged or destroyed were the *Arizona, Nevada, Oklahoma, Pennsylvania*, and *Tennessee*. All had been commissioned over a quarter of a century earlier. See "Battleships: Overview and Special Image Section," Naval History & Heritage Command, available at http://www.history.navy.mil/photos/usnshtp/bb/bb.htm, accessed on December 14, 2012.

As has often been the case in the past, a competitor whose military objectives require the projection of power over a relatively modest distance will enjoy an advantage over an enemy who must project power over much longer distances to counter him. Moreover, regional maritime powers with local objectives may also enjoy significant advantages over a global maritime power with global responsibilities. The regional power will enjoy a cost advantage in that it costs more to project and sustain power over long distances than short distances. The regional power will also have an "optimization" advantage, in that the regional power can optimize its maritime force to operate with maximum effectiveness in its region. A global maritime power, on the other hand, is precluded from optimizing for operations in one area, as it must design its forces to operate effectively across multiple regions involving more diverse missions.

Moreover, contemporaneous with the emergence of a mature maritime precision-strike regime, a range of other prospective technological developments *that lie outside the scope of this assessment* seem likely to exert significant influence on the character of the maritime competition. As noted earlier, ongoing advances in laser technology could greatly boost the reliability of line-of-sight communications and enhance a competitor's ability to maintain battle networks in the face of determined efforts to degrade them.[164] Advances in directed-energy weaponry could greatly enhance air and missile defenses.[165]

At the same time, competitors are developing technologies that threaten the battle network's connectivity. For example, the emergence of high-power microwave weapons has the potential to disrupt or destroy many of a battle network's elements, as could narrowband digitally controlled RF jammers and cyber weapons.[166]

Moreover, it is now possible to use digitally controlled RF energy to transmit a signal into an antenna that will generate a false target, obscure an actual target to render it undetectable, or send a signal to alter the operation of components of the battle

164 A major challenge for maintaining the integrity of a battle network is to move high volumes of information and to do so securely. Laser-based communications offer a possible solution in that light can carry much more information than other forms of wireless communication and is more secure. Its security comes from the laser's very narrow beam. The information in the beam cannot be compromised unless the interceptor is directly in its path. This is a marked contrast to radio waves, which produce "lobes" near the point of transmission that make it possible for an enemy to listen in. Both the U.S. Air Force and the U.S. Navy among other military organizations are exploring the potential of laser communications. Some modest laser communications systems have been established at the U.S. Air Force base in Bagram, Afghanistan. Office of Naval Research, "Laser Communications," August 2008, available at http://www.onr.navy.mil/en/Media-Center/Fact-Sheets/Laser-Communications.aspx, accessed on January 13, 2012; "New Radio: Laser Beams," *Discovery News*, December 13, 2012, available at http://news.discovery.com/tech/gear-and-gadgets/laser-communications-121024.htm, accessed on January 22, 2013; and Stew Magnuson, "Game-Changing Laser Communications Ready for Fielding, Vendors Say," *National Defense*, January 2013, available at http://www.nationaldefensemagazine.org/archive/2013/January/Pages/Game-ChangingLaserCommunicationsReady-ForFielding,VendorsSay.aspx, accessed on January 22, 2013.

165 Gunzinger and Dougherty, *Changing The Game: The Promise of Directed-Energy Weapons*, pp. 22–29.

166 David Axe, "How 'Revolutionary' Is CHAMP, New Air Force Microwave Weapon?" *AOL Defense*, November 28, 2012, available at http://defense.aol.com/2012/11/28/how-revolutionary-is-champ-new-air-force-microwave-weapon/, accessed on December 16, 2012.

network.[167] Cyber weapons, like air power in the interwar period, are shrouded in a fog of uncertainty regarding their prospective capability at the tactical, operational, and (especially) strategic levels of war.[168] In an environment like the mature maritime precision-strike regime posited in this assessment, where scouting and battle networks play a major role, the potential of high-power microwave, digitally controlled RF jammers and cyber weapons to deny, destroy, or provide misleading information could exert a major influence on the competition. It is no exaggeration to say that scouting in the electromagnetic and cyber domains may be more critical to a competitor's effectiveness than scouting in the physical world.

Artificial intelligence (AI) could emerge as a fallback option to enable a maritime competitor to conduct strikes with an acceptable level of effectiveness while the battle network is disrupted, in the undersea domain where communication options are limited, or where electronic emissions would render stealthy platforms vulnerable to detection—for example, unmanned systems that can leverage AI to function at a substantial fraction of their potential even when communications and data links are interrupted or severed. In this way they can buy time for these links to be restored while still undertaking important missions.

Militaries operating within the context of a mature maritime precision-strike regime will not be able to ignore the possibility that their enemy may employ nuclear weapons.

Prospective advances in propulsion fuels and battery technology could exert an enormous influence on the competition to the extent they enable platforms to operate over long distances or for protracted periods of time before they need to be refueled.

This may be particularly important for stealthy unmanned systems, such as UUVs and UAVs that do not need to return to base at relatively short intervals because of limitations on human crews.[169] This could have important consequences for these systems' ability to employ more capable sensors such as synthetic aperture sonar or operate either over long distances for protracted periods, or both.

One relatively mature technology being continually enhanced by at least some maritime competitors is nuclear weapons. Militaries operating within the context of a mature maritime precision-strike regime will not be able to ignore the possibility that their

[167] Digital Radio Frequency Memory (DRFM) is an example of how digitally controlled RF can be employed. DRFM electronically captures, stores, alters, and retransmits an RF signal. As the retransmitted signal is a coherent representation of the original signal, the transmitting radar will not be able to distinguish the DRFM-generated return from other legitimate signals it receives and processes as targets. Thus an enemy using DRFM can generate targets to the transmitting radar where, in reality, there are none, and fail to present targets where they actually exist. In this way digitally controlled narrow-band RF energy can change the electromagnetic "landscape" depicted by a battle network's scouting element. I am indebted to Bryan Clark for this observation.

[168] Krepinevich, *Cyber Warfare: A "Nuclear Option"?*, pp. 9–14.

[169] For example, the limiting factor of aircraft with a single pilot is endurance (about eight to twelve hours). Even though the aircraft can be refueled in flight to extend its time aloft for days or even weeks, the human in the cockpit cannot withstand the stress of such a long period aloft and still perform at a high level. Unmanned systems, however, do not have this problem, and therefore the ability to remain aloft is much more a function of their fuel capacity and the amount of energy the fuel can provide per unit of weight. Christopher J. Bowie, *The Anti-Access Threat and Theater Air Bases* (Washington, DC: Center for Strategic and Budgetary Assessments, 2002), pp. 11–13.

enemy may employ nuclear weapons. There are several reasons for this; the first is that the number of existing or prospective significant maritime powers that are nuclear powers has grown since the end of the Cold War. Since that time three states have joined the nuclear club, and more seem likely to do so. Second, states are developing new generations of nuclear weapons, including some with very low yields, which are blurring the distinction between nuclear weapons and precision-guided munitions.[170] Third, the military doctrine of certain nuclear-armed states suggests they will employ nuclear weapons as a means of offsetting their inferiority in conventional capabilities.[171] Fourth, given the development of nuclear weapons with very low yields, at least some maritime competitors may see little difference in employing "precision nukes"—particularly those that generate a localized electromagnetic pulse—at sea where there is likely to be little collateral damage. *The temptation to employ such weapons may be particularly strong if a competitor is at the point of exhausting its magazine of non-nuclear PGMs and sees nuclear use as an effective alternative.* The incentive to employ nuclear weapons may also be strong if one very low-yield nuclear weapon can do the work of multiple conventional PGMs or address targets that are too deeply buried or hardened for conventional PGMs. This incentive may be heightened if the strikes are to be conducted at long-range, as inventories of conventional systems for such missions will likely be modest, given their relatively high cost.

Maritime Missions in a Mature Maritime Precision-Strike Regime

Command of the Sea

The object to naval warfare must always be directly or indirectly either to secure the command of the sea or to prevent the enemy from securing it…[T]he most common situation in naval war is that neither side has the command [of the sea]; the normal position is not a commanded sea, but an uncommanded sea.

Julian Corbett[172]

As Corbett observed at the dawn of the Dreadnought Revolution, maritime forces traditionally have only been able to command the seas where their fleets or ships were physically located. They could also command the seas indirectly by either sinking the enemy fleet or blockading it in port. As used in this assessment, "command of the sea," or "sea control" (the terms will be used interchangeably), refers to a competitor's ability to secure its own access to the maritime domain while denying its enemies the same. Command of the sea thus enables one's forces to move through the controlled seas at

170 See Watts, *Nuclear-Conventional Firebreaks and the Nuclear Taboo.*

171 See Vipin Narang, "Posturing for Peace? Pakistan's Nuclear Postures and South Asia Stability," *International Security*, 34, No. 3, Winter 2009/10; and Dima Adamsky, *Russian Regional Nuclear Developments* (unpublished paper: Long Term Strategy Group, September 2010).

172 Corbett, *Principles of Maritime Strategy*, p. 87.

Rather than surface ships being the nearly exclusive participants in the competition for command of the sea, as they were in Corbett's time, the competition in a mature maritime precision-strike regime involves forces operating in or from all domains.

will, whereas all competitors are denied this ability, or do so at an unacceptably high risk (e.g., an inferior fleet attempting to break through a blockade to the open seas would incur a substantial risk of catastrophic damage). In Corbett's time the very short ranges over which maritime forces could scout and strike, and the relatively few ships available to police the enormous area covered by the seas, meant that most of the ocean's surface went unpatrolled—or "uncommanded."

This situation has changed dramatically beginning with the rise of aviation and advances in the ability to scout and then strike, promptly, over great distances. This is particularly important within the overall context of an A2/AD force posture. In the mature maritime precision-strike regime, scouting and striking ability extends to locating and attacking mobile targets at sea—ships. But the situation is more complicated than that. Rather than surface ships being the nearly exclusive participants in the competition for command of the sea, as they were in Corbett's time, the competition in a mature maritime precision-strike regime involves forces operating in or from *all* domains.

As competitors create and enhance their scouting and precision-strike capabilities residing in all the warfighting domains, the result will be a progressive shrinking of "uncommanded" seas and the continuing expansion of areas of contested sea control or, what seems more likely, mutual sea denial—a maritime "no man's land" for surface vessels, be they warships or cargo vessels, over large areas. Thus a high priority in the competition in a mature maritime precision-strike regime will center on identifying operational concepts that enable a competitor to restore his freedom of maneuver in the maritime domain, whether in selected places for a specified time, or more generally as the enemy's A2/AD forces are rolled back. (The rollback issue will be addressed presently.)

This is not to say that all maritime surface vessels will be readily identified and easily engaged—warfare remains too messy for that. Rather, deploying surface warships and commerce on the high seas within this A2/AD network will likely become a far riskier proposition than today. In a mature maritime precision strike regime—*as long as each side's battle network remains operational*—in areas where they overlap, command of the sea will likely prove difficult, as both sides have the capacity to scout and effectively engage at extended ranges. Even absent the battle network, semi-autonomous or autonomous systems—such as submarines, mines, and AUVs—may make movement on the sea's surface problematic. Of course, to the extent one side has a decided advantage in the quantity or quality of its scouting and strike forces—such as when a maritime power is within range of its enemy's A2/AD forces—the maritime forces compelled to operate far from its bases would likely be at a decided disadvantage.

Forward Presence

Forward presence has long been a principal mission for the forces of major maritime powers, as a means both of deterring or intimidating prospective enemies and of reassuring ally and partner states. Warships were particularly useful in this role, as they could appear on the horizon—outside the "three-mile limit"—as a tangible sign of their state's power and interest. Unlike land forces, ships need not infringe upon an enemy's (or ally's) sovereignty in order to present a show of military might, and they can be quickly and easily withdrawn. And unlike ground (and later air) forces that require bases on land, naval forces do not require the permission of any third party to conduct combat operations.

Unlike land forces, ships need not infringe upon an enemy's (or ally's) sovereignty in order to present a show of military might, and they can be quickly and easily withdrawn.

In a mature maritime precision-strike regime, however, naval forward presence will likely undergo a fundamental change. As a surface fleet moves closer to a prospective enemy's coastline, it comes within range of progressively more enemy A2/AD forces. Given the exceedingly short warning and engagement times associated with missile attacks (both anti-ship ballistic and cruise missiles), and the growing challenges posed by mines, UUVs, and AUVs, a forward-deployed maritime surface task force could represent a tempting target rather than a source of intimidation to rivals and assurance to allies. The temptation for an adversary to employ its precision fires may be particularly acute during a crisis, just when the need for both deterrence and assurance is greatest. This temptation to attack may be further heightened since forward-deployed maritime forces are within range of an adversary's relatively plentiful short-range precision-strike weapons and present a relatively easy problem for scouting forces.

Given these considerations, greater emphasis will inevitably need to be placed on forces that can deploy forward and evade detection, as well as on forces that can accomplish their missions at extended range.[173] Both, of course, would have to possess sufficient combat power lest they represent little more than a bluff. Submarines, owing to their stealth, can operate in relative safety close to a rival's shore, as can UUVs and AUVs. But they have small magazines. Submarines may also be able to transport towed payload modules carrying missiles, sensors, or other cargo that can take station on the seabed along an adversary's continental shelf or remain attached to the submarine to enhance its payload capacity. When stationed on the seabed, these undersea missile pods could be monitored by a combination of fixed sensors and sensors aboard patrolling UUVs and AUVs to ensure against tampering.

