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WHILE WE CAN

Arresting the Erosion of America's Military Edge

By Shawn Brimley

Foreword by Michèle Flournoy and William J. Lynn III

Center for a New American Security

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The views expressed in this report are mine alone. I am solely responsible for any errors in fact, analysis, or omission.

Cover photo: U.S. Marine Corps Corporal Daniel Hopping, an assaultman with Weapons Company, 1st Battalion, 7th Marine Regiment, shields himself from dust kicked up from a CH-53E Super Stallion helicopter lifting off April 28, 2014, during a mission in Helmand province, Afghanistan. The company's mission was to disrupt Taliban forces in Larr village and establish a presence in the area. (DoD photo by Cpl. Joseph Scanlan, U.S. Marine Corps)

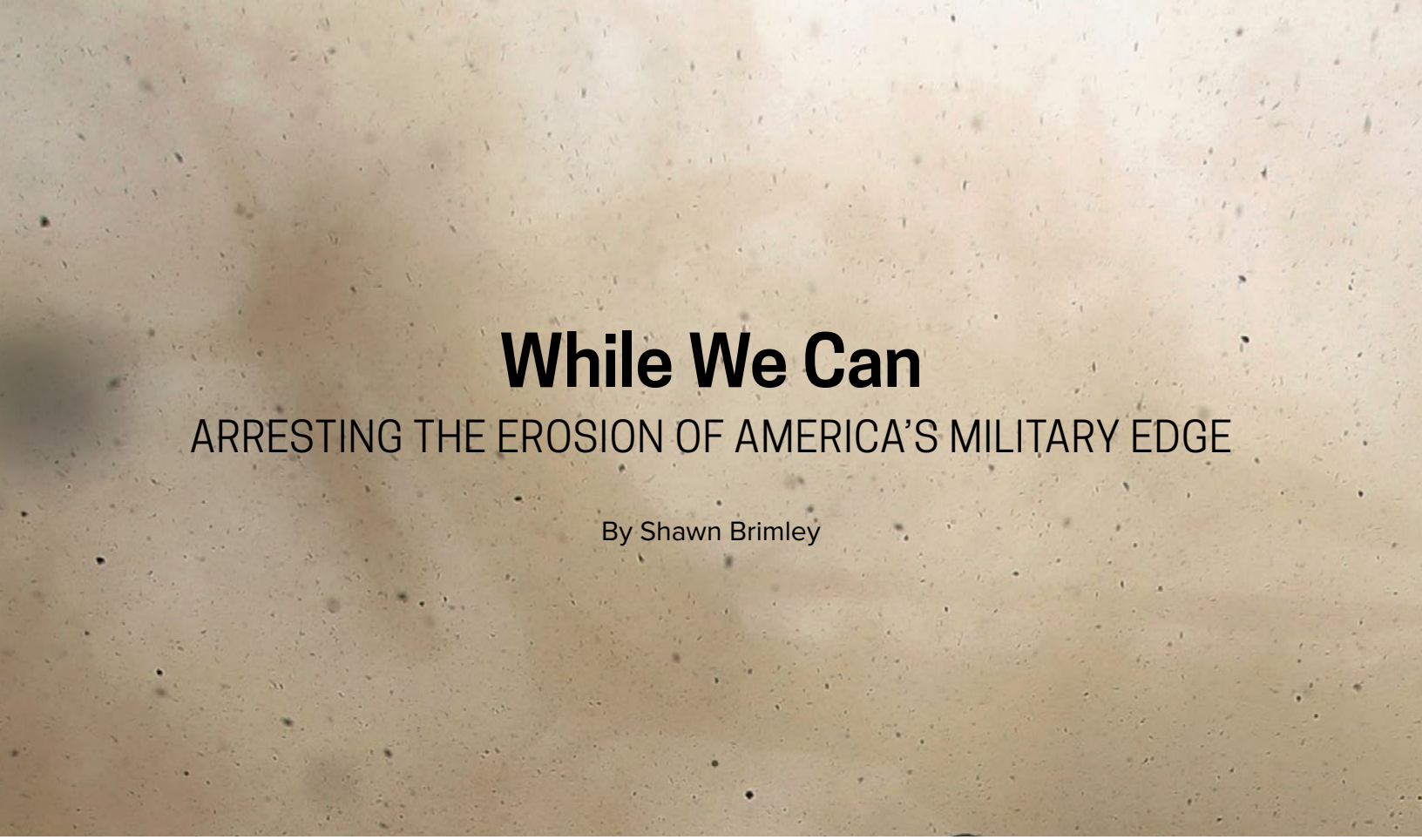

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TABLE OF CONTENTS

A Joint Terminal Attack Controller controls an HC-130J Combat King II from the 81st Expeditionary Rescue Squadron at Grand Bara, Djibouti, in October 2015. (U.S. Air Force, 1st Lieutenant Allie Delury)

