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China's Missile Revolution and PLA Strategy against U.S. Military Intervention

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In March 1996, China conducted military exercises and live missile firings in the Taiwan Strait as a response to the increasingly pro-independence stance of Taiwan's president, Lee Teng-hui. The United States responded in turn by maneuvering two aircraft carrier groups into the island's vicinity. China and the United States did not come to a standoff, and the issue ended peacefully, although not without ominous messages being received by all parties. China had signaled its willingness to use military force to check Taiwan's incipient independence ambitions, and the United States had conveyed its resolve to defend Taiwan against aggression from the mainland.[1]

The incident, which made the possibility of armed conflict between the United States and China palpable for the first time in decades, precipitated a crisis in China's security planning. The Chinese leadership understood that if it were dragged into a military conflict with the Americans to reverse a Taiwanese declaration of independence or a like provocation, it would have no chance of prevailing in what it believes to be both a domestic issue and its most important (and increasingly volatile) security concern. The subsequent and still ongoing surge in China's military modernization, force-posture restructuring, and doctrinal overhaul has thus been energetically focused on constructing the capability to fight and win a regional war over Taiwan with the world's strongest and most technologically advanced military. This does not mean that China is hostile to the United States or that it expects to fight a war with the United States in the near future. However, it does mean that it sees armed conflict with the United States over conflicting regional interests as a possible and very serious contingency and that it is determined to be ready to meet it.

Nevertheless, although American analyses of China's likely performance against Taiwan abound, to date there has been no attempt to define, map, and assess comprehensively China's likely operational strategy and its potential for success against *U.S.* forces. The main reason is that the literature on Chinese security policy has been generally skeptical of China's battlefield capabilities, leading many independent analysts to dismiss the military threat the People's Liberation Army (PLA)* poses to the American forces.[2] Furthermore, American analysts have attributed this view to the PLA itself and therefore, rather unduly, posited its unwillingness to engage the United States in combat. Instead, the dominant view in American policy circles is that China is pursuing what has been called an "access-denial strategy," aimed not at directly confronting U.S. forces but at circumscribing, slowing down, and imperiling their access to the theater of operation so as ultimately to delay their intervention or render it ineffective.[3]

According to consecutive versions of the U.S. Defense Department's (DoD's) annual *Military Power of the PRC* report, "China's approach to dealing with [U.S. military intervention] centers on what DoD's 2006 Quadrennial Defense Review report refers to as disruptive capabilities: forces and operational concepts aimed at preventing an adversary from deploying military forces to forward operating locations, and/or rapidly destabilizing critical military balances."[4] Similarly, the Congressional Research Service argues that "consistent with the goal of a short-duration conflict and a fait accompli, observers believe, China is constructing a force that can deter U.S. intervention, or failing that, delay the arrival or reduce the effectiveness of U.S. intervention forces."[5] A scholar at the Security Studies Program at the Massachusetts Institute of Technology concludes that "China's military preparations for potential conflict over Taiwan have focused on delaying or slowing the deployment of U.S. forces to the theater and potentially frustrating U.S. military operations around the island if a conflict erupts."[6]

According to such views, China seeks to "deter," "slow down," "disrupt," and "complicate" the *deployment* of American assets to the theater of operation rather than to engage them in combat. China's investment in such systems as naval mines, electronic-warfare capabilities, and antisatellite weapons are given as the evidence. Notably, some works go farther, claiming China's investment in conventional assets like submarines, aircraft, and missiles as evidence for a commitment to access denial. For example, according to a widely published retired U.S. Navy admiral, "The critical aspects of a new navy and the highly significant

* "PLA," or the People's Liberation Army, refers in this article to China's military in general, rather than its army branch alone. The army service is designated here the "PLA Army," the navy the "People's Liberation Army Navy," or PLAN, and the air force the "People's Liberation Army Air Force," or PLAAF. The Second Artillery is a quasi service responsible for land-based nuclear and conventional ballistic and cruise missiles.

synergies that may develop between it and the missile and air forces warrant full attention, because they are directed specifically at deterring, delaying, or complicating timely and effective U.S. access and intervention."[7]

The access-denial approach thus sees China's strategy as indirect, defensive, limited in scope and effect, and—owing to its putative reliance on disruptive technologies and conventional assets deliberately reconfigured for disruptive missions—inherently suboptimal compared to a conventional military campaign, which, this view assumes, will remain beyond China's means for some time. Most pointedly, a recent and highly influential RAND report on China's strategy concludes that "the possibility that the Chinese People's Liberation Army (PLA) might employ antiaccess measures in a conflict with the United States is the product of the PLA's view of the nature of modern war, its awareness of China's military weaknesses, and its recognition of U.S. military superiority."[8]

Nevertheless, evidence suggests that China's emerging strategy is actually much more ambitious, direct, and therefore dangerous for the United States. The access-denial assumption largely overlooks what I believe to be the most salient, but revolutionary, developments in the Chinese military—the wide proliferation of long-range ballistic and cruise-missile technologies and the convergence of Chinese military power around a missile-centric, rather than the conventional platform-centric, model of mass-firepower combat.

In analyzing these developments further, with particular attention to evidence of the missiles' technical capabilities and China's emerging C4ISR* architecture, it becomes clear that China's successes in missile technology have much more significant implications than previously thought. Rather than simply compiling a loose portfolio of individual disruptive capabilities, China is pursuing an ambitious program of military innovation in air and naval warfare geared toward not harassment but paralysis and destruction of the adversary's forces through a concerted campaign.

My thesis is not only that China's strategy is thus increasingly methodical but that, with its organizing missile-centric focus, it promises to transform *how* China's forces engage in combat in general, to supply them with previously unavailable military options against the United States, and to render irrelevant American superiority in a number of key areas. Since their first use in the 1996 Taiwan crisis, Chinese conventional missiles thus have gone from being militarily irrelevant spook weapons to highly accurate, flexible, and lethal modes of precise and concentrated firepower around which China's military strategy is increasingly converging. I argue that the impact of this change is significant

* Command, control, communications, computers, intelligence, surveillance, and reconnaissance. C2 and ISR are partial variations.

Naval War College Review, Vol. 64 [2011], No. 2, Art. 3

enough that, absent a major effort to offset China's gains, the United States would no longer be able to win a regional air-naval war with China over Taiwan's status were it to occur.

This, of course, does not mean that China itches for a war or that in a cross-strait conflict it would prefer engaging the U.S. forces in a full-on military campaign rather than deterring them from intervening in the first place. In fact, the opposite is most likely true. However, even if China in fact prefers to deter the United States from intervening or to coerce withdrawal early on by imposing limited attrition, this does not lead us back to access denial. In reality, whether the United States intervened or not would be up to the United States, not China. China is realistic enough to understand that it would not be able to assure deterrence against the world's strongest power, with a security commitment to Taiwan, broad regional interests, and a reputation at stake. However, whereas the access-denial literature is strangely silent about what China plans to do if deterrence fails or once the delayed U.S. forces finally do arrive at its doorstep, evidence in China's weapon procurement and force structure suggests that its hopes of deterring American intervention in a Taiwan conflict altogether are underpinned by a capability not to delay and harass U.S. forces but to defeat and *destroy* them in a regional war. The purpose of my article is to assess this capability.

The remainder of the article is organized in the following fashion. The first section describes in some depth China's investment in a variety of missile technologies and the convergence of its conception of firepower combat around a missile-centric model. The second section discusses targeting and asset-coordination capabilities. The third and fourth sections strive to conceptualize China's operational performance on the battlefield and evaluate its potential for success against U.S. forces in a limited regional war. These sections address the novel combat options that missiles allow China, the mechanics of missile combat, and the level of threat it poses to the U.S. platform-centric forces. Specifically, the third section discusses operations against land-based and docked targets, the fourth—against moving targets at sea. The fifth section also assesses American missile defenses, from the perspective of Chinese missile capabilities and likely countermeasures against defenses. The concluding section offers policy considerations for the U.S. government and military.

CHINA'S FORCE STRUCTURE AND ITS IMPLICATIONS

Despite the prominent position U.S. government publications give to access denial, little in PLA doctrinal writings suggests that China is committed to a delaying or even a defensive strategy. As (paradoxically) admitted even by the cited RAND report, no term equivalent to "access denial" appears anywhere in Chinese military writings.[9] Quite to the contrary, Chinese doctrine emphasizes not delaying or harassing tactics but a rapid and methodical offensive campaign aimed at first paralyzing and then annihilating the enemy as quickly as possible. It is true that the PLA doctrine discusses information and special-operations warfare and the like, but it never loses its offensive spirit, in that it clearly stipulates that contrary to what the access-denial approach argues, such operations would be a means rather than a goal and would be carried out "to produce the strategic and campaign superiority, creating conditions for *winning the decisive battle*" or "create favorable conditions for *the main force*."[10] The methodical nature of China's military doctrine is particularly striking in that it focuses not on delivering spread-out delaying attacks but on concentrating firepower against vital military targets. The bulk of Chinese military writings, including the 2008 China defense white paper, *The Science of Military Campaigns* (the primary doctrinal source for the PLA), and, unsurprisingly, *The Science of Second Artillery Campaigns,* focus on applying firepower efficiently and innovatively to achieve victory over the enemy's force as in a conventional military campaign, even if a limited one.[11] It is here that China's extensive investment in theater missile technologies takes root, and its staggering scope not only reinforces China's commitment to a missile-centric strategy but gives us important insights into the true ambitiousness of China's strategic and operational goals in a potential conflict with the United States.

Missiles are cheap, fast, expendable, risk no friendly casualties and, most importantly, are difficult to preempt. Moreover, they do not require air superiority to operate and offer a high, often even uninhibited, rate of defense penetration. China can thus use missiles not only to achieve strategic surprise but to dismember U.S. assets on the ground or at sea without putting its own hardware or personnel in harm's way. For this reason, missiles have permeated the PLA's doctrine for every important kind of operation, from denial to blockade, and the PLA officer corps views them more and more as *the* way to level the playing field against a superior adversary.

Hence, every type of theater missile China operates has seen substantial growth in numbers and improvement in lethality in the recent years, and these trends alone afford remarkable insight into China's apparent goals and priorities.[12] The Second Artillery's older DF-21 medium-range ballistic missile (MRBM) has an estimated maximum range of 2,150 km and a circular error probable (CEP) of seven hundred meters.[13] China has also begun the procurement of the much more potent DF-21A and, most recently, DF-21B. These missiles have an extended range of 2,500 km and are reported to use in-flight Global Positioning System (GPS) updates and a radar-correlation terminal-guidance system, which allows the DF-21A to achieve a CEP of fifty meters and the more accurate DF-21B one of a remarkable ten meters.[14] The DF-21/21A/21B missiles

Naval War College Review, Vol. 64 [2011], No. 2, Art. 3

are carried by transporter-erector-launchers (TELs) and are capable of carrying unitary high-explosive (HE), submunition, chemical, nuclear, and electromagnetic-pulse (EMP) warheads.[15] The sheer number of these missiles has grown as well. The annual American report on China's military power put the number of DF-21/21As (CSS-5 Mod 1/2) at nineteen to twenty-three in 2005, forty to fifty in 2007, and eighty to ninety in 2010.[16] This means that since procurement started, the number of Chinese MRBMs has been increasing by ten or eleven missiles per year, with procurement still ongoing.