While worth exploring, employing submarines and undersea missile pods for forward presence fails to provide a visible physical manifestation of maritime power. Given their stealth, how do rivals or partners know if submarines are present to provide "presence"

173 A third option exists, namely employing small vessels possessing little combat value. This would make them expendable in wartime and prospectively an attractive option if the cost to the enemy of destroying these vessels far exceeds their value. It is difficult to envision, however, an enemy devoting disproportionate resources to defeating a weak force, especially if the destruction of such a force would require a highly disproportionate expenditure of resources. As will be discussed presently, it is also possible—indeed, likely—that competitors finding themselves in these circumstances will look for ways (e.g., novel operational concepts, new capabilities, or combinations of the two) to restore freedom of maneuver for maritime forces.

unless they surface, for example, to conduct port visits?[174] The same can be said regarding sensor and strike modules emplaced on the seabed. In both cases, to reveal their presence is to disclose their location and lose the stealth that enables their effective forward deployment in the first place. Long-range strike systems suffer from a similar problem in that they represent "distant presence," not "forward presence," and thus will likely lack the deterrent and assurance value traditionally associated with maritime forward presence forces.

Thus satisfying "forward" presence requirements may require novel approaches (such as rotating a small number forward), as well as educating allies and partners (and rivals as well) regarding the new approach. This may drive the forward-presence mission more in favor of systems that are expensive owing to the high cost of either their stealth (submarines) or extended range (e.g., long-range carrier-based aircraft and long-range missiles), or that are novel, such as hardened land-based forces or undersea-based systems. In this context, it bears repeating that the maritime competition has long since ceased being the exclusive province of naval forces. With the advent of air and missile power in the early and mid-twentieth century, the ability of land-based forces to influence the maritime competition has grown dramatically, as this assessment's Mediterranean theater case studies and others show. Linked to battle networks engaged in maritime scouting, land-based forces can potentially match or even outrange any ship-based strike systems or munitions, including missiles. Forward-based, land-based forces can also be made more survivable than similarly deployed surface ships, given that they can use land terrain for passive defense (e.g., cover and concealment, mobility, and hardening).[175] In summary, just as enemy land-based systems have contributed to the fielding of A2/AD forces that increase the risk of friendly naval forces operating at sea, so too can friendly forward-deployed land-based forces at least partially offset the loss of surface maritime forces in the forward-presence mission (and, as will be elaborated upon presently, in other missions as well).

Naval Force Strike

Over the past seventy years or so the ability of naval forces to strike at ever-greater ranges has been a major feature of the maritime competition. The U.S. Navy has dominated this competition in a way rarely seen in history. From aircraft capable of carrying modest bomb loads over a few hundred miles in the Korean and Vietnam wars to the TLAMs

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174 Another way to detect submarines or UUVs occurs in the event they need to transmit information. One possible way of avoiding detection in such circumstances would be to release a buoy to transmit a message. An enemy might detect the signal, but the location would be that of the buoy, not the submarine or UUV.

175 Unless forward-based forces are deployed on sovereign territory, their employment may be hostage to securing the host nation's approval, limiting their ability to deter or assure. On the other hand, if they are deployed on an ally's territory for defensive (as opposed to power-projection or offensive) purposes, their effectiveness in terms of both deterrence and assurance could be quite robust.

employed in the First Gulf War, from carrier aircraft striking land-locked Afghanistan[176] in the months after 9/11 to SSBNs armed with ballistic missiles that can strike at targets thousands of miles away, U.S. naval forces have greatly expanded their ability to strike over vast distances and, in so doing, greatly enhanced their combat potential.

One of the reasons for this dominance has been the absence of a major naval rival. Over the past sixty years or so the U.S. fleet has not encountered a major threat from an enemy surface fleet.[177] During this time the U.S. Navy's strike operations have been conducted under conditions where the seas have been a sanctuary from enemy attack. In instances where access was contested (for example, the Eastern Mediterranean during the Cold War), executing strikes from the sea against land-based targets posed substantial challenges. These challenges will be magnified in the face of an enemy's A2/AD forces in a mature maritime precision-strike regime. The problem will be exacerbated as fleet elements that make up the overwhelming majority of the U.S. fleet's strike capability—carriers and other surface warships armed with relatively short-range combat aircraft or missiles—are likely to be well within the range of an enemy's extended-range strike elements, whether they operate from land or sea.[178]

A competition in which maritime no man's lands is one of its principal characteristics will likely find competitors shifting their emphasis away from fleets built around surface combatants and toward forces and systems oriented on penetrating and defeating the enemy's long-range scouting and strike systems, and A2/AD defenses. Systems that are stealthy (e.g., nuclear-powered submarines and towed payload modules); land-based (e.g., mobile or hardened ASCM batteries); seabed-based (e.g., emplaced towed payload modules and sensor arrays); or that have extended range (e.g., bombers, as well as ground- and submarine-launched ballistic missiles) would appear to be relatively attractive for this purpose. That said, submarines may prove the least attractive of these alternatives should it prove difficult or costly to link submersibles (e.g., submarines, AUVs, and UUVs) to the battle network conducting the scouting and cueing functions.[179] With respect to AUVs and UUVs, while they will certainly become more important for

176 Note that these aircraft required multiple aerial refueling operations in order to accomplish this feat, and that these operations were conducted in a benign (uncontested) aerial environment.

177 The principal Soviet threat was in the form of its submarines and land-based air forces.

178 The Navy's Tomahawk Land Attack Missile (TLAM) has a range of roughly 900 nm, whereas the combat range of its new F-35C strike aircraft is roughly 600 nm. In addition to range, there is a scale problem. The U.S. Navy has allocated much of its surface warship VLS tubes and carrier deck space to missiles and aircraft, respectively, with missions other than strike (such as air and missile defense).

179 The concern here is the battle network's durability. American attack submarines, for example, have experienced little difficulty in receiving information. They have fired numerous TLAM strikes without difficulty, as mission data are generated off-board, and arrive via extra-high-frequency (EHF) communications. The picture changes if the submarines must raise their signatures by transmitting information to accomplish their mission (such as scouting or to control UUVs).

specific tasks and missions, they will most likely remain limited by their size (i.e., capable only of carrying small payloads), endurance, reliability, and communications.[180] Significant AUV and UUV limitations in fuel and power supplies suggests they will also need to be transported close to their assigned mission areas and refueled on station—perhaps by a nuclear-powered "mother ship," such as an SSGN.

If this new mix of naval strike elements, consisting of penetrating systems (submarines and towed payload modules armed with missiles, and stealthy[181] *long-range* carrier-borne strike aircraft—both manned and unmanned), proves effective, it may, combined with the land-based systems described in the preceding paragraph, open the door to the subsequent employment of more traditional forms of maritime strike (carriers with short-range, non-stealthy aircraft; and surface combatants with large numbers of VLS tubes) later in the conflict.

This is important for two reasons. First, as noted earlier, thanks to the long service lives of legacy systems (and U.S. fiscal woes) the U.S. Navy is likely to have a substantial number of such systems as short-range, non-stealthy aircraft and large non-stealthy surface combatants. Second, the systems described above as being potentially more effective in operating under the initial conditions of a conflict occurring in a mature maritime precision-strike regime are likely to represent a significantly more costly way of conducting strike operations than is currently the case. Thus, as with the German Army's panzer divisions in France in 1940 and the U.S. Navy's fast carriers at Midway in 1942, a relatively small—though expensive—force may be relied upon to create the conditions under which the rest of the force, including many legacy systems, can carry out their missions effectively at an acceptable level of risk.[182]

180 Given current technology, a UUV's endurance would be limited mostly by low-energy-density power supplies like batteries. Fuel cells are better in some respects but have their own shortcomings. Another likely major UUV limitation is reliability. Unlike an unmanned aircraft changing altitude, UUVs, because of the density of water, must take on or discharge ballast as it changes depth. This requirement will increase as UUVs grow in size to carry more energy, sophisticated sensors, and payloads. This added weight exacerbates the reliability problem. A stuck ballast valve that a submarine crew could easily override could be fatal to a UUV. I am indebted to Captain (Ret.) Karl Hasslinger for this insight. There are some U.S. Navy UUV designs similar to a small diesel submarine, with a range in excess of 3,000 nm and an endurance of roughly six months. The UUV would need to snorkel periodically, adding another significant design challenge to those listed above.

181 In this case stealthy refers to the aircraft having sufficient signature reduction to detect desired targets with onboard sensors at sufficient stand-off range from adversary SAMs to survive and launch a short-range, stand-off weapon.

182 Similarly, in a more recent example, the use of its relatively small (and expensive) force of stealth aircraft and precision-guided munitions (including TLAMs) at the outset of the First Gulf War created the conditions in which nonstealthy aircraft could operate at an acceptable level of risk. With respect to expense, U.S. carriers (including their complement of aircraft) in World War II were not appreciably more expensive than battleships; however, they were among the fleet's most expensive capital stock. The combination of expense and long construction time made it difficult to move quickly to a fleet optimized for the new way of war. While the U.S. Navy had but a handful of carriers in 1942, it would have nearly 100 of all types by war's end. Germany, lacking America's industrial might and suffering from attacks on its industrial base, was never able to shift to a predominantly mechanized force during the war.

Scouting Competition

Warfare will become more of a competition between "hiders" and "finders." Targets that can be identified and tracked (if they are mobile) will run a high risk of being destroyed, not only near the forward edge of the battle area…but over the entire breadth and depth of an enemy state or theater of operations.

Andrew Krepinevich, 1992[183]

This assessment has defined scouting as described by Wayne Hughes. Thus scouting is:

> …information gathered by any and all means—reconnaissance, surveillance, cryptanalysis, or any other type of what some call information warfare—and is completed when the information is delivered to the commander.[184]

As the Russians and, later, the Americans discovered, in an environment where the speed of engagement may be highly compressed (i.e., reconnaissance-strike complexes or scouting-strike battle networks), the ability to understand and act quickly upon what the information that scouting forces provide may be critical. Hence linking scouting and strike forces when possible is highly desirable, particularly when targeting mobile targets such as surface warships or even cargo ships.

Moreover, effective scouting that enables a competitor to strike the first blow has proven increasingly important in naval combat in light of the increased lethality of anti-ship ordnance. This is especially the case in offense-dominant regimes where to strike first against an enemy's scouting forces can make it much more difficult for him to locate and track one's own. At the Battle of Midway, for example, the Americans' ability to locate the Japanese carriers first enabled them to execute a devastating first strike with U.S. carrier aircraft. By according priority to sinking the Japanese carriers the Americans destroyed the Japanese navy's ability to strike at long range and its ability to scout over extended distances as well.[185] Revealingly, the Haystack concept and UPTIDE exercises during the Cold War were designed primarily to negate the effectiveness of the enemy's scouting force (i.e., prevent enemy scouting forces from detecting the fleet) as opposed to destroying it.

The growth of emphasis on battle networks and the exploitation of the electromagnetic spectrum strongly suggest that the need to win the scouting competition is almost certain to be even greater in a mature maritime precision-strike regime, where the ability to strike with precision means that to be seen is to be hit—assuming the weapon can get to

183 Krepinevich, *The Military-Technical Revolution: A Preliminary Assessment*, p. 14. This is a 2002 reprint of the original, unpublished paper completed in 1992 for DoD's Office of Net Assessment.

184 Hughes, "Naval Tactics and Their Influence on Strategy," p. 8.

185 The U.S. carrier raids against Japanese naval bases from 1943 to 1945 that gave priority to destroying land-based long-range patrol planes and bombers used as scouts lends weight to the importance attached to defeating the enemy's offensive strike capability and his ability to scout effectively.

the target quickly enough. It will likely benefit the defender more to prioritize avoiding detection, reducing the precision of detection, preventing communication of detections from reaching strike forces, and reducing the effectiveness of terminal seekers than to emphasize destroying scouting forces.

While the assertion merits further analysis, it appears that even a modest degradation of an enemy's scouting capabilities—through passive or active measures—could produce disproportionate advantages to friendly forces.[186] For example, it might create additional "holes" or gaps in an enemy's scouting coverage, enabling friendly forces armed with short-range scouting and strike elements to surge forward and shift the military balance in their favor, even if only temporarily as the enemy shifts assets to close the gap.

Yet the competition could shift quickly and dramatically. Recall that in World War II the introduction of long-range radar and radio communications between Fighter Direction Centers (part of CIC) and fighter aircraft, along with reconfiguring the carrier air wing and equipping surface ships with massive numbers of air defense guns, enabled the Americans to shift the balance in the maritime strike competition from offense to defense in the Pacific theater. The same could occur if dramatically more effective defenses, either active or passive, are fielded.[187] They could reduce the value of scouting and the incentive to strike first in a mature maritime precision-strike regime.

That being said, the competition here as elsewhere is likely to be dynamic, not static. Militaries will continually look for opportunities to improve the effectiveness of their scouting forces. For example, advances in missile stealth could render directed-energy weapon defenses ineffective by undermining the scouting forces' ability to detect the missile in the first instance—"you can't shoot at what you can't see." Assuming the cost of incorporating advances like enhanced stealth into missiles was comparable to or significantly less than the cost of fielding effective scouting forces against them, it would shift the balance back toward the offense.

The potential for cryptanalysis and cyber operations to have a major effect on the scouting competition should not be underestimated. Code breaking played a major role in World War II in enabling the Allies to achieve a competitive advantage in both the European and Pacific theaters of operation.[188] American signals intelligence (SIGINT) proved

[186] Assuming this is correct, it would further undermine traditional methods of employing naval forces to conduct forward-presence operations. Unless scouting forces were viewed as expendable, they would be particularly tempting targets operating so deeply within an enemy's A2/AD zone.

[187] Such enhancements in the defense could arise from improved missile defenses (particularly in the area of directed-energy weapons), decoys and deception (as the U.S. fleet employed in the Haystack and UPTIDE exercises), better ship armor, and improved damage control.

[188] The U.S. Navy's decisive victory at the Battle of Midway in June 1942 was, in part, the product of superior U.S. strategic and operational intelligence derived from breaking the Japanese war code. Hughes, *Fleet Tactics and Coastal Combat*, p. 114; and Spector, *At War, At Sea*, p. 199.

an important source of intelligence during the Cold War.[189] Cyber operations have the potential to glean important intelligence from the enemy regarding his disposition of forces. Moreover, cyber operations can also delete or corrupt a battle network's data, destroying information or inducing it to provide false information.

Should corruption or denial of data or information cause a competitor to lose confidence in his scouting element or battle network, it could produce a catastrophic failure, particularly in his ability to strike mobile targets or targets at extended range. This would almost certainly result in a major shift in the maritime balance. Important questions arise from this possibility. For example, could a battle network and its scouting functions be quickly restored following such attacks? Could the effects of an attack be localized so that other elements of the battle network could continue to perform and provide reliable information, or would a massive attack of this kind produce catastrophic levels of damage to (and to the confidence in) the battle network? Might quickly restoring the battle network in the wake of such an attack prove difficult and perhaps impossible?

Should corruption or denial of data or information cause a competitor to lose confidence in his scouting element or battle network, it could produce a catastrophic failure, particularly in his ability to strike mobile targets or targets at extended range.

Correspondingly, feeding an enemy's scouting forces false information could lure him into engaging false targets and, in so doing, depleting his magazines of expensive, precision-guided munitions that he would find difficult to replace. Given such concerns, and the uncertainties surrounding both cyber warfare and modern cryptanalysis, arriving at a better understanding of the potential—and limitations—of one's own capabilities, including cyber attacks, as well as those of the competition should be accorded high and persistent priority.

Commerce Raiding and Defense—Shipping

It is commerce and finance which now more than ever control or check the foreign policy of nations . . . Modern developments and changes in shipping and naval material have indeed so profoundly modified the whole conditions of commerce protection, that there is no part of strategy where historical deduction is more difficult or more liable to error.

Julian Corbett[190]

Corbett wrote these words over a century ago. But they still apply to the matter of commerce defense when examining the changes that will transpire between current conditions and those in a mature maritime precision-strike regime. Just as Corbett was writing during the last phase of the great wave of economic globalization that emerged in the nineteenth century, the world today is riding an even stronger wave of global economic trade that has bound economies together more tightly than ever before. Globalization has also increased many states' economic vulnerability to having their maritime trade threatened or cut off.

[189] See, for example, the accounts of the U.S. Navy's tapping of Soviet undersea communications cables during the Cold War in Sherry Sontag and Christopher Drew, with Annette Lawrence Drew, *Blind Man's Bluff* (New York: Public Affairs, 1998), pp. 125, 158–63, 211–20, 236–52, 311.

[190] Corbett, *Principles of Maritime Strategy*, pp. 95, 269.

Today the overwhelming majority of international trade continues to move by sea. A mature maritime precision-strike regime defined by the ability to strike both fixed and mobile targets on the Earth's surface at long-range, effectively and with precision, will require major adjustments in our thinking about commerce defense. History reminds us how risky it was for ships to transit across the Mediterranean during much of World War II in the face of enemy land-based air reconnaissance and strike elements, submarines, and mines. Moving cargo in a mature precision-strike regime promises to be even more daunting, given improved scouting and how fast attacks can occur.

There are, of course, differences from the Mediterranean case study that need to be taken into account. On the one hand World War II ship-killers employed comparatively cheap ordnance (such as "dumb" gravity bombs and torpedoes) from close range. If commerce raiding in a mature maritime precision-strike regime centers on expending costly, scarce PGMs to attack shipping at extended ranges, the direct and indirect opportunity costs may prove daunting. Yet some maritime targets, such as oil super tankers, could well merit the high cost of engagement, depending on the value of the ship and its cargo to the enemy. Alternatives may be sought as well. For example, submarines may provide an excellent means of penetrating an enemy's A2/AD defenses to prey on shipping. Or long-range precision strikes may be employed directly against ports in the knowledge that any ships located there could be destroyed, or that the loss of port infrastructure will make it difficult or impossible to offload cargo.

Assuming both sides in a commerce war have deployed robust A2/AD forces, we may view commerce defense as occurring in one of three general areas (see Figure 7). One, the rear area, is defined as being within the friendly force's own A2/AD umbrella and outside of the enemy's, save for his long-range scouting and strike forces. This includes enemy submarines that must transit long distances to penetrate deeply within the friendly force's A2/AD defenses. The high cost of long-range scouting and strike forces would keep their inventories at modest levels for both sides, making them reluctant to employ them against low-value targets such as individual merchant ships or lesser combatants.[191]

Under these conditions, it may be possible to move seaborne cargo in relative safety in home waters. (Yet even this could prove difficult if the enemy can emplace and replenish smart mines in littoral waters.) The existence of a rear area assumes, of course, that the two maritime competitors are quite distant from one another. The United States provides a good example of a competitor whose geographic position gives it a large rear area, as its littorals and continental shelf are remote from other major maritime powers. The same would not apply, for example, to China or Japan, given their proximity to each

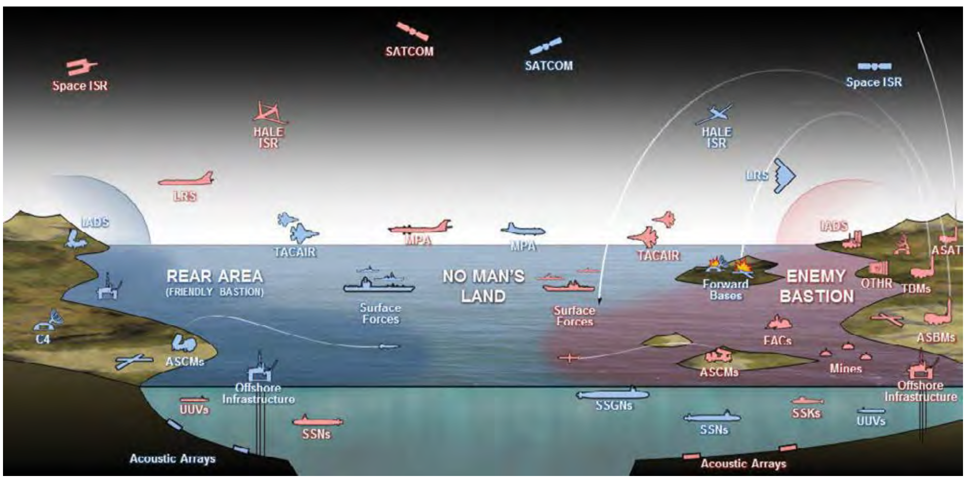
191 While a submarine commander would be reluctant to use an MK-48 Advanced Capability (ADCAP) torpedo (whose cost is roughly $1 million) to kill a coastal merchant, there may be times and places where it is warranted. For example, sinking a ship either by torpedo or with a mine could prove a strong deterrent against those who seek to transit coastal waters. Or it could compel an adversary to escort merchant shipping, prohibiting these key assets from accomplishing other missions.

other, where the competitors would both operate in the teeth of each other's A2/AD forces, as well as the large U.S. maritime forces in the Western Pacific.

Beyond the rear area, forces might enter a maritime "no man's land," defined as any maritime region where only the long-range maritime scouting and strike force capabilities of both competitors overlap. As the name suggests, operating on the ocean's surface in this area is a risky proposition for *both* sides. In a mature maritime precision-strike regime, parts of the Western Pacific, including around China, Japan, and forward-based U.S. maritime forces, could become a maritime no man's land.

Beyond no man's land, friendly maritime forces would encounter the enemy's maritime bastion, the area where enemy A2/AD defenses are concentrated but beyond the effective range of most friendly maritime forces.[192] The enemy's bastion is the equivalent of the friendly force's rear area. From a U.S. perspective, a Chinese maritime bastion might exist in the Western Pacific if Japan were to dissolve its alliance with the United States and if the remnants of U.S. maritime forces were limited to distant outposts in places like Australia and Hawaii. The same condition could arise if U.S. maritime forces lost their access to the Persian Gulf.[193]

FIGURE 7: MARITIME ZONES



192 A bastion can be generally defined as a maritime region where the enemy can operate in wartime with a high degree of freedom and friendly maritime forces operate at great peril. In this assessment friendly maritime bastions are referred to as "rear areas," to differentiate them from enemy bastions.

193 Recall that, as used in this assessment, maritime forces include not only those that operate on the surface or under the sea, but also those forces that can influence the competition at sea. Just as naval forces can influence the military competition in other domains (such as land, air, and space) so too can forces operating in these domains influence the maritime competition. Thus losing access to the Persian Gulf can include loss of access for forces based on land (e.g., shore-based ASCM batteries, mine-clearing helicopters, air and missile defenses supporting the defense of warships, and merchant ships operating in the Gulf), in the air, and in space (e.g., ground-based tracking stations).

Friendly maritime commerce defense operations will likely prove challenging in no man's land and daunting when operating in an enemy's bastion. In the former case maritime powers might apply some of the lessons learned by the Royal Navy in the Mediterranean theater during World War II. The British relied considerably on deception and cryptanalysis to gain an advantage over when and where the Italians and Germans would attempt to move supplies. The same will likely hold true in a mature maritime precision-strike regime. Furthermore, cyber and other operations that undermine the effectiveness of an enemy's scouting efforts could prove critical.[194]

Yet even then, assuming the enemy has a robust battle network and scouting force employing multiple means of identifying ships at sea—for example, space-based sensors, manned and unmanned aircraft, AUVs and UUVs, sensors embedded in smart mines or buoys, and undersea sensor grids similar to SOSUS[195]—it may be difficult to render an enemy's scouting force and battle network ineffective. Hence efforts to maintain prewar levels of trade will prove difficult and perhaps impossible against a major maritime adversary. The more relevant question is likely to be: Is it possible to keep critical supplies flowing in sufficient quantities to sustain the war effort?

How might this be accomplished? Given our definition of a mature maritime precision-strike regime, keeping such supplies flowing is likely to prove both difficult and hazardous. To be sure, during the world wars convoys proved capable of sustaining an adequate level of goods for Great Britain. Yet during both world wars the Allies suffered heavy losses from German attacks, and moving small maritime tonnage through the Mediterranean Sea proved difficult from 1940 to 1943.[196] The U.S. Navy conducted a highly successful commerce-raiding campaign against Japan in World War II, primarily with submarine forces, while Germany's U-boats brought Great Britain perilously close to defeat in both world wars, although at high cost to the submarine forces of both navies.[197]

194 A major challenge with these kinds of counter-scouting operations will be developing effective means of conducting "battle damage assessments." How do friendly forces know when the enemy's data have been destroyed or corrupted? What level of confidence is required before sending a convoy on its way?

195 The term SOSUS stands for the Sound Surveillance System, a chain of underwater listening posts deployed between Greenland, Iceland, and the United Kingdom during the Cold War. Its purpose was to track the movement of Soviet submarines into the Atlantic Ocean. Other more modest undersea sensor networks were established at other locations.

196 The British often routed the far greater distance around the Horn of Africa and through the Red Sea to Suez in order to avoid the dangers of sending convoys through the Mediterranean.

197 Nearly 20 percent of U.S. submarines were lost during World War II, the highest proportion of any U.S. forces. German U-boat losses were roughly 70 percent, the highest casualty rate of any Service of any combatant during World War II. William P. Gruner, "U.S. Pacific Submarines in World War II," Historic Naval Ships Association, available at http://www.hnsa.org/doc/subsinpacific.htm, accessed on February 12, 2013; and "British and German Submarine Statistic of World War II," Naval Historical Society of Australia, available at http://www.navyhistory.org.au/british-and-german-submarine-statistics-of-world-war-ii/, accessed on February 12, 2013.