Although China is still a long way from matching the United States in military prowess across the board, its goal of defeating American forces in a limited theater war may well be within reach.

The Second Artillery has also built an inventory of hundreds of accurate, long-range land-attack cruise missiles (LACMs). China's HN-1/2/3 cruise missiles, launched from a variety of platforms, have ranges between six hundred and three thousand kilometers, and due to inertial and terminal TV guidance boast accuracies between fifteen to twenty meters for the HN-1 and a stunning five meters for the HN-2/3.[17]

The scope of operations now performed by the Second Artillery—which fields but one type of weapon, missiles—and its integration into the rest of the PLA are also remarkable. Although originally created as a nuclear command, the Second Artillery has been reorganized primarily for conventional strike, as most of the missiles it now operates are conventional ballistic missiles. Furthermore, using these missiles, it is now tasked with conducting many of the operations hitherto conducted only by aircraft and vessels in other services—including attacks against C4ISR targets, airfields, ports, logistics networks, and, soon, moving ships.[18]

To a similar extent, China's strategy for engaging U.S. aircraft carrier groups relies on missiles, as opposed to platforms. The original Congressional Research Service report cited above identifies, consistent with other analyses, the following as China's sea-denial threats to the United States: ballistic missiles (including those capable of attacking moving ships), advanced cruise missiles, land-based maritime attack aircraft, submarines, surface combatants, and naval mines.[19] Tellingly, every single one of these threats, save the last, relies on long-range antiship cruise missiles (ASCMs) to engage U.S. surface assets. To that end, over the past decade the PLAN has procured a large number of ASCMs, Russian-made and indigenous, specifically designed to attack U.S. carrier groups. Deployed to various platforms, these missiles are equipped with inertial guidance, in-flight GPS updates, and terminal radar guidance; they deliver HE warheads weighing from 165 to 513 kg. The most advanced missiles—the SS-N-22 Sunburn, on the *Sovremenny*-class destroyer, and the SS-N-27 Sizzler, on the Kilo-class submarine—travel at supersonic speed and drop to just ten meters above the surface in the attack stage, making 10*g* maneuvers to evade defenses and attack at unexpected angles. Most critically, the vast majority of Chinese ASCMs are capable of ranges between 160 and 400 km, outranging the principal ASCM used by the United States and its allies, the RGM-84 Harpoon, by factors as large as 3.25.[20]

The most remarkable fact, though, is the extent to which ASCMs have pervaded the Chinese navy and naval aviation. The PLAN has fitted advanced ASCMs on four out of its five destroyer classes, two out of three frigate classes, five out of seven attack submarine classes, and just about every aircraft in its inventory, including the obsolete fighters and heavy bombers of 1960s vintage.[21] The PLAN is also heavily investing in fast attack craft (FACs), whose role appears to be exclusively that of dedicated missile platforms. The PLAN has fitted thirty-seven of its 190 older FACs with advanced ASCMs.[22] In 2004 it has introduced the Houbei/Type 022 class of ASCM-armed catamaran; as of the end of 2009, over sixty units were in service, with as many as a hundred expected by the end of the production run.[23]

In addition to standard LACMs and ASCMs, China has procured at least two types of advanced antiradiation missiles (ARMs). The first was an Israeli missile/drone, the IAI Harpy. Launched from a truck, the Harpy boasts a two-hundred-kilometer range and can loiter unnoticed for hours before identifying and striking a target either on land or at sea.[24] The second was the Russian Kh-31P, delivered by aircraft and boasting supersonic speed, a complex flight profile, a 110–200 km range, an eight-meter CEP, and the ability to attack targets on land, at sea, or in the air.[25]

Finally, China is on the cusp of deploying an additional capability for engaging moving U.S. carrier groups, again using missiles—the vaunted DF-21C ground-based antiship ballistic missile (ASBM), equipped with a maneuverable reentry vehicle (MaRV). The DF-21C, sometimes referred to as the DF-21D, DF-21E, or DF-25 depending on the source, has an estimated maximum range of 1,500 km. When fired at the target, the missile would deliver its reentry vehicle to the general vicinity of the carrier group, at which point a terminal-guidance suite—believed to be active-radar, infrared (IR), or laser—would seek the target and maneuver the reentry vehicle onto it at high hypersonic speed. Its maneuvers, carried out in a complex trajectory, are designed to guarantee penetration of antimissile defenses and then a hit.[26] The warhead type or types are unknown at this time but believed to be HE, armor-penetrator, submunition, or EMP. It appears that the missile went into production in 2010 and could be fielded as early as 2011. Extrapolating from the DF-21 yearly production cycles, we can expect to see ten or so new DF-21Cs deployed each year.[27] (See the table.)

Naval War College Review, Vol. 64 [2011], No. 2, Art. 3

CHINA'S THEATER MISSILES WITH RANGES OF 100 KM OR MORE

MISSILE	TYPE	LAUNCH PLATFORM	WARHEADS	RANGE	CEP
DF-21/21A/21B	MRBM	TEL	500 kg (DF-21), 600 kg (DF-21A/21B): HE, submunitions, EMP, nuclear, chemical	2,150 km (DF-21) 2,500 km (DF-21A/21B)	700 m (DF-21) 50 m (DF-21A) 10 m (DF-21B)
DF-21C	ASBM	TEL	n/k	1,500 km	5 m
DF-11/11A	SRBM	TEL	800 kg (DF-11), 500 kg (DF-11A): HE, submunitions, FAE, nuclear, chemical	280 km (DF-11) 350 km (DF-11A)	600 m (DF-11) 200 m or 20–30 m (DF-11A)
DF-15/15A	SRBM	TEL	500 kg: HE, submunitions, EMP, FAE, nuclear, chemical	600 km	300 m (DF-15) 10–30 m (DF-15A)
HN-1A/B, 2A/B, 3A/B	LACM	TEL, ship, submarine, aircraft	400 kg HE, submunitions	600–3,000 km	10 m (HN-1) 5 m (HN-2/3)
YJ-63	LACM	Aircraft	513 kg HE	100–200 km	n/k
Kh-31P	ARM	Aircraft	87 kg HE	110–200 km	8 m
IAI Harpy	ARM	TEL	100 kg HE	~200 km	n/k
SS-N-22 Sunburn	ASCM	Ship	320 kg HE	200–250 km	n/k
Kh-41 Moskit	ASCM	Aircraft	320 kg HE	250 km	n/k
SS-N-27 Sizzler	ASCM	Submarine	400 kg HE	300 km	n/k
YJ-6/61/62	ASCM	Aircraft	513 kg HE	110 km (YJ-6), 200 km (YJ-62)	n/k
YJ-2/83	ASCM	TEL, ship, submarine, aircraft	165 kg HE	120 km (YJ-2 TEL/ship/sub), 180 km (YJ-2 air), 160 km (YJ-83 TEL/ship/sub), 250 km (YJ-83 air)	n/k
YJ-91/12	ASCM	Aircraft	205 kg HE	400 km	n/k

Notes: FAE = fuel air explosive, i.e., incendiary. N/k = not known.

Sources: Lennox, ed., *Jane's Strategic Weapon Systems;* Saunders, ed., *Jane's Fighting Ships;* Fisher, *New Chinese Missiles Target the Greater Asian Region;* "Military: Chinese Missiles," GlobalSecurity.org; Lum, "China's Cruise Missile Programs," pp. 67-73.

It is illogical to consider that China, rigorously building up such fundamental advantages over the U.S. Navy as it is, is seeking merely to harass and slow down U.S. ships approaching Taiwan. Instead, China appears to be committed to securing the capability to win a regional-scale campaign against the U.S. Navy, and it appears to see transcending the platform-centric concept of naval warfare as the key to this goal.

In the end, China's overwhelming emphasis on missile technologies undermines the argument that it is merely pursuing access denial for two reasons. First, missiles are fundamentally destructive, rather than disruptive, weapons. Their wide proliferation within the PLA suggests a commitment to crippling the adversary's campaign effort and imposing maximum casualties on its forces, rather than merely impeding their deployment. In fact, it is likely that China would actually allow an adversary to mass its assets within striking distance, specifically to maximize the effectiveness of missile attacks. In either case, there is no reason to see the wiping out by missile strikes of a squadron of fighters at a forward operating base in Japan or Korea as merely disruptive and delaying rather than a conventional-battle goal of inflicting attrition on the adversary's assets, reducing its operational capability, and degrading its campaign effort while furthering one's own.

Second, China's missiles can target only forces that have already entered the theater. Only a few MRBMs and LACMs could strike land targets as far away as Guam, and none could target U.S. forces beyond the "second island chain."[28] Chinese ASCMs can attack targets at most four hundred kilometers from their launch platforms. As China's ability to operate those platforms—surface combatants, submarines, and aircraft—far from its shores remains limited and would be risky in any case, it would not be able to engage U.S. carrier groups until they were within hundreds of kilometers from Taiwan. Overall, China has procured close to a hundred MRBMs and hundreds of ARMs and LACMs, and it has armed nearly every boat, ship, submarine, and aircraft in its navy with supersonic ASCMs. Moreover, all these types of missiles above are highly effective against targets within the theater but are incapable of striking targets attempting to access it. In the end, then, it does not follow that China's primary strategy is access-denial or that its missiles somehow represent an extension of that strategy. Rather, its force structure and its weapon-procurement trends indicate strongly that China has instead maintained a commitment to the conventional aerospace/naval campaign, but revolutionized it by couching it in a missile-centric rather than platform-centric model of firepower combat. Moreover, as the destructive properties and the theaterwide (but clearly not transocean) ranges of China's missiles suggest, their advent points to a Chinese commitment to an energetic strategy of engaging and defeating an adversary directly in the theater, not merely delaying and disrupting its access, with uncertain options thereafter.

However remarkable in itself the ongoing convergence of China's strategy around missile-centric concepts is, even more disturbing is the fact that theater missiles are showing real potential to expose the heretofore well-shielded weaknesses of U.S. expeditionary forces, including long forward-deployment times, the exposed state of equipment at forward operating bases, and the obsolescence of ASCMs carried by surface combatants. Furthermore, China's missiles, supported by recent strides in C4ISR, promise to provide the country with transformative options, long coveted but previously unavailable, that would offset or even render irrelevant American superiority in several key areas, including air defense and integrated naval warfare.