Then there is the matter of geography. To the extent trade routes require shipping to transit chokepoints (such as the Strait of Gibraltar, Suez Canal, Malacca Strait, and Strait of Hormuz), this will go a long way toward solving the enemy's scouting problem. The enemy can then concentrate his limited scouting assets (particularly if the chokepoint is at an extended distance from friendly force bases) on chokepoints knowing that merchant shipping cannot avoid transiting through them. Moreover, whether chokepoints exist or not, merchant ships must ultimately dock at a port. Thus the set of major ports comprises another known chokepoint, further reducing the enemy's scouting problem. As will be elaborated upon presently, two keys to effective commerce defense of shipping will be defeating the enemy's scouting forces and effective ASW.[198]

Commerce defense may also be aided by creating stockpiles of strategic materials or by employing alternative methods of moving critical cargo, such as by sending it along land routes (by truck, rail, or pipeline). During the early years of World War II, for example, Germany was able to defeat Great Britain's efforts to stifle its seaborne commerce by obtaining supplies over land from the Soviet Union or via local waters, such as Swedish iron ore via the Baltic Sea. Even then, naval forces armed with long-range strike elements could be employed to support a "land blockade" by striking onshore supply routes.[199]

Finally, if moving cargo through no man's land will be challenging in a mature maritime precision-strike regime, attempting to accomplish this in the enemy's maritime bastion would likely be suicidal, with catastrophic levels of attrition in both merchant shipping and surface naval escorts. Ostensibly the only reason for even attempting such operations will be to move small amounts of badly needed cargo to a force or an ally that is absolutely essential to the war effort. An example of this is found in the Royal Navy's efforts to slip convoys through to Malta, particularly in 1941–42 when Axis forces in the Mediterranean were at their strongest. One can envision such an operation to reinforce U.S. Army outposts defending along the First Island Chain in some future conflict.[200]

198 To this we might add effective air and missile defenses. However, absent major breakthroughs that enable a major shift in the competition from the offense (which it currently favors by a significant margin) to the defense, this does not appear to be a profitable area in which to compete for those seeking to protect seaborne commerce.

199 The U.S. Navy has already demonstrated such a capability. During the First Gulf War, for example, it fired TLAMs against targets deep inside Iraq. Following the 9/11 attacks, carrier-based aircraft conducted sustained strikes in Afghanistan, a land-locked country.

200 For example, during the Japanese siege of U.S. forces on the island of Corregidor during World War II, the Americans received small supplies of munitions transported by submarine. This was the only means of moving cargo at an acceptable level of risk, as Japanese forces controlled both the air and sea around the island. The Americans also employed their submarines to transport critical cargo off the island, to include much of the Philippine government's gold and silver bullion. Edward Michaud, "Corregidor: The Treasure Island of World War II," 1999, available at http://corregidor.org/chs_trident/trident_02.htm. A few PT boats were also used to transport small amounts of critical cargo, including General Douglas MacArthur, from the island. In the future, a Towed Payload Module might be used to transport small amounts of critically needed supplies.

Commerce Defense—Undersea Infrastructure

As discussed earlier in this assessment, a competitor's economic assets at sea no longer consist of only seaborne cargo it is either exporting or importing.[201] The ongoing development of an undersea economic infrastructure that began in the years immediately following World War II represents a valuable asset—and therefore an attractive target—for many major maritime powers.

Most of a state's principal undersea economic infrastructure lies along its continental shelf. So in many cases the infrastructure may be in the state's maritime rear area. This would be the case, for example, with U.S. assets in the Gulf of Mexico, as there is no major maritime power within the region. Yet it would still be possible to attack an enemy's undersea infrastructure located in its rear area by employing systems capable of operating with stealth, and at long ranges, such as nuclear-powered submarines and any SOF, AUVs, and UUVs they might carry. There may also, however, be undersea infrastructure in highly contested maritime zones. For example, the emergence of a mature maritime precision-strike regime may well coincide with major undersea economic development in the Eastern Mediterranean and South China Sea, areas that could both easily be categorized as maritime no man's lands, or perhaps where two major maritime powers are in close proximity to one another, as with China and Japan. In such instances where bastion zones overlap, both sides will find themselves operating in a maritime no man's land where the full weight of their forces can be brought to bear.

In a conflict involving multiple competitors, a major challenge for a competitor attempting to defend his infrastructure may be accurately *identifying the source of an attack.*

In a conflict involving multiple competitors, a major challenge for a competitor attempting to defend his infrastructure may be *accurately identifying the source of an attack*. This is because a third maritime power—including one not actively engaged in the conflict—may be able to trigger a catalytic war between the other two powers or to influence the course of a conflict covertly by executing attacks on one state's infrastructure that are misattributed.[202]

Systems like SSNs, SSGNs (including those carrying SOF), towed payload modules, UUVs, and AUVs may be among the more attractive ways of both scouting and striking undersea infrastructure. The scouting problem may be minimal as most targets are likely to be fixed, and the areas in which they are located will be well defined. To the extent these scouting and strike systems are stealthy (e.g., quiet to avoid acoustic detection), they may be able to avoid a rival's defenses. Should this condition obtain, it then

201 This cargo may be carried in ships that do not belong to firms based in the competitor's state, or even ships flying the flag of his state. This in itself could present difficulties in protecting commerce, since private firms, both foreign and domestic, may be reluctant to risk their ships in a war zone.

202 For example, a war could result if two powers, A and B, are at a crisis point. A third power, C, could attempt to trigger a conflict between A and B by conducting an attack on A that A's leaders attribute to forces belonging to country B. The premise here is that A will then retaliate against B, and the war will be on. During the conflict C might continue trying to influence the outcome by conducting covert attacks against one side or the other, or even both. The attribution problem merits attention, particularly in a mature maritime precision-strike regime where many states, and even some non-state entities, will have the means to scout and strike undersea targets at considerable distances, and with precision.

becomes a question for the defender of its undersea infrastructure's active defenses and resilience (level of hardening, asset distribution vice centralization of operations, etc.) in the face of attacks.

How might one deter such attacks? If reliable attribution is possible (or, more to the point, if an enemy believes that its rival can accurately identify its attacks), then it may be possible to deter them through the threat of retaliation. Deterrence might be reinforced if the enemy has extensive undersea infrastructure and believes that it can be placed at similar risk of damage or destruction in retaliation for any attacks he might conduct on the infrastructure of his rival. It is far from clear, however, that either condition will obtain in a mature maritime precision-strike regime.

Assuming deterrence is not a particularly sturdy pillar on which to base the security of one's undersea economic infrastructure, it is appropriate to ask: How might a state defend itself against such attacks? The answer appears to be "with great difficulty." While the answer to this question depends to a significant extent on the circumstances surrounding a given contingency, erecting a SOSUS-like barrier around an undersea economic domain would seem both technically challenging and expensive.[203] Still, an array with active sources might be effective, especially in small geographic areas.

A defense employing sensors and kinetic or directed-energy defenses could take various forms, such as a perimeter defense that, as the name suggests, would run along the periphery of critical undersea economic infrastructure. Depending upon its characteristics, it might prove desirable to emplace a point defense that would concentrate defense assets at key vulnerabilities in the infrastructure. Of course, a competitor might opt for a layered defense combining perimeter and point defenses. The defense might include passive elements (barriers such as nets, hardening, and redundancy in key parts of the infrastructure) and active elements (from patrols by systems ranging from submarines, to AUVs and UUVs, to mines).[204] Most likely a competitor would deploy some combination of these defenses.

The effectiveness of a defensive sensor barrier would likely be affected by the noise generated from the economic activity inherent in offshore energy extraction and shipment. Of course, in such an environment an enemy might generate noise to divert or decoy attention from his efforts to scout, map, and conduct strikes on the infrastructure. Moreover, an attacker employing UUVs or AUVs with their low signatures, when coupled with limited sensor ranges on defending systems, would derive a significant advantage.

[203] The SOSUS relied on passive detection; it detected target noise. In the case considered here, such a system would encounter several major challenges. First, the noise level in coastal areas is high. Second, small undersea systems like AUVs and UUVs will not generate much noise. Even if detected, it is not clear how these systems would be tracked and engaged. Nets might prove useful, but the netting required to cover an EEZ would be enormous and prohibitively expensive.

[204] Most active defense systems would also incorporate sensors as well.

To the extent both scouting and strikes against the undersea economic infrastructure can be accomplished anonymously, or within the context of plausible deniability, efforts would be made in peacetime to map a prospective enemy's undersea infrastructure—and perhaps mine it as well.[205] Given the prospect of undersea towed payload modules, it is feasible that small explosive charges could be emplaced by the very systems undertaking scouting and mapping activities, especially where defenses are weak or perhaps even nonexistent. In a mature maritime precision-strike regime where an enemy's undersea economic infrastructure is likely to reside in its maritime bastion, well beneath his A2/AD umbrella, the only way to attack it promptly and effectively in war may require undertaking these kinds of preparatory activities in peacetime.[206]

Assuming the absence of an effective defense, the defender will have to deal with the consequences of successful attacks. How can damage best be limited if defense fails? How long will it take repairs to bring the infrastructure back on line? What are the costs of failing to quickly restore economic activity? The answers to these questions lie beyond the scope of this assessment, but they could exert a significant influence on the maritime balance, particularly if the economic costs of such attacks are high, which seems likely.[207] Given the preceding discussion it seems likely that the ability to threaten a competitor's undersea economic infrastructure will be an effective cost-imposing strategy—especially if most of the costs of scouting, mapping, and emplacing munitions are incurred in peacetime, thereby avoiding the use of scarce long-range assets for this purpose in wartime.

[205] There is some precedent for this kind of activity. During the Cold War, U.S. submarines conducted operations in which they penetrated Soviet waters to conduct surveillance. See Sontag and Drew, *Blind Man's Bluff*.

[206] This matter merits persistent analytic focus to determine the characteristics of the undersea competition with far greater clarity than has been presented here. For example, many energy firms employ UUVs and AUVs to monitor their undersea infrastructure. Depending on these systems' effectiveness, it may be difficult to emplace munitions prior to a conflict.

[207] As an example, it cost over $14 billion to remediate the damage caused by the oil spill that occurred when a British Petroleum undersea well-head exploded in the Gulf of Mexico on April 20, 2010. Selina Williams, "BP Remains in Troubled Waters Over Oil Spill," *Wall Street Journal*, November 15, 2012, available at http://blogs.wsj.com/source/2012/11/15/bp-remains-in-troubled-waters-over-oil-spill/, accessed on January 3, 2012. The U.S. government settled for a payment of $4.5 billion from BP in November 2012. "BP Settles with U.S. Government for $4.5B in Gulf Oil Spill," *Fox News*, available at http://www.foxnews.com/politics/2012/11/15/bp-settles-with-us-government-for-45b-in-gulf-oil-spill/#ixzz2HIYfP0VK, accessed on January 3, 2012. Other estimates place the actual cleanup costs, including remediating the environmental damage, at roughly $19 billion. "BP's Potential Pricetag for Gulf Oil Spill," *Insurance Journal*, March 5, 2012, available at http://www.insurancejournal.com/news/national/2012/03/05/238184.htm, accessed on January 3, 2012.

Blockade

The "proper place" for our battle-fleet had always been "on the enemy's coasts," and now that was precisely where the enemy would be best pleased to see it.

Julian Corbett[208]

Corbett was speaking of the dangers posed for naval forces operating in littoral waters by the introduction of submarines and torpedo boats armed with torpedoes, and of the use of mines. Owing to their stealth (torpedo boats typically were deployed at night) these systems made it risky for maritime forces to operate close to shore. Consequently, in World War I the Royal Navy abandoned its long-standing preference for close blockade in favor of distant blockade.[209]

The problem confronted by the British fleet nearly a century ago would remain, albeit in a much altered form, in a mature maritime precision-strike regime. With both enemy scouting and strike capabilities vastly greater than those confronted by the Royal Navy in World War I, a friendly force's ability to execute a blockade over the maritime activity occurring within an enemy's maritime bastion could prove both difficult and costly. Friendly SSNs could patrol within this zone and prey on shipping, either directly, such as by firing torpedoes or ASCMs,[210] or by emplacing mines.[211] Friendly long-range, stealthy cruise missiles and unmanned aircraft might be able to loiter along maritime bastion trade routes scouting for targets and striking them when they are discovered. These resources, however, are likely to be among the most expensive in a competitor's maritime force, and thus in scarce supply. It is not clear that given competing mission priorities these resources will be available in sufficient numbers to conduct blockade operations within the enemy's A2/AD defenses.

This could change, however, if the two warring powers were in close geographic proximity to one another so that the seas between them were in each other's maritime bastions—that is, where the bulk of their A2/AD forces overlapped. As noted above, such a condition would exist in at least some maritime areas lying between China and Japan (Figure 8), for example, or for Saudi Arabia and the United Arab Emirates in a conflict

208 Corbett, *Principles of Maritime Strategy*, p. 122.

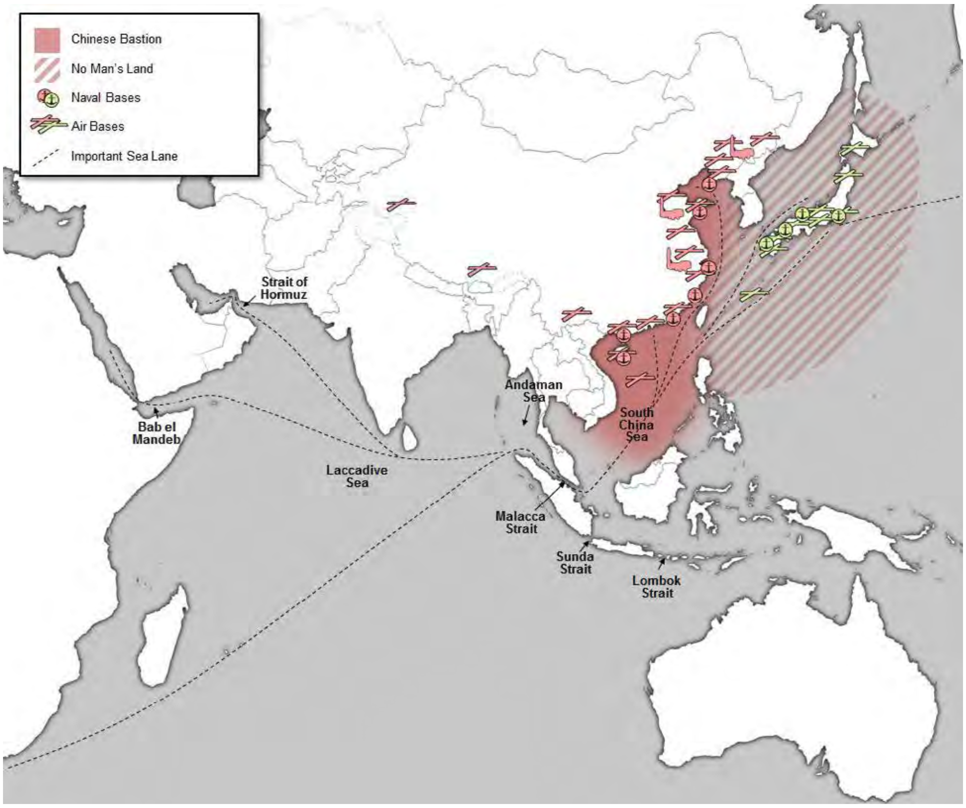
209 The difficulties associated with a blockade of maritime commerce are many indeed, and are not limited to military operations alone, but are intertwined with them. See, for example, Nicholas A. Lambert, *Planning Armageddon* (Cambridge, MA: Harvard University Press, 2012).

210 Current ASCMs may prove effective in creating "mission kills" against large merchant ships, creating damage requiring several months to repair. They may not, however, be very effective as "ship killers." Yet as noted earlier there is nothing to prevent a competitor from fielding ASCMs with larger warheads, or with warheads specifically designed to sink even the largest merchant ship.

211 Mines would be particularly effective at maritime chokepoints. Yet with the advent of "smart mines"—mines that are mobile and incorporate sensors enabling them to detect and track their targets—it may be possible for a just a few mines to threaten far larger areas than is currently the case. Of course one may also anticipate advances in countermine operations as well.

with Iran. The ability of both sides to employ the full range of their maritime forces, at both short and long range, could find them engaged in intensive blockade operations.[212]

FIGURE 8: CHINA-JAPAN MARITIME ZONES



In a global economy, a considerable portion of a major power's maritime trade is likely to occur beyond its littoral, transiting beyond its maritime bastion and through no man's land.[213] Here the potential to conduct distant blockade operations within the context of a mature maritime precision-strike regime appears to be far greater, both in enhanced effectiveness and reduced cost.

212 A version of this occurred during World War II when geographically close rivals, Germany and Great Britain, both engaged in blockades against each other. For several reasons, not least of which is distance, Germany never seriously contemplated a blockade of the United States, nor did Great Britain think of trying to blockade Japan. Only a maritime power with the economic might of the United States was able to undertake very long-range blockade operations. Even in this case, however, the U.S. fleet benefited from a growing number of forward bases from which to operate.

213 The enemy may not be able to project scouting and strike forces beyond its own maritime bastion. For example, in a mature maritime precision-strike regime where a war occurs between the United States and Iran, large portions of the maritime domain may be outside the range of any U.S. A2/AD forces and any Iranian long-range scouting and strike forces. This situation is not elaborated upon in this assessment, as there is an absence of competition in this area.

In a maritime no man's land, surface ships of all stripes on both sides of a conflict attempting to run a distant blockade would appear to be at great risk. This situation would be comparable to commerce raiding, only instead of sinking ships bound for enemy ports, the ships could be told not to enter what might be viewed as a maritime "free-fire" blockade zone. Another difference is while commerce raiding can be expected to involve actions against ships actively defended by the enemy (such as by the presence of convoys of some type), blockade assumes local sea control where cargo ships either avoid steaming in the proscribed area or, if they do, are intercepted and routed away from enemy ports rather than being sent to the bottom.

The general contours of a mature maritime precision-strike regime presented above suggest that war at sea will likely become far more lethal and power projection much more difficult.

One of the problems encountered by the Royal Navy in shifting to a distant blockade in the face of Germany's proto-A2/AD forces centered on the enormous increase in the number of ships required to enforce it.[214] The means employed in conducting blockade operations would be different in a mature maritime precision-strike regime than in "traditional" blockades. The great improvements in scouting, for example, would enable ships to be tagged and tracked by satellite and by air (e.g., manned aircraft and UAVs) as they leave port and move through maritime chokepoints. These ships can be ordered out of restricted areas via electronic communications and, if need be, engaged at great distances and with precision by maritime forces. In remarkable contrast to the Royal Navy's problem a century ago, it may be possible to conduct an effective extended blockade with very few naval combatants, that is, by employing primarily non-naval means.

Break Out?

The general contours of a mature maritime precision-strike regime presented above suggest that war at sea will likely become far more lethal and power projection much more difficult. This prompts the question of whether such a regime will prove stable—creating an enduring "new normal" for the maritime competition. Or whether, owing to advances in other areas of the military competition ranging from artificial intelligence and cyber warfare to directed-energy and novel nuclear weapon designs, a way can be found to restore freedom of maneuver in the maritime domain. This is the subject of the following chapter.

[214] The number of ships required to reduce the number of successful blockade runners in a close blockade was small compared with the number of ships required to achieve comparable results in a distant blockade, primarily owing to the much greater distances that had to be covered. See Lambert, *Sir John Fisher's Naval Revolution*, p. 179.

RESTORING MARITIME FREEDOM OF MANEUVER

[B]ecause of the growing expense of deep-strike systems and munitions, a crucial measure of effectiveness for the deep strikes that exploit information dominance will be an ability to identify a relatively small number of targets that, when successfully engaged (or engaged on a recurring basis), cripple an enemy's effectiveness or capacity to resist.

Andrew Krepinevich[215]

Even when the author wrote this over two decades ago, there was a sense that long-range scouting and strike systems would not be plentiful once the military revolution spawned by the information revolution had matured. Consequently, as in previous eras of military competition, such resources would have to be employed carefully to ensure they achieved the maximum possible effects.

In World War II, for example, the U.S.-British Combined Bomber Offensive found the two allies debating with themselves and each other over which targets—oil, electricity, arms production, transportation, etc.—to strike in Germany, knowing that only a small fraction of the overall target base could be attacked.[216] Similarly, another high-cost asset, aircraft carriers, was employed primarily against the most critical targets (the main body of the Imperial Japanese Navy) in the Pacific theater.[217] Many of the systems and

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215 Krepinevich., *The Military-Technical Revolution: A Preliminary Assessment*, p. 30.

216 See James G. Roche and Barry D. Watts, "Choosing Analytic Measures," *The Journal of Strategic Studies*, June 1991, pp. 165–209.

217 Destroying the primary striking power of the Imperial Japanese Navy in the form of its carriers was considered the top priority when such strikes were possible (i.e., when Japanese carriers were within range of U.S. carrier striking power)—as, for example, at the battles of Midway (June 1942), the Eastern Solomons (August 1942), Santa Cruz (October 1942), and the Philippine Sea (June 1944). Carrier task groups performed other missions as well, however, especially after the U.S. Navy had broken the back of Japan's naval air power. These missions included attacks on island air bases, invasion support, and land attack missions against Formosa (Taiwan) and Japan itself.

capabilities that can scout and strike over long distances (such as satellites, stealthy long-range manned and unmanned aircraft, submarines, manned and unmanned submersibles, and sensor arrays) are expensive and, consequently, available in correspondingly limited numbers, even among the militaries of the wealthiest maritime powers. These capabilities—which constitute the key sources of military effectiveness in a mature maritime precision-strike regime—will therefore need to be employed most judiciously in war.

The answer to how they should be employed depends on whether or not the emergence of a mature maritime precision-strike regime will usher in a "new normal" in the military competition described here. By "new normal" is meant a maritime regime whose defining characteristics will endure for a protracted period of time (i.e., a decade or more). If so, the rise of A2/AD defenses and maritime no man's lands will make it far more difficult for surface warships and merchant ships to move about on the seas than is currently the case—especially for the United States—while the undersea economic infrastructure will no longer enjoy sanctuary. In summary, the maritime competition would have shifted substantially in favor of the defense—except in the undersea infrastructure competition, where the offense seems likely to dominate.

It is far from clear, however, that should such a competitive environment emerge, it will endure. At least some maritime powers will have a strong incentive to displace it. Advances in technology, new methods of conducting war (operational concepts), or some combination of the two may enable maritime powers to restore, at least partially, their freedom of maneuver.

How might this be accomplished? What might the next move in a mature maritime precision-strike regime be? As stated at the beginning of this assessment, the paths toward a mature maritime precision-strike regime are likely to be varied, most competitors have not moved very far along these paths (although their momentum seems to be increasing), and promising developments (such as in directed energy, cyber weapons, artificial intelligence/robotics) in military capabilities may mature over the next ten to twenty years. Because of these circumstances, it is difficult to describe with confidence the initial state of the new maritime competitive environment. Describing prospective countermoves therefore presents an even greater challenge.

That being said, if the mature maritime precision-strike regime conforms to the description presented above, one can imagine some ways in which competitors might restore freedom of maneuver to project maritime power. Four possibilities are presented here. They are not mutually exclusive. Two of the four options focus on elements of the "reconnaissance-strike" network—specifically, the enemy's ability to scout effectively and his (presumably) limited arsenal of long-range strike weapons. Of course, there is nothing to prevent a competitor from suppressing enemy extended-range scouting and strike forces simultaneously, save for his own limited ability to conduct effective long-range strikes. The other two options focus on relatively crude strategies of prompt and protracted attrition, respectively.

Option 1: Win the Scouting Campaign

Given the growing vulnerability of surface warships and transport ships, most major maritime powers will presumably have an increasing portion of their naval forces moving and operating beneath the surface of the seas. Thus surface warship operations will be limited primarily to a competitor's maritime rear area and perhaps no man's land. As for transport ships, nearly all maritime commerce occurs on the surface of the seas, since transporting it undersea is not economically feasible. Undersea transport (such as by submarine) has occurred rarely and only when surface transport was deemed too risky and the movement of the cargo in question was deemed to have the highest priority.

Yet if a maritime power can substantially degrade its enemy's ability to scout effectively, his mobile maritime assets may be able to operate with much less risk of sustaining damage or being destroyed.

Given their ability to scout over wide areas, their cost, and the long lead times associated with their construction and deployment, neutralizing or destroying an enemy satellite's ability to scout will likely be accorded high priority.

Priority in a campaign to win the scouting competition would likely be given to securing one's maritime rear areas and no man's land.[218] It seems likely that most of a competitor's maritime commercial traffic would occur in these areas, and therefore the greatest benefit would arise from degrading the enemy's scouting capabilities in these areas. Success here may also be easier to achieve given that the enemy's scouting assets capable of operating at long range will likely be relatively few compared with those that can operate only at short range, that is, within the enemy's A2/AD defensive zone or maritime bastion.[219]

The campaign to win the scouting competition will likely involve a series of kinetic, cyber, and (perhaps) directed-energy strikes. Given their ability to scout over wide areas, their cost, and the long lead times associated with their construction and deployment, neutralizing or destroying an enemy satellite's ability to scout will likely be accorded high priority. The ability to attack satellites employing kinetic interceptors and directed-energy weapons has already been demonstrated, and it may be possible to disrupt or corrupt their functions through cyber attacks. An enemy's scouting forces that are located at *fixed* facilities—for example, long-range stealthy UAVs located at an air base, OTH radars located at fixed sites, and satellite ground stations—would be relatively easy targets for friendly long-range systems to engage and

218 As noted earlier, it is possible that maritime competitions may occur between belligerents where there are overlapping maritime zones (e.g., China and Japan). For the purposes of this assessment, an example encompassing all three zones is employed.

219 This is not to say that all enemy scouting undertaken in a no man's land and the enemy's maritime bastion are conducted using long-range systems (e.g., satellites, submarines, and long-range manned and unmanned aircraft). Forward-based systems and weapons (e.g., UAVs operating from austere land airfields, cyber "logic bombs," and embedded undersea sensors) may provide scouting information.

destroy, as the scouting effort associated with locating them would be modest.[220] There is always the matter, however, of the size of the enemy force and the need to overcome defenses. How large is the enemy's basing structure and force relative to our means for destroying them? What kind of active and passive (e.g., hardening) defenses must be overcome? Finally, assessing the battle damage from such strikes could prove more challenging for friendly forces. Was the target destroyed? Has it been repaired or replaced?

Simultaneous with the attacks on space-based scouting systems and fixed land-based systems, friendly forces would undertake operations aimed at suppressing a wide range of other enemy scouting forces, such as manned and unmanned aircraft, undersea sensor grids, and enemy agents. These agents could range from those planted within friendly intelligence organizations to individuals simply forwarding whatever scraps of information they can gather, such as warships departing their home port or a convoy's movement.