The fact that stationary targets are vulnerable to surprise air strikes has been apparent since even before Pearl Harbor. Nevertheless, in the recent decades it would have been nearly impossible for a regional adversary to carry out a successful air raid against a U.S. force assembling on the adversary's borders, due to constant American satellite surveillance of enemy forces, considerable flight distances involved, nonexistent or insufficient tanker support, formidable allied air defenses, and the marked superiority of U.S. fighters.

But China's conventional MRBM, LACM, and ARM technology allows it to attack U.S. forces not only with great precision and flexibility but with expendable airframes fired from safe distances, thereby overcoming the once-decisive limitations of Chinese aircraft. First, unlike aircraft, ballistic missiles are launched from mobile, widely dispersed, inconspicuous, and easily hidden or disguised TELs, which are nearly impossible to identify and track;[29] therefore, they do not betray their user's intent as they take their firing positions. In addition, because ballistic-missile flight times are no longer than several minutes, their launch would not provide sufficient warning for the aircraft to clear the tarmac. Second, again unlike aircraft, ballistic missiles do not need air superiority to operate and would be unaffected by screens of American or allied defensive fighters below them. Third, because MRBMs reenter the atmosphere at hypersonic speeds, there are currently no viable defenses against them and, as I argue below, there will not be in the near future. This ultimately means that if they are as accurate as analysts believe, their ability to destroy any stationary target identified by Chinese ISR assets, no matter how valuable to the United States, is all but assured.

The Chinese ability to threaten moving ships is equally remarkable. The vulnerability of U.S. surface assets to ASCMs has been evident for some time. Today, China's maritime strategy—acquiring missile technologies for which the U.S. surface assets simply have no effective defenses, integrating them into every combat arm of its navy, and developing the capabilities for C2 and ISR necessary to sustain concentrated missile raids against U.S. carrier groups—is doing for the ASCM what blitzkrieg did for the tank. Rather than simply integrating a powerful weapon into existing doctrine and force structure, China has refined its doctrine and constructed a force structure in support of a weapon in order to fundamentally redefine that weapon's potential.

The unprecedented adaptation of ballistic missiles for antiship operations is equally transformative. Given its 1,500 km range and a flight time measured in minutes, China's revolutionary DF-21C ASBM not only offers its launcher virtual impunity from counterattack but represents potentially the most robust strike option currently possible. The speed, flexibility, range, and launcher survivability of the ASBM cannot be matched by any other weapon, and as will be seen, antiair warfare (AAW) and missile defenses and preemption would be of little use against it.

FINDING AND TARGETING U.S. FORCES

The most important question for many in considering the PLA's missile threat is whether China has the C4ISR architecture necessary to find and target U.S. forces. I argue that in just the past five years China has achieved a sufficient proficiency in this domain to manage a successful missile campaign.

China has deployed sky-wave and surface-wave over-the-horizon (OTH) radars in recent years, offering constant coverage as far out as three thousand kilometers within a field of view of sixty degrees. If, as is likely, China has built more than one site, it could have uninterrupted radar coverage of all the surrounding seas. These assets would be instrumental in locating and tracking U.S. surface forces within the theater. Although the radars are large systems, their locations might be unknown to the approaching force.

China's space-based ISR capabilities have grown exponentially in the past several years. As of November 2010, China has thirty optical, synthetic aperture radar (SAR), IR, and multispectral intelligence satellites in orbit. The PLA also operates three JianBing 3 and twelve YaoGan surveillance satellites, and several additional YaoGan platforms are expected in orbit each year. The JianBing 3 platforms offer optical and IR imagery with a resolution under two meters. In the more advanced YaoGan program, seven satellites are believed to be electro-optical, offering resolution of 0.6 to one meter;[30] five are believed to be SAR satellites, capable of all-weather imaging with five-meter resolution.[31]

China also operates a considerable number of less capable observation satellites producing optical, SAR, IR, multispectral, and hyperspectral imagery that is likely used for military intelligence as well as its primary civilian purposes.[32] These platforms include two CBERS/ZiYuan earth-observation satellites, two HuanJing and three ShiYan environment-observation satellites, three HaiYang maritime-surveillance satellites, three FengYun and one Chuangxin meteorological satellites, the Beijing-1 resources-observation satellite, and finally TianHui, a high-resolution (approximately five meters) mapping satellite.[33] To facilitate the relay of intelligence, China launched in 2008 a TianLian 1-01 data-relay satellite, offering near-real-time communication and coverage of 50 percent of the globe. The successor program, TianLian 2, envisions two satellites and 85 percent global coverage in this decade.[34]

According to an analysis by Eric Hagt and Matthew Durnin published in these pages in 2009, assuming a then-accurate total of twenty-two satellites with an off-nadir (i.e., side-to-side) field of view of sixty degrees, China could ensure that each area was revisited by a satellite every forty-five minutes, on average.[35] This would be sufficient to monitor stationary concentrations of aircraft and ships at regional bases. Also, the space-based ISR architecture may already be able to locate and track moving carrier groups, especially when combined with other ISR assets. Hagt and Durnin deemed the forty-five-minute revisit rate insufficient for tracking carriers continuously with space-based assets.[36] However, extrapolating from their study, having thirty satellites in orbit would reduce that interval to thirty or thirty-five minutes. Furthermore, the Hagt-Durnin model somewhat plays down the importance of other facets of China's ISR assets and their ability to overlay and complement each other. Significantly, a carrier group, once its general location has been detected by a certain ISR asset, does not need to be tracked by the same asset. General coordinates from the OTH radar or a satellite could be passed to a nearby submarine or to aircraft that would close in on the carrier to engage it or continue tracking it.

In addition to ocean-bottom sonar beds, China operates fifty-five submarines, all of which could assist with carrier detection and tracking. The boats of the relatively old and noisy Romeo and Ming classes would likely lie in wait with their engines stopped, serving as listening posts. Newer, quieter submarines would likely be able to track U.S. surface assets while shadowing them undetected. Many observers have pointed out the likelihood that China would fit a number of inconspicuous civilian vessels, such as fishing boats, with equipment to detect U.S. carrier groups and relay their locations. Finally, China would call on its surface combatants and maritime reconnaissance aircraft to assist in locating and tracking U.S. surface assets. In fact, China's Gaoxin Project is developing seven specialized variants of the indigenous Y-8 cargo aircraft, with versions specializing in electronic and signal intelligence collection, communication and data relay, and electronic warfare, all useful against American air and naval assets in the theater.[37]

China is also proficient in remote-communication technologies, which would be essential for coordinating assets in a high-intensity campaign. It operates four dedicated military communications satellites: three FengHuo vehicles and the DongFangHong-4, launched in 2010.[38] Also, it has access to a number of commercial communication satellites, like Sinosat. China has also bolstered its AWACS* capability and is continuing to push for greater airborne C2 capability. The PLAAF has added four Y-8 early-warning planes and at least four A-50 Mainstay AWACS aircraft to its force in the recent years.[39] It is working on the KJ-200 and KJ-2000 projects, based on the Y-8 and A-50 platforms, respectively.[40]

Even more strikingly, China appears to be pursuing naval asset integration through Aegis-like technology. The first two ships of the PLAN's latest destroyer class, Luyang II, are designed as China's first ships capable of integrated air defense. The ships are equipped with the Tombstone phased-array radar with 360-degree coverage, a C2 suite, and state-of-the-art SA-N-20 AAW missiles, which more than double the range of the current PLAN air defenses and represent a leap toward correcting the PLAN's perennial weakness in this area of warfare.[41] Experts expect the new naval assets to make use of Russia's advanced AT2M data-link technology (analogous to NATO's Link 16), which should contribute to the integration of Chinese naval task forces.[42] The advent of the Luyang II class and PLAN integration not only increases the air-defense capabilities of Chinese surface combatants but allows them to be organized into battle groups. Self-sufficient, integrated battle groups operating phased-array radars could not only help track U.S. assets more efficiently but coordinate and concentrate their missile firepower, in support of one of the major tenets of China's missile strategy.

Every type of theater missile China operates has seen substantial growth in numbers and improvement in lethality in the recent years.

Finally, China is now capable of supplying navigation, positioning, and crucially, missile guidance systems through indigenous technology. China completed its first BeiDou 1 navigation constellation between 2000 and 2007, covering China and the immediate region; of the original four satellites, three are still active.[43] BeiDou 1's successor, BeiDou 2, or Compass, is China's own global positioning system; it has both civil and military applications, comparable to GPS, GLONASS, and Galileo. It has already launched the first five Compass satellites, offering coverage of most of the region.[44] China plans to extend the constellation to a total of ten satellites by 2012, achieving coverage of all of Asia, and to a complete network of thirty-five satellites, for global coverage, by 2020.[45] Many of China's extremely long-range ASCMs currently rely on GPS

* Airborne Warning and Control System.

updates for guidance; should the United States jeopardize China's access to GPS during hostilities, China is already able to exercise the same capabilities with its current Compass structure.

This wealth of development in the recent years—the deployment of thirty military and dual-use intelligence satellites, a strong all-weather capability, OTH radars, sonar beds, and a large number of ISR-capable ships, submarines, and aircraft—has greatly illuminated China's "strategic view" and allows it to locate, track, and target U.S. assets on land and at sea much more easily. The PLA's impressive leap in integrated air defense reveals that technologically and operationally, the PLA is already capable of targeting U.S. assets in the theater. Hagt and Durnin suggest that by 2014 China would be able to locate and track U.S. carrier groups with its space-based ISR alone.[46] As additional technology comes on line—with a new satellite launch every several months—China's already sufficient ability to conduct coordinated air-naval operations and missile strikes is becoming stronger, which, together with the lethality of its ordnance, presents the loss-averse American assets with a powerful challenge.

ATTACKING LAND-BASED TARGETS

Consistent with its doctrine, China is likely to give priority to attacks on C4ISR assets, in order to paralyze American operations. This would include striking radars (with MRBMs, LACMs, or ARMs) and C2 centers (with MRBMs armed with earth-penetrating warheads). Importantly, this target set would also include AWACS and ISR aircraft on the ground; these aircraft are large and conspicuous enough to be easily visible and vulnerable to most elements of China's missile architecture.

Most attacks, however, would undoubtedly be concentrated against groups of unsheltered fighters on the ground. In Operations DESERT STORM, ALLIED SHIELD (the Kosovo campaign), and IRAQI FREEDOM, U.S.-led coalitions used 2,400, 1,055, and 1,801 aircraft, respectively, nearly all of them deployed directly to the theaters of operation.[47] During DESERT STORM, for example, coalition forces deployed 2,400 aircraft, of which seven hundred were land-based fighters.[48] The land-based fighters were deployed mostly to Saudi Arabia, at an average deployment rate of fifteen fighters per day and with an average concentration density of thirty-four aircraft per airfield.[49] In the two months between the start of deployment to the theater and the commencement of combat operations, these aircraft remained parked in open areas, their personnel housed in sprawling tent cities nearby.