Winning the scouting campaign will also extend to securing information on the enemy's scouting plans and operations and destroying or corrupting the information provided by his scouting operations. This would probably involve cryptanalysis to break the enemy's codes, or engaging in cyber operations to exfiltrate unencrypted data, thereby gaining insight into how and where he plans to employ his (hopefully diminishing) extended-range scouting assets. If success can be achieved here, it may be possible to identify the "holes" in the enemy's scouting coverage, or at least to predict with some confidence areas of reduced risk to friendly forces and cargo. (As noted earlier, a major challenge for friendly forces involves achieving high-quality battle damage assessment, or BDA.) This operation would also see efforts to feed the enemy false information regarding friendly operations, as well as cyber attacks designed to corrupt enemy scouting data, ideally to the point where he loses confidence in major elements of his scouting capabilities and battle network.

Finally, the campaign to degrade the enemy's eyes and ears can be supported by friendly forces' efforts to develop a competence in electronic emissions control (EMCON) and engage in other defensive measures, such as enhanced cyber defenses and narrow-beam laser communications. As demonstrated in the Haystack and UPTIDE Cold War era exercises, these counterscouting efforts can significantly hamper the enemy's efforts.

Assuming the campaign proceeds as described, it should be possible to introduce a wider array of friendly scouting and strike forces, particularly in the maritime no man's lands. Establishing control over no man's land could, over time, enable friendly forces to contest the enemy for control of his maritime bastion, to include enabling surface warships (and high-priority convoys) to operate at acceptable risk by exploiting gaps created in the enemy's scouting umbrella.

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220 For a discussion of a notional scouting (or "blinding") campaign, see Jan van Tol, Mark Gunzinger, Andrew Krepinevich, and Jim Thomas, *AirSea Battle: A Point of Departure Operational Concept* (Washington, DC: Center for Strategic and Budgetary Assessments, 2010), pp. 56–63.

For example, it may be possible to conduct scouting and strike operations by forces that enter the "gapped" area for a brief time and then depart before the enemy can close the scouting gap. Again, recall the Haystack and UPTIDE exercises that sought to do the same for U.S. carrier strike operations in the Mediterranean. These operations would also be somewhat reminiscent of the Doolittle Raid in April 1942.[221] Carriers (especially those with long-range aircraft) and surface ships armed with long-range missiles able to operate at acceptable levels of risk in a maritime no man's land where enemy scouting forces have been suppressed could make a valuable contribution to taking down the enemy's maritime bastion defenses. *Of course, the greater the range of their aircraft and missiles, the less time they would have to remain in the maritime no man's land*—which is why the Doolittle Raid was conducted using long-range Army bombers and not Navy aircraft, which had far less range.[222]

To be sure, even if friendly forces are able to "win" the scouting campaign, they are unlikely to eliminate the enemy's scouting ability entirely, or his ability to regenerate at least some portions of it. This strongly suggests that the enemy will not be "blinded" in the sense that a person who is blinded has lost his sight entirely and is very unlikely to recover it. Rather, the competition may be more analogous to throwing sand in the enemy's eyes, causing him to blink and to suffer impaired vision while clearing his eyes to enable his vision to return to normal. The distinction between "blinding" the enemy

221 The Doolittle Raid conducted on April 18, 1942, was the culmination of a series of raids by U.S. carrier forces following the Japanese attack on Pearl Harbor in December 1941. The U.S. carrier *Hornet* steamed within Japan's inner maritime defenses to a position roughly 650 miles away from the homeland and launched sixteen Army Air Corps bombers for an attack on Tokyo—the heart of the Japanese empire. Intensive scouting preceded the U.S. strike to ensure that Japanese scouting forces had not uncovered the operation. Submarines were sent deep into Japanese waters, while the carrier *Enterprise* sent scout aircraft out to determine if the U.S. task force had been spotted. *Enterprise* and *Hornet* detected several "enemy surface craft" as they approached the attack launch point. Upon sighting one within visual range the attack was immediately launched—still roughly 250 miles away from the planned launch point. (The boat was one of those in a picket line consisting of some fifty radio trawlers on an arc about 700 miles to the east of Japan, part of a long-range layered scouting system that also included aircraft and submarines.) While the attack imposed trivial damage on Tokyo, it did cause the Japanese to withdraw considerable naval forces, including carriers, to home waters. Moreover, three Japanese Army air groups were established to provide for homeland defense, and two new fighter groups were added. A total of four fighter groups were maintained in Japan throughout 1942 and 1943. George W. Baer, *The U.S. Navy: One Hundred Years of Sea Power* (Stanford, CA: Stanford University Press, 1993), pp. 216–17; Rose, *Power at Sea*, pp. 200, 250–51; and Norman Polmar, *Aircraft Carriers* (Dulles, VA: Potomac Books, 2006), pp. 205–6, 209. See also Roche and Watts, "Choosing Analytic Measures," pp. 184–89.

222 This is the principal reason the Doolittle Raid was executed by Army Air Corps bombers and not naval aircraft. The bombers' range far exceeded that of their naval counterparts. Interestingly, the Japanese picket line did succeed in warning of the approaching attack; however, the Japanese air defense command assumed that the strike would be conducted by naval aircraft and, based on the reported sightings and shorter range of naval carrier-based strike aircraft, believed the attack would occur one or two days later than it did. Polmar, *Aircraft Carriers*, p. 206.

and degrading his scouting forces is critical, as it has significant implications for the conduct of operations and the second-order implications for doctrine, capabilities, force mix, and basing.

Finally, a key metric in winning the scouting campaign will center not only on degrading the enemy's ability to scout, but also *to know when this has been accomplished*, and to what degree, and for how long. The key questions are: How do you know when you have been successful? And if you know, how long will success last before the enemy restores his scouting ability? In military terms this translates into effective BDA. Given the characteristics of a mature maritime precision-strike regime, determining with a high degree of confidence that an enemy's scouting ability has been degraded to an acceptable level promises to be challenging.

As in the case of winning the scouting competition, depleting the enemy's inventory of long-range PGMs and associated systems could enable friendly forces to enjoy a greatly enhanced ability to maneuver in no man's land at an acceptable risk.

In some cases, such as when kinetic munitions destroy an OTH radar, BDA may be easy. Yet even in these cases friendly forces, such as satellites, stealthy UAVs, and SOF must be able to scout the area, which may prove difficult as it seems reasonable to assume the enemy will give priority to degrading friendly scouting forces. If PGMs are used, such as small-diameter bombs that minimize collateral damage, it may be difficult to ascertain with sufficient confidence that the target has been rendered inoperable. Given the importance of effective scouting in a mature maritime precision-strike regime, friendly forces must anticipate that the enemy may feign a loss of his scouting ability in the attempt to draw friendly forces forward into an ambush.

Option 2: Deplete the Enemy's Long-Range Strike Systems

Another option for restoring freedom of maneuver in the maritime domain centers on neutralizing or destroying an enemy's extended-range strike platforms and weapons, including his land-based missiles or their launchers, strike aircraft (manned and unmanned), aircraft carriers, submarines (including AUVs and UUVs), and surface ships armed with missiles. This could involve both offensive and defensive operations, as well as deception. The logic here is that the enemy's loss of much of his ability to strike, especially at extended ranges, would reduce dramatically the risks not only to mobile forces (e.g., surface warships) but also to those maritime forces at fixed locations (e.g., naval bases, air bases, and satellite ground stations).[223] As in the case of winning the scouting competition, depleting the enemy's inventory of long-range PGMs and associated systems could enable friendly forces to enjoy a greatly enhanced ability to

[223] Winning the scouting competition may reduce the risk to forces at fixed locations, but not as dramatically. This is because the loss of the ability to scout a fixed location would not reduce the enemy's ability to strike it. The loss of scouting capacity might, however, find the enemy striking fixed targets in a suboptimal way, such as striking at an air base that had flushed its complement of aircraft, as opposed to attacking the base to which they had relocated.

maneuver in no man's land at an acceptable risk. This could enable friendly forces with shorter-range strike elements to contribute to the defeat of enemy forces concentrated in his maritime bastion.

How might this be accomplished without correspondingly depleting the magazines of friendly long-range strike forces in the process? One competitor would not appear to gain an advantage by depleting an enemy's long-range strike forces at the expense of depleting its own. While it cannot be ruled out that there may be an unequal trade-off that favors the attacker, it would be particularly risky to assume such an advantage even before the first major engagement in a mature maritime precision-strike regime.[224]

In order to husband one's own long-range strike forces while encouraging the enemy to deplete his own, other means and methods should be explored. To the extent they prove effective, several possibilities merit consideration.

One involves operational deception against an enemy's scouting efforts. Decoys, for example, have long been a part of war and have been employed to great effect. If successful, a decoy will draw an attack on itself instead of on the target whose signature the decoy is designed to mimic. During the Cold War the U.S. Navy experimented with acoustic decoys to mislead the Soviets as to the true location of its carriers. In a mature maritime precision-strike regime, for example, nuclear-powered submarines might dispense relatively "cheap" UUVs that emit acoustic signals mimicking those of the submarine, and at a higher sound level. If the ploy is successful, enemy ASW forces might expend substantial resources to attack the decoy and not the submarine.[225] Similarly, against an enemy relying heavily on either unmanned systems or missiles to execute long-range strikes, carrier strike groups might attempt a similar deception, hoping to

224 Given possible asymmetries in other areas of the competition (e.g., in short-range scouting and strike systems, and dependence on overseas resources), it may be advantageous for one competitor to tolerate the mutual degradation of both its enemy's long-range systems and its own. For example, if a competitor has a commanding advantage in short-range scouting and precision-strike capabilities, he may welcome the mutual drawdown of his and his enemy's long-range scouting and precision-strike capabilities in order to better exploit his advantage in short-range systems. An assessment of this and related scenarios, is beyond the scope of this preliminary assessment. Another possibility is that there is *an asymmetric trade-off* in the attacker's favor in at least some cases where friendly long-range strike forces are employed against the enemy. A classic example is found in the U.S.-Soviet nuclear competition, where one nuclear weapon employed against a strategic bomber air wing at an air base could result in the destruction of dozens of enemy nuclear weapons. Another example is found in the competition between U.S. and Japanese naval aviation forces during World War II. Early in the war the Japanese apparently believed a carrier air wing could sink two enemy carriers in a single strike. As the competition shifted increasingly in favor of the defense, this assumption proved faulty. As Wayne Hughes observed, the Japanese "gambled, likely even believed, that one carrier [air wing] could sink two [carriers]. Even though wrong, this was a good gamble at the beginning of 1942. By the end of 1942 it was a very bad gamble." Hughes, *Fleet Tactics and Coastal Combat*, p. 115. Of course one reason this was a bad gamble was that the United States enjoyed a huge advantage in its ability to build carriers, making an even trade-off disastrous for the Japanese. In this case the asymmetry worked against the attacker.

225 Depending on progress made in AUVs and UUVs, it may be possible for submarine forces to deceive an enemy into diverting ASW forces into one theater when in fact friendly submarine forces are concentrated in another.

Other *de facto* missile sinks could emerge in the form of hardened air and naval bases that require far greater expenditure of scarce precision munitions and delivery systems to achieve desired levels of damage or destruction.

draw attackers away from them and toward the false targets, creating a "missile sink" of sorts.[226]

Other *de facto* missile sinks could emerge in the form of hardened air and naval bases that require far greater expenditure of scarce precision munitions and delivery systems to achieve desired levels of damage or destruction. Ideally, the cost (and opportunity cost) to the enemy in conducting the attacks would exceed that incurred by friendly forces from defensive efforts such as hardening and rapid repair/remediation.[227] If the enemy cannot or will not target such bases, it may be possible to position friendly shorter-range strike forces in maritime no man's lands and even within the enemy's bastion (i.e., on forward bases within the enemy's A2/AD defensive zone), further shifting the strike balance in friendly forces' favor.

Geography permitting, if the scouting and strike competitions are waged in tandem, and if the scouting campaign is successful in substantially degrading the enemy's capabilities, friendly forces may benefit from employing multiple bases, shifting their operations among them so as to create a shell-game problem for the enemy. Given that friendly forces would operate from only a fraction of the total bases available to them, the enemy—forced to operate with weakened scouting forces—could be compelled to strike all the bases simultaneously to destroy a significant fraction of friendly forward-based strike forces.[228] Should the cost of striking the bases in this manner outweigh the cost of friendly forces adopting such a posture (by including the cost of second-order effects in both cases), this may prove an effective means of depleting the enemy's long-range strike forces.