A prominent 1999 RAND study of the vulnerabilities to missile strikes of assets and personnel so deployed found that given typical hardstand spacing, a ballistic missile with a five-hundred-kilogram unitary warhead could in a direct hit destroy six fighters the size of F-15s.[50] More disturbingly, the study also reported that if the unitary warhead were replaced by a submunition dispenser containing 825 steel balls, the lethal area of the same missile would increase eightfold. A single missile covering such an area, according to the RAND authors, would thus be able to destroy eighty-two F-15-sized aircraft, or more than an entire air wing.[51]

Ten years later, in 2009, another RAND study, modeling attacks by short-range ballistic missiles (SRBMs) on all parking ramps of all ten of Taiwan's air bases, concluded that assuming warheads with eight hundred submunitions each and to a large extent regardless of CEP, a mere two missiles would be required to achieve a 90 percent chance of destroying all aircraft on a given ramp, or only one missile for a 70–80 percent chance. Given the overlap between hardstands, this would translate to needing from twenty-four to thirty-six missiles to clear all parking ramps on all ten bases.[52]

In the last decade, China has in fact adopted a submunition warhead for SRBM and MRBM delivery, unquestionably with this very mission in mind. Although its parameters are not known, it is most probable that the warhead uses a large number (in the hundreds) of steel balls or shards. If this is so, China very likely possesses an MRBM operational capability with ordnance lethal area and accuracy on a par with, or better than, that hypothesized in the studies above.[53] This means that if the United States were to deploy 340 fighters, with associated support aircraft, to ten forward operating bases, China could potentially destroy them all with as few as twenty DF-21/DF-21As, or only two missiles for each base.[54]

Missile attacks against individual aircraft shelters, in bases that possessed them, would be prohibitively costly. However, such bases would remain China's strategic priority, as the United States is likely to deploy its most capable fighters, including the F-22, to them. For these targets China would likely use MRBMs to cut runways, trapping the fighters; continue the attack with LACMs and ARMs against radars, surface-to-air missiles (SAMs), and other critical infrastructure; and then follow up with aircraft strikes targeting individual shelters by using much cheaper precision-guided munitions. The 2009 RAND model suggests that two missiles with CEPs of eighty-two feet (about twenty-five meters) carrying warheads with eighty-two earth-penetrator submunitions each would render a single runway inoperable with a 70 percent probability.[55] Notably, China could strike bases just outside the usual reach of its SRBMs—including those on Okinawa and Kyushu and in South Korea—by using lighter warheads on its numerous DF-15A SRBMs, thereby extending their range. An even easier solution would be to send SRBMs on boost-glide, or depressed, trajectories, which would increase their range by as much as 31.2 percent.[56]

Naval War College Review, Vol. 64 [2011], No. 2, Art. 3

Chinese missiles would also pose a significant threat to U.S. ships entering ports around the region. The United States maintains a carrier group on continual patrol in the western Pacific, homeporting the USS *George Washington* strike group in Yokosuka, Japan, as part of that rotation.[57] The *George Washington* group remains in port about six months out of the year and is on patrol for the other six.[58] Even on patrol, it must periodically enter port for replenishment, maintenance, and other purposes. These requirements, in addition to potentially having to enter port to repair battle damage, would also apply to any additional carrier groups that the United States would maintain in the theater for a prolonged period of time, giving China's missiles a periodic set of lucrative, stationary targets that could be attacked with not only ASBMs and ASCMs but, every time the ships enter into dock, standard MRBMs and LACMs as well.

Finally, China could use missile strikes against vulnerable U.S. logistics networks. Each forward-deployed combat aircraft, such as an F-15C, requires about 133 tons, or three C-17 loads, of ammunition, force protection equipment, vehicles, personnel, and the like. According to one Chinese analyst, each F-15C consumes almost seventeen tons of fuel per day.[59] If supporting C2 and ISR aircraft are deployed with the fighters, the requirement for fuel rises substantially. As U.S. aircraft initially deploy with supplies for only two to five days, they rely thereafter on continuous airlift and sealift.[60] The dependence of American carrier groups on replenishment, particularly in fuel, is even more extensive. A single strike group requires sixty thousand tons of fuel and thirty thousand of aviation fuel every five days.[61] Although transport aircraft on the ground and supply ships in port could themselves be targeted, China might instead go for more lucrative repositories. Since most fuel, ammunition, and other equipment have to be stored in depots too large to be hardened, LACM attacks using standard HE warheads would imperil U.S. operations even if military platforms and transport vessels remained intact.

ATTACKING SEA-BASED TARGETS

The consensus in the American maritime-security literature and apparently the U.S. Navy itself is that its surface assets have no reliable defenses against Chinese- or Russian-made state-of-the-art ASCMs.[62] Because of the missiles' low flight profiles, brief flight times (twenty-five to thirty-five seconds), and resilience to electronic-warfare attack, they are difficult to track and either intercept or jam in flight.[63] Specifically, because they drop to only several meters above the water in the final stage of flight, they would effectively slip below not only the U.S. carrier radars but the minimum vertical range of AAW missiles. What is more, these missiles close in for the attack at supersonic speeds, and, as noted above, often make 10*g* turns to evade defenses and attack from unexpected angles.[64] This makes them virtually impossible to intercept with AAW missiles. The only other shipborne system that the U.S. surface combatants could employ against them is the Vulcan Phalanx close-in radar-guided gun; however, its radar guidance is starkly insufficient for tracking and engaging objects performing evasive maneuvers at supersonic speeds.[65] Finally, although ASCMs like the Sunburn were once too short legged to engage U.S. ships, significant increases in their ranges over the past several years have effaced this reassurance. Furthermore, as already argued, range disparity allows the PLAN to target American assets from well outside the range of U.S. carrier groups' own ASCMs.

Observers believe China is developing the capacity to capitalize on this acute vulnerability by means of saturation missile raids launched simultaneously from a variety of platforms on, below, and above the sea surface, with intervals between launches on the order of only seconds to minutes.[66] Granted, it is unlikely that China would be able to synchronize simultaneous attacks by forces hundreds of kilometers apart for some time to come. However, given its proficiency in C2, satellite communications, and data relay, as well as theaterwide coverage provided by its OTH radars, sonar beds, and possibly disguised merchant vessels, China very likely is now capable of massing volleys from individual fighting squads, such as aircraft or surface-combatant strike groups, all of whose platforms can be cued to the target's location by the same C2 center. The PLAN believes—and, it appears, quite correctly—that if it can mount such attacks with adequate proficiency, the sheer number of missiles attacking from diverse azimuths in massed, sustained waves, even if not synchronized, would inevitably saturate American defenses and take a heavy toll on the exposed ships, which, reeling under the onslaught, would be unable to retaliate in kind. China's commitment to such a strategy is evident in its development of a force structure —including aircraft, submarines, surface combatants, and FACs—able to deliver ASCMs from multiple axes. The total number of missile carriers in the PLAN, multiplied by the number of missiles each carries, is truly formidable and, with the introduction of new vessels each year, is shifting the naval balance decidedly in China's favor.

The PLAN operates over seven hundred maritime strike aircraft, most already fitted with between two and four ASCMs or Kh-31P ARMs.[67] PLA doctrine describes aircraft as having advantages in ASCM delivery, in that they are fast, versatile, and highly mobile.[68] Furthermore, aircraft are safe from U.S. submarines and antiship weapons and, unlike other assets, they can be detected only by radar, and with no guarantee of that at low altitudes.[69] Finally, the ranges of air-launched ASCMs tend to be longer than those of their ship-, submarine-, and ground-launched counterparts. All this makes aircraft an effective and dangerous launching platform.

Naval War College Review, Vol. 64 [2011], No. 2, Art. 3

Due to their inherent ability to go undetected anywhere in the theater, submarines are another leg of China's antisurface force structure. The PLAN operates twenty-nine submarines equipped with advanced ASCMs, each usually carrying eight missiles, with new units added each year.[70] Although more difficult to coordinate than surface combatant or aircraft strike groups, significantly slower than other assets, and, by virtue of operating alone, offering much smaller concentrations of missiles, submarines are currently China's stealthiest platform for antisurface warfare.[71] The deterioration of U.S. antisubmarine warfare capabilities since the end of the Cold War, China's marked numerical advantage in the theater, and the western Pacific's maritime topography's adverseness for submarine detection would make ASCM attacks by PLAN submarines a threat throughout a campaign even with extensive American antisubmarine warfare assets present.[72]

The PLAN also operates thirteen destroyers and twenty-two frigates equipped with ASCMs.[73] Although they lack the speed of aircraft and the stealth of submarines, they carry the most missiles, eight to sixteen per destroyer and four to eight per frigate.[74] Furthermore, China would likely organize its surface combatants into battle groups, each coordinated by a Luyang II–class destroyer, allowing concentration of firepower and AAW capabilities. Although coordination of synchronous missile volleys from widely separated assets may remain beyond China's means for some time, the integration capabilities of the Luyang II ships would already allow China to launch synchronized mass volleys from all surface combatants within each battle group led by a Luyang II.

Last but not least is the PLAN's rapidly growing FAC fleet. These vessels are small, stealthy, fast, and maneuverable, making them difficult targets. What's more, each craft carries four to eight ASCMs—the same armament as many of the PLAN's fleet ships. Perhaps their most important characteristic, though, is that given their low cost relative to that of surface combatants and submarines, they can be deployed in much larger numbers—it appears that as many as a hundred are planned by early next decade.[75] These factors not only make this modern-day "mosquito fleet" particularly well suited for executing mass ASCM strikes, but lessen the impact of the loss of any one craft, rendering any exchange of casualties with U.S. surface combatants inherently favorable to the PLAN. Although FACs themselves are limited to coastal areas, the long range of their ASCMs enables them to engage surface combatants five to six hundred kilometers to sea, putting U.S. ships within striking distance of China's territory at very significant risk.

Another weapon that warrants discussion is, of course, the DF-21C ASBM, which should see deployment beginning in 2011. Although due to ASBM cost and limited inventory, it is unlikely that China would use them in barrages, they have remarkable capability nonetheless. The missiles are launched from inconspicuous TELs on land, cover their entire 1,500 km range in seventeen minutes, accurately maneuver onto their target within a wide radius, and—even with forced reduction of reentry speed, but provided accurate targeting—strike their targets at high hypersonic speed. The reentry vehicle entering at such velocity would be immune to shipborne AAW and close-in gun defenses. Moreover, as the next section discusses, because of standard countermeasures in the midcourse phase and complex reentry maneuvers, ASBMs also could not be intercepted by U.S. missile defenses. Maneuvering to get out of the missile's seeker would also likely prove ineffective. According to a 2010 analysis in this quarterly, it would take approximately thirty-five minutes from the detection of the target for the PLA to communicate its location to a relevant C2 center, issue an engagement order (with no delay assumed) to the launcher, and fire the ASBM, and for the missile to travel its full range. During these thirty-five minutes the carrier group could travel thirty-one kilometers, making a circle with a radius of thirty-one kilometers the missile's area of uncertainty and therefore the required seeker footprint for a single missile to find the target.[76] Although no authoritative data on the DF-21C's seeker footprint exist in the open literature, Chinese sources suggest twenty-, forty-, and hundred-kilometer footprints.[77] Given the missiles' high cost, it is unlikely that China would opt for an overly narrow footprint, making a hundred, or perhaps forty, kilometers more credible than twenty. Hence, chances are that each individual ASBM would be able to find its target and, once it does, achieve a virtually assured hit.

The U.S. Navy, as noted, has been aware of the difficulty of defending against ASCMs for some time. To this concern have been added those about ASBMs in recent years. For this reason, the American operational concept against antiship missiles has, since the late Cold War, stressed "killing the archer rather than his arrows."[78] The U.S. fleet's ability to kill arrows will remain dismal for some time to come. However, the most fundamental asymmetry represented by China's ASCMs and ASBMs is an ability to keep the archer himself well out of reach.

The SM-2 and Sea Sparrow AAW missiles have ranges of less than 170 km, and the subsonic Harpoon ASCM has a range of only 130 km.[79] On the other hand, to use just a few examples, the Sunburn has a range of 250 km, allowing the *Sovremenny*-class destroyer to attack American assets 120 km before it would come into range of surface-launched Harpoon missiles.[80] Similarly, the range of the air-launched YJ-91 is four hundred kilometers, which allows its vector, the Su-30MK2 fighter, to release the missile and safely turn back some 230 km before it could come into the range of ship-launched American AAW missiles.[81] The DF-21C has a range of 1,500 km, keeping its launcher beyond U.S. carrier groups' radar coverage.

The U.S. Navy's ability to kill the archer usually has traditionally resided in its ability to engage firing platforms with carrier-borne aircraft. However, when flight decks are damaged by missile strikes, launching and recovering aircraft becomes impossible. Here, too, China's launcher architecture allows it a number of robust options.

Chinese aircraft generally lack the range to engage the enemy or protect the PLAN's surface combatants beyond a thousand kilometers or so from China's coast. It is therefore unlikely that China would use its aircraft at longer ranges, where they would be vulnerable to American carrier-borne fighters. Past perhaps a thousand kilometers from its coast, China would most likely rely on submarine-launched ASCMs and submarine- and land-based ASBMs to paralyze carrier air before the carrier groups could be engaged safely by other assets. Not only would the Chinese submarines *consistently* be able to get within firing range of the U.S. carriers due to the factors outlined above, but they would typically remain too far away to be countertargeted before they escaped.

China is pursuing an ambitious program of military innovation in air and naval warfare geared not toward harassment but to paralysis and destruction of the adversary's forces through a concerted campaign.

Closer than a thousand kilometers from the coast, countertargeting would become even more difficult. The submarine and ASBM threats would remain equally persistent. Also, Chinese surface combatants and maritime strike aircraft now threatening the carriers not only would have their own antiair capability, but would be covered by several thousand land-based PLAN and PLAAF fighters, several hundred of them comparable or superior to U.S. carrier-borne fighters. Apart from the threat they would pose to the carriers themselves, their persistence would make attacking Chinese surface combatants and maritime strike aircraft with carrier-borne fighters all the more difficult. Within five hundred or so kilometers of China's coast, the U.S. forces would also be within the range of FAC-launched missiles. Finally, within two hundred kilometers carriers would be vulnerable to all of the above plus land-based S-300 SAM batteries.

In addition to all this, the U.S. naval and air forces would be unable to countertarget ballistic-missile launchers, including ASBM launchers, on land. The United States would be unable to rely extensively on airborne ISR platforms, as they are highly vulnerable to Chinese SAMs. This would force the Americans to depend largely on space-based reconnaissance. Optical satellites, however, have trouble penetrating cloud cover, which is perennial in southwest China. As China extensively employs sophisticated camouflage, concealment, and decoy techniques, many of its assets would be indistinguishable to radar, or even optical satellites or airborne ISR.[82] Lastly, and most importantly, Chinese TELs would operate in densely populated areas, where, even if not hidden inside buildings or under bridges, they would need to be identified among vast numbers of civilian vehicles. For these reasons a dedicated RAND study that extensively models attacks against Chinese TELs with the most advanced existing and developmental American technology concludes that they would be nearly impossible to target, especially at long ranges.[83]

In the end, it would be remarkably difficult for U.S. carrier groups to count on destroying Chinese missile launchers with airpower, or by any other means, before their own flight decks were disabled. The United States would be forced to try to shoot down Chinese ASCMs after all—and no effective technology exists to do so effectively and consistently.

OVERCOMING THEATER MISSILE DEFENSES

To cope with the rising missile challenge in the past several decades, the United States has invested heavily in active missile defenses.[84] Unfortunately, the current and projected American strategies are unlikely to provide any reasonable measure of effectiveness against China's missiles. For its part, China has invested in a number of countermeasures specifically meant to foil U.S. missile defenses.

Currently the U.S. theater missile defense (TMD) architecture is designed to engage ballistic missiles in their midcourse and reentry phases. The chief system to strike down missiles in the midcourse stage is the sea-based SM-3 missile.[85] The principal systems to engage ballistic missiles in the reentry phase are the Terminal High Altitude Area Defense (THAAD), for the "upper tier" of the atmosphere, and the PAC-3 SAMs and Navy's SM-2 Block IV SAM, for the lower tier.[86] However, even this multilayered defense network has serious, and probably insurmountable, limitations in terms of simultaneous-engagement volume, available interceptor inventories, and interceptor performance.

The first limitation is on the number of targets that it can realistically engage within a single time window. As no interceptor would have better than an 80 percent chance of success even under ideal conditions, it is almost certain that two interceptors would have to be fired per target. However, one "target" does not mean one *missile.* It is common for modern ballistic missiles to release chaff or from five to ten decoys, indistinguishable from the warhead to TMD sensors, during the midcourse phase.[87] The PLA also discusses firing previously decommissioned obsolete missiles, less accurate or capable armed weapons (some releasing their own decoys), and even cheaper SRBMs as "bait" for interceptors. Thus a volley of ten missiles could produce from fifty to a hundred targets, aside from chaff. The TMD system would be forced either to select targets randomly or to attempt to engage them all. Since the vast majority of the targets would be decoys, the former would offer an impracticably low probability of picking out the true warheads; the latter would exhaust the interceptor launch capacity at once. Either way, the TMD system would allow unengaged targets, many of them presumably warheads, to penetrate to their targets. Notably, whereas decoys would burn up during reentry, decommissioned or otherwise low-capability missiles would survive and continue acting as decoys against reentry-phase defenses. For these reasons, the PLA feels confident of its ability to saturate the defense in this way in each launch window.[88]

The second major limitation of the TMD is in interceptor inventory. For example, the United States is currently planning to procure 329 SM-3 missiles, tasked with midcourse stage interception, for its entire navy.[89] Because two interceptors would most likely be fired per target, that entire *inventory* might intercept at most 160 or so targets. However, it is fallacious to assume an exchange based merely on respective ballistic-missile and interceptor inventories. Factoring in decoys released in the midcourse stage, 160 targets could correspond to as few as sixteen to thirty-two actual missiles. If decommissioned missiles and the like are added, the number of high-value airframes the Chinese would need to deplete the entire SM-3 inventory falls even lower. Other interceptor systems are similarly limited in their inventories. This means that a number of concerted volleys of low-value missiles containing just several capable missiles, especially if equipped with decoys, would inevitably deplete the entire TMD inventory, let alone the fraction of it deployed to the theater.

The third limitation of the TMD lies in the doubtfulness of its interceptor capabilities. Few realistic data exist. For example, the SM-3 missile-based architecture has demonstrated sixteen successful intercepts in twenty attempts.[90] However, a prominent analysis suggests test conditions (which provide the basis for developers' claims) tend to be far from what the missiles would deal with in a real combat scenario.[91] What is more, the deployed systems are strictly limited in the kinds of targets they can intercept at all. Notably, the PAC-3 and SM-2 Block IV are designed for SRBM interception but would be ineffective against longer-range ballistic missiles, due to the targets' higher reentry speeds. The speed of a PAC-3 interceptor, the faster of the two, is only 2.5 kilometers per second, allowing it to intercept only missiles with ranges no longer than 1,500 km.[92] Indeed, U.S. forces deployed to the theater would be within 1,500 km of China's launch points. But the Chinese could respond by simply sending MRBMs on lofted trajectories, traveling the same horizontal distance but descending at much higher velocities and so easily outrunning lower-tier defenses. Also, although THAAD, PAC-3, and SM-2 Block IV missiles can engage objects descending on set trajectories, they cannot chase down MaRVs descending in unpredictable trajectories at high hypersonic speeds.[93] Finally, all lower-tier defenses have IR seekers; simply enclosing reentry vehicles in cooled shrouds would throw them off.

Hence, none of the missile defense systems in development by the United States could provide effective protection from Chinese missiles. Moreover, because fielding additional missiles and developing additional countermeasures are always substantially easier and cheaper than expanding or enhancing missile defenses, this is not an imbalance that the United States could realistically hope to redress. This prospect ultimately gives China three options for dealing with American theater missile defense. First, it could attack campaign-relevant targets regardless of TMD. Using decoys, high reentry speeds, and penetration aids, China would likely be able to strike its preferred targets with MRBMs and ASBMs, accepting the risk of potentially losing a few missiles to interceptors. Second, in the unlikely event that U.S. defenses proved particularly effective in intercepting individual missiles, sustained high-volume missile volleys, possibly including decommissioned missiles, could consistently saturate them, allowing the majority of the missiles in each wave to leak through. Third, China might attempt to target the TMD architecture itself early in the campaign. Attacking PAC-3 batteries with MRBMs, THAAD TELs with ARMs, and TMD-capable ships with either ASBMs or ASCMs would significantly degrade the TMD architecture and greatly facilitate subsequent missile strikes against campaign-relevant targets.

SKIPPING A GENERATION: POLICY CONSIDERATIONS

What China is poised to achieve is truly remarkable and unprecedented in modern warfare. Within just a few years, China would acquire the capability to attack—accurately, rapidly, and with nearly complete assurance—U.S. forces on the ground anywhere in the East Asian theater, regardless of the air and missile defenses the United States could bring forward. Chinese forces would be able to conduct wide-scale naval operations against battle groups as far as 1,500 kilometers from the mainland while remaining safely out of range themselves. Hence, although China is still a long way from matching the United States in conventional military prowess or combat proficiency across the board, its goal of defeating American forces in a limited theater war may well be within reach. The consequences for American war planning of failure to give due consideration to the tremendous threat posed by the Chinese missiles and the stark inadequacy of current and anticipated U.S. defenses against them may prove disastrous in a combat scenario. If the United States wishes to maintain its ability to intervene in a militarized Taiwan scenario, it is imperative that it take the measures necessary to offset China's missile threat.