Yet another means of compelling the enemy to expend his long-range strike elements involves horizontal escalation. This would be possible if a competitor was able to compel his maritime rival to fight for an objective outside both the enemy's thickest A2/AD defenses (his maritime bastion) and no man's land. Under these conditions friendly forces could rely *solely* on their short-range scouting and strike forces, whereas the enemy is compelled to employ his long-range systems if he wants to contest the objective. This could occur, for example, in a conflict between China and India, where India is able to contest for control of the Strait of Hormuz by employing primarily short-range scouting and strike forces whereas China must rely much more heavily on forces that can operate at extended ranges see Figure 9). Another example would be in a U.S.-China conflict where

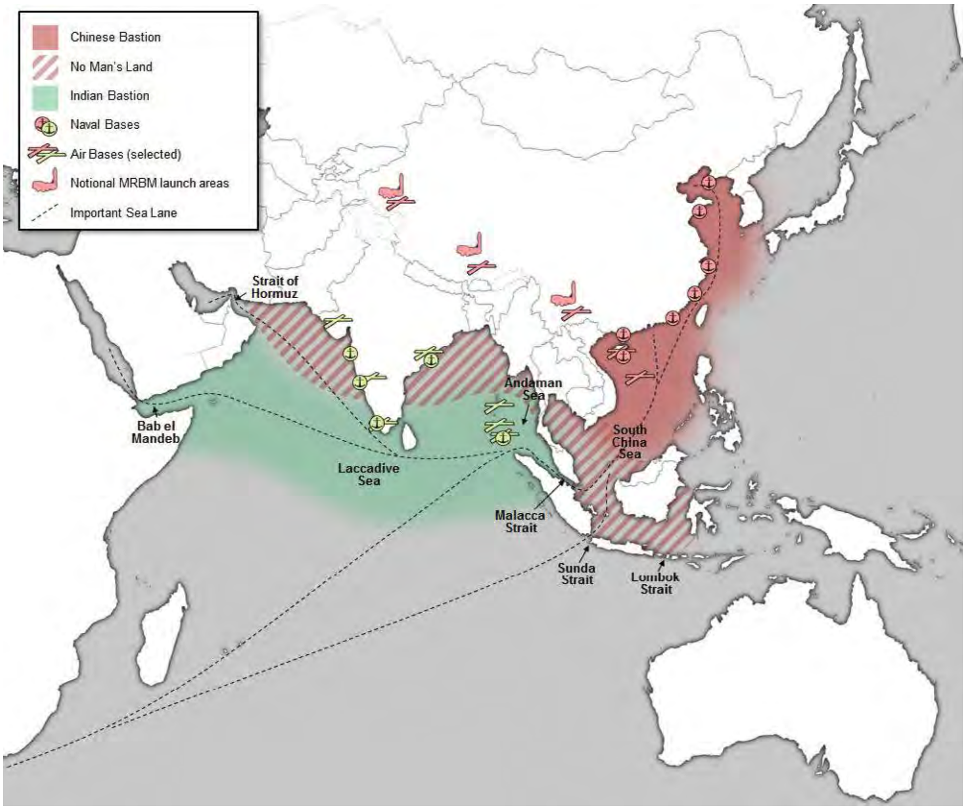
[226] In pursuing this concept, it may be necessary to ensure that certain elements of the enemy's scouting force remain operational, in order that they have the capacity to be deceived.

[227] The benefit could be even greater if the repairs can be done quickly, thus requiring the enemy to cope with a higher "revisit rate" of strikes in order to keep the base out of operation.

[228] The enemy might choose to employ relatively novel forms of scouting, such as spies providing information via the Internet or cell phones. This assumes that friendly forces have not taken effective steps to address this element of the scouting campaign. It also assumes that it is still possible to communicate via cellular transmissions and the Internet in the midst of an intense electronic combat to gain information superiority.

forward-based American maritime forces in the Persian Gulf region enjoy a pronounced advantage over Chinese forces in contesting for control of the Strait of Hormuz.

FIGURE 9: CHINA-INDIA MARITIME ZONES



Defenses may also play an important role in efforts to degrade the enemy's extended-range strike forces. As described earlier, PGMs may offer accuracy independent of range, but they do not offer range independent of cost—and range costs, especially when part of the mission involves penetrating enemy A2/AD defenses. The side that can mount the more effective defense of its maritime forces—particularly surface warships—may enjoy several advantages. First, in a duel of long-range fires, friendly forces with a defensive advantage will require fewer strikes to achieve the same level of destruction to the enemy's ships. Alternatively, under these conditions friendly forces can operate at closer range, accepting the risk of incurring greater damage—but also increasing their ability to inflict more damage by bringing more weapons to bear.

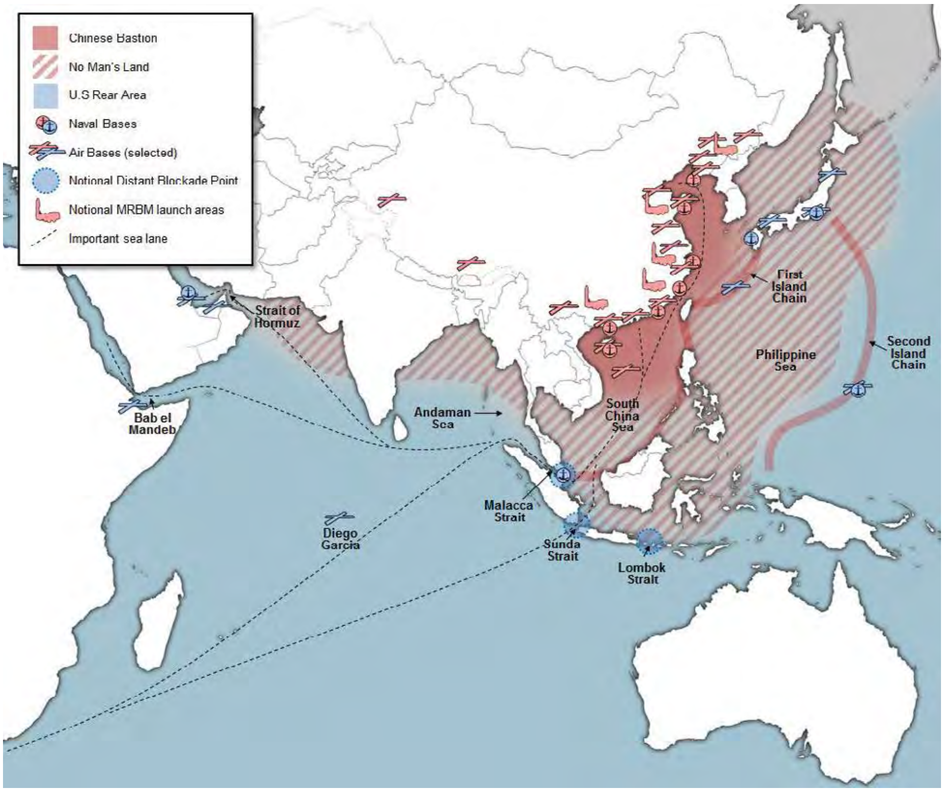
How might this defensive advantage be achieved? Several possibilities come to mind. These possibilities are of value to the extent that within the concept of operations anticipated for them, they will prove effective against attack. That is to say, it will cost the attacker more to defeat improved defenses than the cost of the improvements themselves.[229] One possibility involves improvements in surface ship passive defenses, such as increased armor and enhanced damage control. Another entails the use of various means of deception to draw off enemy missile attacks from true targets. Still another involves active defenses—although at present the competition appears to heavily favor the attacker. This could change significantly, however, with the maturation and introduction of directed-energy weapon defenses, such as chemical, solid-state, fiber, and free electron lasers; high-powered microwave weapons; and electromagnetic rail guns. Employing these prospective defense enhancements in combination could impose even more disproportionate cost on the attacker, depending upon the mission being undertaken and how the forces are used (the operational concept).

Option 3: Pursue Prompt Attrition

This option will prove unattractive for maritime competitors, who will see this as the least bad option to be pursued under difficult circumstances. A maritime competitor will likely pursue this option only when he has a major advantage in resources and feels compelled to undertake a mission at all hazards. An example of this option is found in the Royal Navy's willingness to run the gauntlet to reinforce Malta during World War II. In the future, there may be similar "Maltas" situated in the enemy's A2/AD defensive zone (maritime bastion) or in no man's land that cannot be abandoned without incurring a severe operational or even strategic defeat. This might occur, for example, in a U.S. defense of Japan in the event of aggression by China, which could necessitate American maritime operations in China's bastion or in no man's land.

229 Measuring the effectiveness of defenses is likely to be more complex than whether a ship can sustain more hits after the improvements are made than it could before—that is to say, by simply calculating the cost of the additional strikes against the cost of the defensive improvements. For example, given the limited number of long-range strike systems available, there are opportunity costs to consider. Employing three missiles instead of one to sink a ship, for example, also involves an opportunity cost. How effectively could both sides have used the resources devoted to enhance attack or defense? Were the resources taken from military capabilities that offered little combat potential, or did the opposite occur?

FIGURE 10: CHINA-UNITED STATES MARITIME ZONES



Take another example, this one from a possible future contingency involving a conflict between China and the United States in a mature maritime precision-strike regime (see Figure 10). If the United States has committed to defending the First Island Chain in the Western Pacific, for example, by deploying ground forces on some of the islands, they will likely lie well within China's maritime bastion. The choice confronting Washington may be similar to reinforcing the Philippines following the onset of the Pacific War in December 1941. Unlike the British and Malta, the Americans decided that they did not have the capability to sustain the Philippines. The last U.S. forces in the Philippines surrendered in May 1942.

These two examples pose two questions. First, is a maritime power willing to pay a disproportionate price to restore freedom of maneuver in a mature maritime precision-strike regime? Second, if so, is it able to accomplish its mission if it sustains such costs? As this approach implies a willingness to suffer disproportionate costs, it will be employed rarely, only when the stakes are high and all other options have been exhausted, and even then with great trepidation.[230]

The freedom of maneuver described here is generally at the tactical or operational level. Can a particular mission be accomplished? But what about restoring maritime freedom of maneuver on a broad scale, where a competitor has established command of the seas? The simple answer is that the prompt attrition option is likely to be pursued only if one competitor has an enormous advantage over another in the maritime balance *and* time is of the essence. Such a contingency in a mature maritime precision-strike regime might arise if Iran attempted to cut off the flow of oil from the Persian Gulf by blockading the Strait of Hormuz and threatening to destroy the oil production and export infrastructure of the Gulf Cooperation Council (GCC)[231] states. These acts would compel the United States and other major maritime powers to act quickly in order to prevent the destruction of the energy infrastructure, restore the flow of oil from the Gulf, and prevent severe damage to the global economy. Given that the U.S.-Iran maritime balance would be greatly tilted toward the United States, the option of prompt attrition of Iranian maritime forces may be both attractive and capable of being executed when time is the primary factor, even at the cost of accepting higher losses than otherwise tolerated.

230 The comparison to human wave attacks may not be entirely apt here, as there have been instances where one side enjoyed a huge manpower advantage over its enemy (e.g., the Chinese People's Liberation Army in the Korean War and Soviet armies against the German *Wehrmacht* on the Eastern Front in the latter days of World War II). Maritime operations are far more capital intensive. As such there are likely to be severe limitations on the ability of any maritime power to mobilize the level of capital stock necessary to overwhelm a major maritime power's bastion defenses, save for on a very selective basis, and perhaps only late in the war when one side has greatly depleted the maritime forces of the other. Another example would be the *Luftwaffe*'s willingness to sustain far greater losses than the Royal Air Force in the Battle of Britain, in both aircraft and pilots. Germany's advantage in men and materiel enabled this, and given the prospective payoff—the invasion and conquest of Great Britain—the cost was arguably justified. Yet another example is the Tet Offensive, where North Vietnam leveraged its advantage in manpower and U.S. aversion to casualties in a campaign that saw Communist forces sustain casualties at roughly a 25:1 ratio and yet succeed in breaking the American political leadership's will to achieve its stated objectives. Andrew F. Krepinevich, Jr., *The Army and Vietnam* (Baltimore, MD: Johns Hopkins University Press, 1986), pp. 238, 248. The U.S. forces suffered roughly 1,500 killed in action. The U.S. command asserted the Communists experieced casualties including some 32,000 to 37,000 killed and 6,000 captured.

231 The GCC is a political and economic union of the Arab states that lie along the southern littoral of the Persian Gulf, and it includes, Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and United Arab Emirates.

Option 4: Pursue Protracted Attrition: Cutting off Commerce

The attempt to seek the enemy with a view to a decisive action was again and again frustrated by his retiring to his own coasts [i.e., within his maritime bastion], where either we could not reach him or his facilities for retreat made a decisive result impossible… It was soon perceived that the only way of dealing with this attitude was to adopt some means of forcing the enemy to sea and compelling him to expose himself to the decision we sought. The most cogent means at hand was to threaten his commerce.

Julian Corbett[232]

The option of prompt attrition can be attractive (or at least acceptable) when time is not on your side. When time *is* on your side the option of pursuing a blockade can be attractive, especially if the other options described above are not.

When time *is* on your side the option of pursuing a blockade can be attractive, especially if the other options described above are not.

Traditional blockade operations (those conducted primarily by surface ships) in a mature maritime precision-strike regime are likely to be undertaken at extended range (a distant blockade), since to try and impose one either within the enemy's maritime bastion risks incurring substantial and possibly unsustainable costs. This is not to say that blockade operations in an enemy's bastion could not occur. For example, depending upon the value of the target, submarines operating within the enemy's A2/AD bastion defenses may venture forward to attack high-priority cargo including "leaker" ships that manage to evade the distant blockade conducted in no man's land. Submarines may also prove essential in interdicting the flow of littoral or coastal shipping—in effect, waging a close blockade. Major enemy ports can be attacked with long-range missiles or stealthy strike aircraft, either to destroy the port's cargo-handling facilities or key transportation nodes leading to and from the ports, or to damage or destroy the ships moored or anchored in the port. Munitions on towed payload modules may prove useful in attacking high-value, predesignated fixed targets, especially if these munitions have been prepositioned, such as by emplacing them on the seabed along the enemy's continental shelf prior to the war. Offensive mining may also be a means of conducting a close blockade, assuming the mines can be deployed in adequate numbers and at the right locations, are sufficiently "smart" to be triggered only by the "right" kinds of shipping (high-value ships), and are difficult to clear.