To begin with, it is quite clear that TMD defenses lack the speed, accuracy, firing rates, and total interceptor inventories to cope with large numbers of sophisticated missiles equipped with countermeasures and, soon, maneuverable

Naval War College Review, Vol. 64 [2011], No. 2, Art. 3

reentry vehicles. Additional investment into TMD would therefore be counterproductive; the funds devoted to it should be shifted to more promising capabilities. For instance, much effort must be put into improving the active and passive defenses against supersonic projectiles. It is crucial that theoretical and practical research on real-life supersonic ASCM flight and attack profiles and on effective defenses against them be conducted. Future American AAW missile developments should focus on trading horizontal range for speed, maneuverability, and the low interception altitudes required against sea-skimming ASCMs maneuvering at supersonic speed. Also, much greater attention should be given to a wide range of passive defenses, including radio-frequency emission controls, deception emitters, obscurants, decoys, and jamming.[94]

The U.S. Navy needs to reinforce its efforts to develop much stronger offensive capabilities at much longer ranges. Although it has high hopes for the long-range electromagnetic rail gun, even its projected range of 370 km may not be sufficient for future needs, leaving the new generation of ASCMs just as relevant as ever.[95] Some currently fielded ASCMs already reach 550 km. If there is any offensive technology in which the United States needs to skip a generation, it is precisely in projectiles with very long range and high closing speed sustained by onboard propulsion—namely, advanced antiship cruise missiles.[96]

The U.S. Navy should also develop a much stronger antiship capability for its submarines. Although its carrier groups would remain outranged by the Chinese naval ASCMs and vulnerable to land-based ASBMs, American submarines would be immune to these threats and just as difficult for the Chinese to detect as Chinese submarines are for the United States to detect. Hence, by trading some of the Tomahawk LACMs carried by *Virginia*-class submarines for ASBMs, the U.S. Navy would enable its submarines to attack PLAN surface forces effectively and in relative safety, despite its ASCM range deficiency. Furthermore, the U.S. Navy should strongly consider increasing the number of submarines that it operates in the Pacific theater.

Similarly, the U.S. Air Force should consider developing a more flexible forward-deployment plan for a Taiwan contingency. Although it would not be able to cancel out the threat from Chinese ballistic missiles, it could mitigate the threat through greater dispersal, camouflage, concealment, and use of decoys. Scattering small groups of aircraft among many airfields, increasing the spacing between parked aircraft, disguising large C4ISR aircraft, and deploying decoys would greatly reduce American losses to individual missile hits. It would also be essential to maintain as many aircraft in the air or on strip alert as possible.

Finally, a much greater role should be given to intercontinental bomber strikes. Although China's SAM network would make the cost of sending non-stealth B-52s and B-1s into Chinese airspace prohibitive, the nineteen available

B-2s could replace many forward-deployed ground-attack aircraft. One of the major developments that makes placing greater emphasis on a bomber force particularly appealing is the advent of 250-pound small-diameter bombs (SDBs), GBU-39, and from 2013, GBU-53.[97] The fielding of SDBs allows U.S. bombers to more than double their bomb loads without reducing the effectiveness of each individual bomb. Hence, whereas in the past the B-2 could carry at most eighty five-hundred-pound bombs, it can now carry at least 216 SDBs.[98] Capitalizing on its ability to carry dozens of highly specific advanced munitions or over two hundred SDBs, the B-2 bomber would be able to take out exponentially more enemy targets, with substantially fewer sorties, than was possible in any of the previous U.S. air campaigns. Moreover, unlike forward-deployed strike aircraft, it would be completely invulnerable to Chinese MRBMs and LACMs, as well as, in all likelihood, Chinese air defenses.

Nevertheless, giving intercontinental bomber strikes a greater role would not make forward-deployed aircraft any safer. Hence, the final consideration for war planning is developing an intercontinental strike capability that would prevent the need to base aircraft within the range of Chinese missiles at all. In the end, although ambitious, this concept would have many advantages and might be the only option for truly defeating China's missile-centric strategy. To construct this capability, the United States should maintain its commitment to developing and procuring in sufficient numbers a new stealth bomber currently slated for introduction in 2018.[99] Assuming that the 2018 bomber would, like the B-2, be able to carry 216 SDBs, a total stealth-bomber fleet of fifty (i.e., thirty-one 2018 airframes and the nineteen existing B-2s) could deliver 10,800 precision-guided bombs *in a single mission*.[100] Given the maximum fighter air-to-ground loadout of between six and nine precision-guided bombs, this would be equal to the maximum payload carried by between four and six *hundred* fighters flying three sorties each from forward operating bases.[101] However, unlike the forward-based fighters, the long-range bomber force would not require air superiority, fighter cover, in-theater operational or logistical support, or any forward infrastructure vulnerable to theater missiles at all. The bombers would take off from Hawaii, Alaska, or the continental United States, refuel over the western Pacific, deliver their ordnance, and return home, refueling over the Pacific once more, all within from twenty-four to thirty-six hours. This operations concept would simplify the air campaign; offer tremendous savings in time, material, and logistical support; render irrelevant China's tactical missile threat to U.S. aircraft operating in the theater; and allow for offensive action in as little as forty-eight hours after a warning order. Equipped with currently available and upcoming munitions for attacks against stationary and moving targets, the bomber fleet would be able to target not only China's C4ISR, airfields, and parked aircraft but moving PLAN surface combatants and landing craft, in conjunction with submarines and carrier groups.[102] Such a concerted air-surface campaign against Chinese efforts in the Taiwan Strait would largely deny China the use of its missiles to either deter or defeat the American intervention force.

Nevertheless, developing effective technology and operational concepts to offset the threat posed by Chinese missiles will take resources and considerable time. Meanwhile, by 2015, nearly all aspects of China's formidable missile-centric strategy, including ASBMs, will have matured. For some time into the future, then, the United States and Taiwan might be left staring at a wide-open window of vulnerability. However, the scope of this vulnerability should prompt Washington not to avoid or deny the problem or to attempt to address it with current technology ill suited to the task but to come up with innovative solutions. To put the risk in poignant context, as of the last day of 2010 the seven-year-old Iraq war had claimed the lives of 4,748 American personnel, taking a deep psychological toll of the military and society alike.[103] It is frightful to think that in an armed conflict with China a single saturation missile strike against a U.S. aircraft carrier, if it sank the ship, would claim nearly five thousand lives within hours. Whatever the American geopolitical interests or stakes for East Asian stability, until this possibility is effaced or at least greatly reduced, China's missile developments should remain of high interest to American security analysts, military officers, and policy makers alike.

NOTES

1. See Robert S. Ross, "The 1996 Taiwan Strait Crisis: Lessons for the United States, China, and Taiwan," *Security Dialogue* 27, no. 4 (December 1996); John Garver, *Face Off: China, the United States, and Taiwan's Democratization* (Seattle: Univ. of Washington Press, 1997); Andrew Scobell, "Show of Force: Chinese Soldiers, Statesmen, and the 1995–1996 Taiwan Strait Crisis," *Political Science Quarterly* 115, no. 2 (Summer 2000), pp. 227–46; and Suisheng Zhao, *Across the Taiwan Strait: Mainland China, Taiwan, and the 1995–1996 Crisis* (New York: Routledge, 2000).
2. See, for example, Robert S. Ross, "Comparative Deterrence: The Taiwan Strait and the Korean Peninsula," in *New Directions in the Study of China's Foreign Policy,* ed. Alastair Iain Johnston and Robert S. Ross (Stanford, Calif.: Stanford Univ. Press, 2006); and Richard C. Bush and Michael E. O'Hanlon, *A War like No Other: The Truth about China's Challenge to America* (Hoboken, N.J.: Wiley, 2007).
3. For prominent works in this approach, see Eric A. McVadon, *Recent Trends in China's Military Modernization,* testimony before the U.S.-China Economic and Security Review Commission, Washington, D.C., 109th Cong., 1st sess., 15 September 2005, and "China's Maturing Navy," *Naval War College Review* 59, no. 2 (Spring 2006); Cortez A. Cooper III, *Chinese Military Modernization: Informationization, Conventional Missiles, and China's Air and Naval Forces,* testimony before the U.S.-China Economic and Security Review Commission, Washington, D.C., 109th Cong., 2nd sess., 16 March 2006, p. 3; Ronald O'Rourke, *China Naval Modernization: Implications for U.S. Navy Capabilities —Background and Issues for Congress*

(Washington, D.C.: Congressional Research Service [hereafter CRS], 2 June 2006), pp. 35–36; Roger Cliff et al., *Entering the Dragon's Lair: Chinese Antiaccess Strategies and Their Implications for the United States* (Santa Monica, Calif.: RAND, 2007); Andrew S. Erickson and Michael S. Chase, "PLA Navy Modernization: Preparing for 'Informatized' War at Sea," *China Brief* 8, no. 5 (29 February 2008), www.jamestown.org; M. Taylor Fravel, "China's Search for Military Power," *Washington Quarterly* 31, no. 3 (Summer 2008), pp. 125–41; and Office of the Secretary of Defense [hereafter OSD], *Annual Report to Congress: Military Power of the People's Republic of China* (Washington, D.C.: 2010) [reports in this series hereafter cited as *Military Power of the PRC* (year)].

4. OSD, *Military Power of the PRC* (2005), pp. 15–16.
5. O'Rourke, *China Naval Modernization* (2006), pp. 35–36.
6. Fravel, "China's Search for Military Power," p. 131.
7. McVadon, "China's Maturing Navy," p. 92.
8. Cliff et al., *Entering the Dragon's Lair,* p. xiv.
9. Ibid., p. 17.
10. For "strategic and campaign superiority," Wang Houqing and Zhang Xingye, eds., *Zhanyi Xue* [The Science of Military Campaigns] (Beijing: National Defense Univ. Press, 2000), chap. 6, p. 3 [emphasis mine], available (selected chapters, trans. Alastair Iain Johnston) at www.people.fas.harvard.edu/. For "favorable conditions," ibid., p. 39 [emphasis original].
11. Wang and Zhang, *Science of Military Campaigns; China's National Defense in 2008* (Beijing: Information Office of the State Council of the People's Republic of China, January 2009); Yu Jixun, *The Science of Second Artillery Campaigns* (Beijing: PLA Press, 2004).
12. Mark A. Stokes, *China's Strategic Modernization: Implications for the United States* (Carlisle, Pa.: Strategic Studies Institute, 1999); McVadon, *Recent Trends in China's Military Modernization;* National Intelligence Council, *Foreign Missile Developments and the Ballistic Missile Threat to the United States through 2015* (Washington, D.C.: December 2005); O'Rourke, *China Naval Modernization* (2006), and *China Naval Modernization: Implications for U.S. Navy Capabilities—Background and Issues for Congress* (Washington, D.C.: CRS, 23 December 2009); Richard Fisher, Jr., *New Chinese Missiles Target the Greater Asian Region* (Alexandria, Va.: International Assessment and Strategy Center, 24 July 2007); Wendell Minnick, "China Developing Anti-ship Ballistic Missiles," *Defense News,* 14 January 2008.
13. Duncan Lennox, ed., *Jane's Strategic Weapon Systems,* 51st ed. (Coulsdon, Surrey, U.K.: Jane's Information Group, 2010), s.v. "DF-21 (CSS-5)." The CEP is the distance from the target within which 50 percent of the weapons will hit. For a technical discussion of weapon-accuracy calculation, see Morris Drells, *Weaponeering: Conventional Weapons System Effectiveness* (Reston, Va.: U.S. Institute for Aeronautics and Astronautics, 2004), pp. 70–93.
14. Lennox, ed., *Jane's Strategic Weapon Systems,* s.v. "DF-21 (CSS-5)."
15. For a useful article about dedicated EMP devices, see Carlo Kopp, "The Electromagnetic Bomb: A Weapon of Electrical Mass Destruction," GlobalSecurity.org.
16. OSD, *Military Power of the PRC* (2005), p. 45; ibid. (2007), p. 42; ibid. (2009), p. 66; Andrew Scobell and Larry Wortzel, eds., *China's Growing Military Power: Perspectives on Security, Ballistic Missiles, and Conventional Capabilities* (Carlisle, Pa.: Strategic Studies Institute, 2002).
17. Lennox, ed., *Jane's Strategic Weapon Systems,* s.v. "HN-1/2/3"; Robert Hewson, ed., *Jane's Air-Launched Weapons* (Coulsdon, Surrey, U.K.: Jane's Information Group, 2005); "Military: Chinese Missiles," GlobalSecurity.org; Geoffrey T. Lum, "China's Cruise Missile Programs," *Military Review* 84, no. 1 (January/February 2004), pp. 67–73.
18. James C. Mulvenon and Andrew N. D. Yang, *The People's Liberation Army as Organization: Reference Volume v1.0* (Santa Monica, Calif.: RAND, 2002), pp. 34–35.
19. O'Rourke, *China Naval Modernization* (2006), p. 37.
20. The data on missiles are from Lennox, ed., *Jane's Strategic Weapon Systems;* Stephen

Saunders, ed., *Jane's Fighting Ships,* 111th ed. (Coulsdon, Surrey, U.K.: Jane's Information Group, 2008–2009); "Military: Chinese Missiles"; Lum, "China's Cruise Missile Programs"; and David Tanks, *Assessing the Cruise Missile Puzzle: How Great a Defense Challenge?* (Cambridge, Mass.: Institute for Foreign Policy Analysis, October 2000).

21. Lennox, ed., Jane's *Strategic Weapon Systems;* Saunders, ed., *Jane's Fighting Ships;* James Hackett, ed., *The Military Balance 2010: The Annual Assessment of Global Military Capabilities and Defence Economics* (London: International Institute for Strategic Studies, 2010).

22. O'Rourke, *China Naval Modernization* (2006), p. 21, and *China Naval Modernization* (2009), p. 14.

23. Ibid.

24. Lennox, ed., *Jane's Strategic Weapon Systems,* s.v. "IAI Harpy."

25. Ibid., s.v. "Kh-31P." Its ability to attack airborne targets would be used to attack carriers' early-warning planes.

26. Marshall Hoyler, "China's 'Antiaccess' Ballistic Missiles and U.S. Active Defense," *Naval War College Review* 63, no. 4 (Autumn 2010); Andrew S. Erickson and David D. Yang, "Using the Land to Control the Sea? Chinese Analysts Consider the Antiship Ballistic Missile," *Naval War College Review* 62, no. 4 (Autumn 2009); Eric Hagt and Matthew Durnin, "China's Antiship Ballistic Missile: Developments and Missing Links," *Naval War College Review* 62, no. 4 (Autumn 2009); Mark A. Stokes, *China's Evolving Conventional Strategic Strike Capability* (Arlington, Va.: Project 2049 Institute, 14 September 2009).

27. Hoyler, "China's 'Antiaccess' Ballistic Missiles and U.S. Active Defense," pp. 88–89.

28. The "second island chain" extends from the Kurils to Indonesia, running through Japan and the Bonin, Mariana, and Caroline island groups. See, among many sources, "Military: People's Liberation Navy—Offshore Defense," GlobalSecurity.org.

29. See, for example, Alan J. Vick et al., *Aerospace Operations against Elusive Ground Targets* (Santa Monica, Calif.: RAND, 2001).

30. Steven Silvio Pietrobon, "Chinese Launch Record (1964–Present)," *Small World Communications;* "China Launches Military Satellites YaoGan Weixing-10," NASAspaceflight.com; "China Launches YaoGan Weixing-10, Press Forward with Lunar and Station Goals," NASAspaceflight.com. The systems include *YaoGan 1* through *YaoGan 8;* three separate satellites, *YaoGan 9A, 9B,* and *9C;* and finally *YaoGan 10* and *YaoGan 11. YaoGan 1* seems to be no longer functioning, bringing the total down to twelve; "Yaogan 1 Erupts," *Arms Control Wonk,* 11 February 2010.

31. "YaoGan Weixing/Remote Sensing Satellites," Sinodefence.com.

32. Pietrobon, "Chinese Launch Record"; Gu Xingfa and Yu Tao, "China Earth Observation Satellite Program: Future Systems for Agricultural Monitoring," *GEO: Group on Earth Observations,* www.earthobservations.org/; Hagt and Durnin, "China's Antiship Ballistic Missile," pp. 99–100; "Space: China," GlobalSecurity.org.

33. "Space: Tian Hui-1," GlobalSecurity.org.

34. "TianLian 1 Data Relay Satellite System," Sinodefence.com; Yan Liang, "China Blasts Off First Data Relay Satellite," Xinhua, 25 April 2008, xinhua.news.xinhuanet.com/.

35. Hagt and Durnin, "China's Antiship Ballistic Missile," pp. 100–101.

36. Ibid., pp. 101–102.

37. "Aircraft: Gaoxin Project," Sinodefence.com.

38. "Space: Feng Huo-1 [FH-1]," GlobalSecurity.org; Pietrobon, "Chinese Launch Record."

39. Hackett, ed., *Military Balance 2010.*

40. Ibid.

41. Saunders, ed., *Jane's Fighting Ships*, s.vv. "Luzhou Class (Type 051C) (DDGHM)," "Luyang II Class (Type 051C) (DDGHM)"; OSD, *Military Power of the PRC* (2009), p. 49.

42. "Kanwa: PRC Accelerates Anti-carrier Operations Studies," *Kanwa Defense Review,* 21 September 2005, www.kanwa.com/, available at Foreign Broadcast Information Service [hereafter FBIS] CPP 200509211477.1_de610a20583ab35d.

43. "BeiDou 1 Experimental Satellite Navigation System," Sinodefence.com.

44. "China Successfully Launches Fifth Satellite for Its Own Global Navigation Network," Xinhua, 1 August 2010.

45. "The Construction of BeiDou Navigation System Steps into Important Stage: 'Three Steps' Development Guideline Clear and Certain" [in Chinese], *China National Space Administration,* 19 May 2010, www.BeiDou.gov.cn/.

46. Hagt and Durnin, "China's Antiship Ballistic Missile," p. 103.

47. See U.S. Government Accountability Office [hereafter GAO], *Operation Desert Storm: Evaluation of the Air Campaign,* GAO/NSIAD-97-134 (Washington, D.C.: June 1997), p. 13; *Operation Allied Force,* RAND Research Brief RB-72-AF (Santa Monica, Calif.: RAND, 2006), available at www.rand.org/; and T. Michael Moseley [Gen., USAF], *Operation Iraqi Freedom: By the Numbers* (Shaw Air Force Base, S.C.: U.S. Air Force Central, 30 April 2003), p. 6, available at GlobalSecurity.org.

48. GAO, *Operation Desert Storm,* p. 13.

49. Christopher J. Bowie, *The Anti-access Threat and Theater Air Bases* (Washington, D.C.: Center for Strategic and Budgetary Assessments, 2002), pp. 16–18.

50. John Stillion and David T. Orletsky, *Airbase Vulnerability to Conventional Cruise-Missile and Ballistic-Missile Attacks* (Santa Monica, Calif.: RAND, 1999), p. 14. Although the model assumes a direct hit, since the lethal area is estimated to be nine hundred feet, or approximately 274 meters, in diameter, the missile can miss by a considerable margin and still be able to cover a large target set.

51. Ibid.

52. David A. Shlapak et al., *A Question of Balance: Political Context and Military Aspects of the China-Taiwan Dispute* (Santa Monica, Calif.: RAND, 2009), pp. 37–44.

53. China's known inventory of cluster munitions includes a 500 kg fuel-air-explosive cluster bomb with three HE submunitions, a 360 kg antirunway cluster bomb with sixteen penetrator submunitions, and a 340 kg antitank cluster bomb with 189 steel-ball submunitions; China country profile in Hewson, ed., *Jane's Air-Launched Weapons*. The 600 kg warhead used by the DF-21A/21B could be a larger version of the antitank bomb. More likely, since much less impact is needed to destroy soft targets like aircraft, the DF-21A/21B warhead could be an all-new design, encompassing a larger number of smaller munitions. Even so, the total number of submunitions is likely to be smaller than the 825 stipulated in Stillion and Orletsky's model. However, judging from previous experience the United States would be unlikely to fit more than thirty-four fighters on a single forward operating base (see Bowie, *Anti-access Threat and Theater Air Bases,* pp. 17–18), chances are that one or two Chinese MRBMs equipped with a submunition warhead would have the coverage to destroy them all.

54. Realistically, of course, the United States could keep a portion of its aircraft in the air at all times, but keeping all in the air would be logistically impossible. Also, it could put some aircraft on strip alert, but with MRBM flight times measured in minutes, only a few aircraft would be able to clear the parking ramps/runways before the missiles struck. Similarly, stacking the aircraft on the runway so as to generate sorties faster under alert would also concentrate them for easy strikes, as Egypt experienced in the 1967 Arab-Israeli War, especially if the incoming MRBMs or LACMs were undetected.

55. Shlapak et al., *Question of Balance,* pp. 37–41.

56. Stokes, *China's Evolving Conventional Strategic Strike Capability,* p. 33. It should be noted that because SRBMs would be vulnerable to PAC-3 interceptors, their use against protected sites would likely be preceded by MRBM or ARM strikes against PAC-3 radars.

57. "Military: Carrier Strike Group (CSG)," GlobalSecurity.org.

58. "Military: Exercises: Navy," GlobalSecurity.org.

59. Jiang Lei, *Modern Strategy for Using the Inferior to Defeat the Superior* (Beijing: National Defense Univ. Press, 1997), pp. 113–14.