[232] Corbett, *Principles of Maritime Strategy*, p. 160.

If the network of undersea fiber-optic cables provides an enemy state with an essential link to the outside world for the purpose of conducting commerce, cutting these cables may be a high-priority mission, particularly against enemies with few good alternatives for high-capacity communications flows.[233] If so, it may be easier to cut the cables close to shore where they may be easier to locate and access, as opposed to doing so at sea or at their terminal point.[234] Submarines carrying special operations forces, UUVs or AUVs, or some combination could conduct cable-cutting operations.[235] Such operations may need to be repeated depending upon the length of the war and the enemy's ability to restore his cables quickly to operation.

Just as close blockades in a mature maritime precision-strike regime will likely be very different from those conducted in the two world wars of the last century, the same can be said of distant blockades.

Just as close blockades in a mature maritime precision-strike regime will likely be very different from those conducted in the two world wars of the last century, the same can be said of distant blockades. In both cases surface ships seem destined to play a much-reduced role, a consequence of their greatly increased vulnerability. In a distant blockade, on the other hand, friendly maritime forces would likely operate almost exclusively outside the range of enemy extended-range scouting and strike systems, beyond the maritime no man's land where possible. Such blockades may be more efficiently conducted than in the past, since satellites, unmanned aerial vehicles, and manned aircraft may be able to perform the bulk of the scouting function. If chokepoints exist, ground forces and land-based air forces may be able to monitor them. Surface warships may be useful in boarding or sinking merchant ships; however, helicopters or special operations forces can also conduct boarding operations, and, if need be, those ships can be sent to the bottom by land-based aircraft and shore-based missiles.

If the enemy escorts his shipping or attempts to run the blockade, his methods for doing so are also likely to be quite different from those in the major conflicts over the past century. For example, the enemy may employ long-range missile strikes on fixed forward land bases guarding chokepoints, or employ attack submarines to deplete naval forces supporting the blockade. Enemy submarines may also engage in ASW operations to keep friendly submarines from feasting on the convoy transports.[236] As noted in the discussion of commerce raiding, even with these efforts an enemy is likely to find it

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233 One of the first acts of war by Great Britain against Germany in 1914 was to cut its overseas telecommunications cables. On August 5, 1914, the Royal Post Office CS *Alert* cut the five German Atlantic submarine telegraph cables. Jonathan Reed Winkler, *Nexus: Strategic Communications and American Security in World War I* (Cambridge, MA: Harvard University Press: 2008), pp. 5–6, 10. Jan van Tol notes, "The dependency on undersea cables for long-distance communications during World War I was very high, with radio eventually helping to undercut that extreme dependency. Huge amounts of communications travel via undersea fiber-optic cables today, but many countries will have considerable alternative capacity via, for example, land fiber optics and satellites. So there may not be the equivalent dependency (depending on the country in question), but cable cutting would certainly appear useful for adding 'friction.'" Email communication with the author, January 13, 2013.

234 Cutting the cables at their overseas terminal point may involve violating the sovereignty of another state.

235 Currently employing SOF (in shallow waters) or a submarine's anchor are the only methods currently available to U.S. maritime forces for cutting seabed cables.

236 This may be another way of encouraging the enemy to deplete his relatively small inventory of long-range strike systems (e.g., submarines) and munitions (e.g., long-range missiles).

challenging to sustain convoys beyond its maritime bastion as long as it has not seized control over no man's land.

An example of this situation might occur in a conflict between China and the United States in which no man's land ends somewhere between the First and Second island chains. In this case, U.S. maritime forces may impose a distant blockade beginning at the Indonesian archipelago and stretching back to China's overseas trading partners, such as the oil exporting states of the Persian Gulf. In this example, the prospect of China's navy escorting oil tanker convoys through the Strait of Hormuz all the way to China seems suicidal against a maritime power like the United States, even if it were able to undertake the kind of operations described above. As with many other aspects of the mature maritime precision-strike regime, however, one would want to examine a range of prospective contingencies involving various competitors before arriving at informed conclusions as to how the competition might play out.

Another contingency worth exploring involves blockade operations between two maritime competitors in close geographic proximity to one another, such as in the case of China and Japan. Here nearly all of the two competitors' maritime capabilities can be brought to bear upon each other; consequently these operations—effectively competing close blockades—would be waged with far greater intensity than those involving a distant blockade. In such contingencies, a state's stockpile of critical materials (such as oil, gas, key metals, and food) or its ability to secure supplies over land routes could significantly influence the effectiveness of a blockade.

Thus in the case of a conflict between China and Japan, China will enjoy a major geographic advantage. Some of China's maritime areas will likely fall outside Japan's maritime bastion, which may not be the case with Japan, given China's long coastline that extends farther from the Home Islands than does Japan's coastal areas from China. Moreover, China has enormous strategic depth and its remote borders abut the world's largest continent, giving it the option of resupply over land transportation routes, including pipelines and cables.[237] Finally, history suggests that blockades can be complex enterprises, as they affect not only the economy of the blockaded state, but of those states—some being both neutral and formidable—that trade with it.[238]

237 This is one reason that Germany proved much less vulnerable to blockade in World War II than it did in World War I, when the Allied blockade contributed significantly to its defeat. For the first twenty-two months of World War II the Germans could rely on the Soviet Union for raw materials, which greatly reduced the effectiveness of the British blockade. Russia was an active ally of Britain from the beginning of World War I.

238 For a detailed treatment of the potential complexities associated with executing a blockade against a major power, see Lambert, *Planning Armageddon*.

NEXT STEPS

The gods refuse the crown of victory to those who rest content after a single triumph. They give it to those who exert themselves in peace-time training, who have therefore won before any fighting begins.

Admiral Heihachiro Togo[239]

Efforts to identify and describe major shifts in the military competition can be successful. Consider that Admirals Sims and Fisher predicted such shifts with remarkable precision. Less than a decade after Admiral Fisher predicted that submarines would revolutionize maritime warfare, squadrons of German submarines conducted an ambitious blockade of Great Britain. Fifteen years after Admiral Sims declared the aircraft carrier the capital ship of the future, a British carrier group executed a devastating attack on the Italian fleet at Taranto.

Although their visions proved remarkably accurate, they were also imperfect. While carriers did emerge as the capital ship of World War II, night surface operations were still much the province of battleships, cruisers, and destroyers. And submarines, not carriers, came remarkably close to winning the Battle of the Atlantic while the U.S. submarine fleet inflicted enormous damage on both Japan's fleet and her commerce. Fisher's emphasis on a ship's speed over its armor proved only partially correct, as the performance of the Royal Navy's battle cruisers at Jutland demonstrated. The same might be said of Fisher's emphasis on long-range fires. It would take further developments in naval aviation, which were not realized until after World War I, before long-range gunnery could realize the significant leap in accuracy that Fisher thought possible.[240]

239 David C. Evans and Mark R. Peattie, *Kaigun* (Annapolis, MD: Naval Institute Press, 1997), p. 124.

240 For a discussion of Admirals Fisher and Sims and their visions of a transformation in maritime warfare, see Lambert, *Sir John Fisher's Naval Revolution*; and Andrew F. Krepinevich, *Transforming to Victory: The U.S. Navy, Carrier Aviation, and Preparing for War in the Pacific* (Cambridge, MA: The Olin Institute, 2000).

These examples strongly suggest that even if the description of a mature maritime precision-strike regime presented in this assessment is generally correct, it will still contain flaws that will emerge only over time. In contemporary parlance, then, what we have is perhaps "Version 1.0" of the mature regime's characteristics.

Where do we go from here in our efforts to understand the emerging maritime competition? If history is any guide, success will require persistent effort over time. Sims's vision, as well as Fisher's, was subjected to vigorous (and often heated) debate among the officer corps in their respective Services. These debates spilled over into the public debate as well. A stream of analytic assessments served to inform, and were informed by, the debate. Science and industry helped in gaining a sense of what new and enhanced military capabilities were possible and when they might be made available. Wargames were conducted regularly to gain a sense of the dynamics of the maritime competition among the various competitors. Efforts were made to understand how existing and prospective rivals envisioned the competition and the paths they were taking—in the form, for example, of doctrine, capabilities, and basing—to enhance their competitive position. These efforts culminated in fleet training and exercises, which offered the closest environment to war itself to test out new capabilities and operational concepts. As this process was sustained over time, both the Royal Navy and the U.S. Navy reduced the level of uncertainty surrounding the new maritime regime's key characteristics well enough to succeed when the ultimate test came in 1914 and 1941, respectively.

This assessment represents one of the early efforts in what will be a long and fitful path toward the mature maritime precision-strike regime. To paraphrase President Eisenhower: assessments are useless; persistent efforts to revise and improve our assessments are everything. As Andrew Marshall noted nearly fifty years ago, in dynamic times such as these it is difficult to estimate with any precision the military postures of competitors ten or fifteen years into the future. What Marshall and Eisenhower realized is that assessments and estimates of this sort should not be the end but rather the beginning of the kind of sustained iterative process described above.

To the extent this assessment of a mature maritime precision-strike regime has merit, it can provide grist for a debate among the professional military and strategic study community regarding the regime's characteristics. The debate can be enriched by considering how some of the key variables mentioned in this assessment—directed-energy weapons, artificial intelligence, advanced-design nuclear weapons, hypersonic weapons, cyber munitions, and competitor paths, among others—could significantly shape and influence the competition and the U.S. competitive position as a result. Priority should also be accorded to identifying how the United States would like to see such a competition evolve over time. Success here will enable further thought as to how the United States might influence competitors to pursue competitive paths less threatening to its interests.

While the process described here will take time, it need not be an expensive endeavor; moreover, the savings to be realized from such an effort are potentially substantial. Accurately gauging the characteristics of a mature maritime precision-strike regime could help the U.S. military avoid investing in capabilities that are ill-suited to meet future challenges, thereby allocating resources to areas that provide the United States with a distinct and enduring advantage in the new competitive environment. Thus the gains in military effectiveness realized through this process could significantly enhance the U.S. military's ability to accomplish its maritime missions at reduced risk to national security.

Although the benefits of embarking on such an effort are clear, it will likely occur only if senior leaders—within both the civilian defense community and the U.S. Navy—take up the challenge and find a way to institutionalize the kind of process described above. This is their great opportunity to sustain U.S. maritime dominance or, should they fail to seize it, run the risk that this dominance will not long endure.

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ABBREVIATIONS AND ACRONYMS

A2/AD	Anti-Access/Area Denial
AI	Artificial Intelligence
ASAT	Anti-Satellite
ASCM	Anti-Ship Cruise Missile
ASM	Air-to-Surface Missile
ASW	Anti-Submarine Warfare
AWAC	Airborne Early Warning and Control
AUV	Autonomous Underwater Vehicle
BDA	Battle Damage Assessment
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance
CAP	Combat Air Patrol
CHAMP	Counter-electronics High-power Microwave Advanced Missile Project
CIC	Combat Information Center
DE	Directed Energy
DEW	Directed-Energy Weapon
DSCS	Defense Satellite Communications System
DSP	Defense Support Program
EEZ	Exclusive Economic Zone
EHF	Extra-High Frequency
EMCON	Emission Control
EMP	Electromagnetic Pulse
GCC	Gulf Cooperation Council

G-RAMM	Guided Rockets, Artillery, Missiles, and Mortars
HPM	High-Powered Microwave
IMINT	Imagery Intelligence
ISR	Intelligence, Surveillance, and Reconnaissance
JDAM	Joint Direct Attack Munition
LCS	Littoral Combat Ship
LNG	Liquefied Natural Gas
MOE	Measure of Effectiveness
NATO	North Atlantic Treaty Organization
OTH-R	Over-the-Horizon Radar
PGM	Precision-Guided Munitions
PLA	People's Liberation Army
POL	Petroleum, Oil, and Lubricant
RF	Radio Frequency
SAM	Surface-to-Air Missile
SIGNIT	Signals Intelligence
SLOC	Sea Lines of Communication
SOF	Special Operations Forces
SOSUS	Sound Surveillance System
SSBN	Ballistic Missile Submarine
SSGN	Cruise Missile Submarine
SSN	Nuclear Submarine
TACAN	Tactical Air Navigation
TASM	Tomahawk Anti-Ship Missile
TFCC	Tactical Flag Command Center
TLAM	Tomahawk Land Attack Missile
UAV	Unmanned Aerial Vehicle
UCAV	Unmanned Combat Air Vehicle
UHF	Ultra-High Frequency
UNCLOS	United Nations Commission on the Law of the Sea
UPTIDE	Unified Pacific Fleet Project for Tactical Improvement and Data Extraction
UUV	Unmanned Underwater Vehicle
VLS	Vertical Launch System

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