60. For supplies, Li Qingshan, *The RMA and High-Technology War* (Beijing: Military Science Press, 1995), pp. 189–90.

61. Jiang, *Modern Strategy,* pp. 113–14.

62. See, for example, GAO, *Defense Acquisitions: Comprehensive Strategy Needed to Improve*

Ship Cruise Missile Defenses, GAO/NSIAD -00-149 (Washington, D.C.: July 2000); Thomas J. Christensen, "Posing Problems without Catching Up," *International Security* 25, no. 4 (Spring 2001), p. 30; Lum, "China's Cruise Missile Programs," p. 68; and James C. Mulvenon et al., *Chinese Responses to U.S. Military Transformation and Implications for the Department of Defense* (Santa Monica, Calif.: RAND, 2006), pp. 63–65.

63. Tanks, *Assessing the Cruise Missile Puzzle,* pp. 3–4.

64. See endnote 20.

65. Saunders, ed., *Jane's Fighting Ships*. It should also be noted that U.S. assets carry missile countermeasures, such as Nulka decoys; however, their use against a determined adversary with a large number of superior ASCMs would be neither effective nor sustainable, forcing the United States to attempt direct interception.

66. See, for example, Thomas Ehrhard and Robert Work, *Range, Persistence, Stealth, and Networking: The Case for a Carrier-Based Unmanned Combat Air System* (Washington, D.C.: Center for Strategic and Budgetary Assessments, 2008), p. 199; Lyle Goldstein and William Murray, "Undersea Dragons: China's Maturing Submarine Force,"*International Security* 28, no. 4 (Spring 2004), p. 193; McVadon, "China's Maturing Navy," pp. 96–98; and "Kanwa: PRC Accelerates Anti-carrier Operations Studies."

67. See entries for Chinese maritime aircraft such as the Su-30 MK2 and Q-5 in Paul Jackson, ed., *Jane's All the World's Aircraft,* 101th ed. (Coulsdon, Surrey, U.K.: Jane's Information Group, 2010–11).

68. Wang and Zhang, eds., *Science of Military Campaigns,* chap. 6, p. 18.

69. In a highly publicized event, Russian fighters flew over the *Kitty Hawk* battle group undetected on two separate occasions on 17 October 2000; on 9 November the same year two reconnaissance planes were able to do the same. "Russian Fighter Planes Said to Fly over *Kitty Hawk,*" Xinhua, 14 November 2000, available at FBIS CPP20001114000152.

70. See entries for the Kilo, Yuan, and Song classes, in Saunders, ed., *Jane's Fighting Ships.*

71. The PLAN's newer submarines incorporate modern technologies—such as sound-dampening tiles covering the hull, seven-bladed propellers, and either nuclear or diesel-electric propulsion—that make it unnecessary to snorkel periodically for air. Goldstein and Murray, "Undersea Dragons," pp. 166–68.

72. McVadon, *Recent Trends in China's Military Modernization,* p. 17. For assessments of China's submarine challenge, see Goldstein and Murray, "Undersea Dragons"; John J. Tkacik, Jr., *China's Submarine Challenge* (Washington, D.C.: Heritage Foundation, 1 March 2006), available at www.heritage.org/; Richard Fisher, Jr., "Trouble Below: China's Submarines Pose Regional, Strategic Challenges," *Armed Forces Journal,* 6 March 2006, available at www.strategycenter.net/; and Bernard D. Cole, "Beijing's Strategy of Sea Denial," *China Brief* 6, no. 23 (22 November 2006), www.jamestown.org/.

73. Hackett, ed., *Military Balance 2010.* This includes all destroyer classes, except the Luda, and the Jiangwei I/II and Jiangkai I/II frigate classes.

74. Saunders, ed., *Jane's Fighting Ships.*

75. O'Rourke, *China Naval Modernization* (2009), p. 14.

76. Hoyler, "China's 'Antiaccess' Ballistic Missiles and U.S. Active Defense," pp. 92–94.

77. Ibid., p. 93. See also Hagt and Durnin, "China's Antiship Ballistic Missile," p. 94.

78. Owen R. Cote, Jr., *The Future of the Trident Force: Enabling Access in Access-Constrained Environments* (Cambridge, Mass.: Center for International Studies, May 2002), p. 11.

79. "Military: U.S. Missiles," GlobalSecurity.org.

80. Ibid.; Lennox, ed., *Jane's Strategic Weapon Systems,* s.v. "SS-22-N Sunburn." Even if U.S. ships managed to come into firing range, Chinese ships would outgun their American counterparts by a factor of two. Each U.S. carrier group typically includes two cruisers and three destroyers, each equipped with eight Harpoons. Modern Chinese destroyers, however, tend to carry sixteen advanced ASCMs each. This means that in a one-on-one engagement, a Chinese ship could fire two missiles for every one the American ship

fired. In addition, Chinese surface combatants would have a considerable chance of intercepting Harpoons with close-in guns, which would not be true for U.S. surface combatants.

81. Lennox, ed., *Jane's Strategic Weapon Systems,* s.v. "YJ-91."

82. John Wilson Lewis and Xue Litai, *Imagined Enemies: China Prepares for Uncertain War* (Stanford, Calif.: Stanford Univ. Press, 2006), p. 124.

83. See Vick et al., *Aerospace Operations against Elusive Ground Targets,* app. II.

84. For a discussion of missile defenses in Asia, see Stokes, *China's Strategic Modernization;* Thomas J. Christensen, "Theater Missile Defense and Taiwan's Security," *Orbis* 44, no. 1 (Winter 2000), pp. 79–90; Kenneth W. Allen et al., *Theater Missile Defenses in the Asia-Pacific Region,* Working Group Report 34 (Washington, D.C.: Henry L. Stimson Center, June 2000); Michael D. Swaine and Loren H. Runyon, *Ballistic Missiles and Missile Defense in Asia,* NBR Analysis (Seattle, Wash.: National Bureau of Asian Research, June 2002); Scobell and Wortzel, eds., *China's Growing Military Power;* and Alan D. Rombert and Michael McDevitt, eds., *China and Missile Defense: Managing U.S.-PRC Strategic Relations* (Washington, D.C.: Henry L. Stimson Center, 2003).

85. Scobell and Wortzel, eds., *China's Growing Military Power,* p. 119.

86. For THAAD, ibid., p. 123.

87. National Intelligence Council, *Foreign Missile Developments,* p. 83; Lisbeth Gronlund et al., *Technical Realities: An Analysis of the 2004 Deployment of a U.S. National Defense System* (Cambridge, Mass.: Union of Concerned Scientists, May 2004), p. 36. Decoys are a problem exclusive to the midcourse stage. Because there is no gravity or air resistance in space, decoys released by missiles can travel at the same velocity as the warhead. Since even simple decoys, like steel balloons, are difficult to distinguish from the warhead, missile defenses might need to target every individual object in a given cluster to ensure the warhead's destruction. This means using a disproportionately large number of interceptors.

88. Scobell and Wortzel, eds., *China's Growing Military Power,* p. 97.

89. Ronald O'Rourke, *Sea-Based Ballistic Missile Defense: Background and Issues for Congress* (Washington, D.C.: 22 December 2009), p. 6.

90. Ibid., summary.

91. Gronlund et al., *Technical Realities,* pp. x–xii.

92. Lennox, ed., *Jane's Strategic Weapon Systems,* s.v. "Patriot PAC-3."

93. For MaRV warheads, however, the reentry speed would need to be tempered, perhaps with retro-rockets, to allow the terminal seekers to function properly.

94. For a recent assessment see Thomas J. Culora, "The Strategic Implications of Obscurants: History and the Future," *Naval War College Review* 63, no. 3 (Summer 2010), pp. 73–84.

95. See "Electromagnetic Rail Gun," *Office of Naval Research,* www.onr.navy.mil/.

96. The Russian Shipwreck missile is believed to have a range of at least 550 km (possibly up to 625 km), inertial guidance with command update, and active-radar/IR and antiradar homing; "Military: P-700 3M-45 Granat/SS-N-19 Shipwreck," GlobalSecurity.org.

97. "Military: Systems—GBU-39 Small Diameter Bomb/Small Smart Bomb," GlobalSecurity.org. So far, the GBU-39 has been fielded on the F-15E Strike Eagle. The weapon will also be fielded on the F-16, F-22, and F-35 fighters and B-52, B-1, and B-2 bombers. "U.S. Air Force Selects Raytheon's GBU-53/B for Small Diameter Bomb II Program," *Raytheon,* www.raytheon.com/; "Department of Defense Announces Selected Acquisition Reports," News Release 1050-10, *U.S. Department of Defense,* 15 November 2010, www.defense.gov/.

98. "WMD: B-2 Spirit," GlobalSecurity.org. In the past, the B-2 maximum bomb load consisted of eighty Mk-82 gravity bombs. Modifications currently under way will allow each B-2 to carry eighty five-hundred-pound GBU-38 Joint Direct Attack Munitions. Most sources quote 216 as the likely number of SDBs that would be carried by the B-2.

99. Bruce Rolfsen, "Leader Says Future Bomber Won't Go Solo," *Air Force Times,* 18 October 2010; Michael Donley [Secretary of the Air

Force], "State of the Air Force: 2010" (remarks at the Air Force Association Conference and Technology Exposition, National Harbor Center at Oxon Hill, Md., 13 September 2010), available at www.af.mil/.

100. By comparison, twenty-three thousand munitions were dropped in the entire DESERT STORM campaign and twenty-eight thousand in Operation IRAQI FREEDOM. Realistically, of course, because the bombers would be carrying heavier, specialized munitions in addition to or instead of the SDBs, the total number delivered in each sortie would be lower. For the B-2's GBU-39 loadout, Jackson, ed., *Jane's All the World's Aircraft.*

101. With air-to-ground loadout, American fighters can carry a maximum of six to eight precision-guided bombs, such as the five-hundred-pound GBU-12. Fighters can also carry two GBU-39 carriages, or eight bombs in total. See ibid., s.vv. "Boeing F/A-18 Super Hornet," "Boeing F-15E Eagle," "Lockheed Martin F-16 Fighting Falcon," "Lockheed Martin (645) F-22 Raptor," and "Lockheed Martin F-35 Lightning II." For a source listing and diagramming all loadout configurations used on the F-15E in each of the recent operations, see *F-15E Info,* www.f-15e.info/.

102. Importantly, the extent to which intercontinental bombers should supplement or supplant carriers for land or surface attacks in a militarized conflict with China would depend on how much the United States can reduce the vulnerability of carriers to Chinese missiles. If their vulnerability remains acute, the United States might find their introduction into the theater at all too risky. If this be the case, it is important for U.S. planning not only to attempt to reduce vulnerability but also to invest in multiple options for antisurface warfare, lest the United States find itself without a viable antisurface capability in a potential war with China.

103. "Iraq Coalition Military Fatalities," iCasualties.org.

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