Foreword

By Michèle Flournoy and William J. Lynn III

The United States military is losing its hard-won technological advantage. The military technologies that, in the hands of the United States and its allies, helped win the Cold War are now rapidly proliferating around the world. Today adversaries, state or non-state, can employ sophisticated military technologies such as GPS, drones, and guided weapons to attack U.S. military forces, partners, and allies.

America's military strategy depends on maintaining a qualitative advantage. The size and global posture of our military are also critically important, but our technological edge cannot be allowed to dull further without significant risk.

We are heartened that Secretary of Defense Ashton Carter and Deputy Secretary Robert Work are leading the Pentagon through a series of reviews and efforts to develop and implement a broad defense innovation agenda. At the heart of this agenda is the so-called "third offset strategy," designed to ensure a defense investment portfolio that can obviate decades of parallel investments by adversaries in key military technologies — guided weapons and their associated command and control networks in particular.

We also note the strong bipartisan consensus that exists on this issue. The 2014 report of the bipartisan National Defense Panel concluded: "In this rapidly changing environment, U.S. military superiority is not a given; maintaining the operational and technological edge of our armed forces requires sustained and targeted investment."

Reestablishing a military-technical edge will take time. Even when achieved, the Pentagon must also compress its innovation cycle to compete with more technologically advanced competitors than America has faced in generations.

To this end, we endorse the goal of this report, which aims to bring clarity to the debate about the role of technology and innovation in sustaining U.S. military power. Most importantly, we endorse the report's recommendations to connect strategy to action, to reward experimentation and innovation, and to ensure strong civilian leadership in developing a U.S. military that can maintain a strong competitive advantage in a complex and dangerous world.

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The Ongoing Disruption in Military Affairs

America's armed forces are the most highly trained, best equipped, and most experienced in the world, but the margin of their battlefield superiority is eroding. Whether our armed forces and international allies and partners are a determined dictatorship fighting for its existence, a rising power determined to flex its military power, or a former great power doggedly refusing to cede influence in its near abroad, beneath those headlines is a consistent trend that powerfully influences the nature global security competitions. That trend is the slow but steady erosion of America's military-technical superiority, which U.S. policymakers have come to assume and our core allies depend on for their own security. Unless that trend is arrested, America's armed forces will find it more difficult to prevail in future conflicts.

Modern American military strategy depends on technological superiority. This was a consistent pillar of strategy during the Cold War, the subsequent interwar years, and the wars of the post-9/11 era. American presidents are rightfully loath to send military personnel into the fray without a clear qualitative edge. What was once an element of deliberate strategy has, over the course of decades, evolved into a presumption of technological superiority.

This presumption stems from nearly thirty years of the United States enjoying an unrivaled military-technical edge in conventional weapons. This edge was carefully honed by the adroit use of defense-directed research and development spending, especially during the twilight years of the late Cold War. This military-technical strategy – now referred to as an "offset strategy" – spurred a revolution in military affairs and then a broader societal shift that thrust the world headlong into the information age. That underlying investment portfolio bequeathed advanced computer networking or what became the Internet; the global positioning constellation of satellites; stealth technologies; advanced intelligence, surveillance, and reconnaissance (ISR) platforms; and precision guided munitions or "smart weapons." The resulting U.S. monopoly on precision munitions and the efficient means of their delivery is among the reasons the United States stood alone and triumphant at the end of the Cold War and has enjoyed unrivaled military superiority in the decades that followed.

But as today's Pentagon leaders are conveying with some urgency, this critical military-technical advantage is eroding, and the United States can no longer rest its defense strategy on the confidence that it enjoys a qualitative military edge against its potential future adversaries.[1] That the United States can no longer base its military planning on its presumed technological superiority is a seismic disruption in military affairs––one not yet fully grasped by many in the defense community.

THE UNITED STATES CAN NO LONGER REST ITS DEFENSE STRATEGY ON THE CONFIDENCE THAT IT ENJOYS A QUALITATIVE MILITARY EDGE AGAINST ITS POTENTIAL FUTURE ADVERSARIES.

American military-technical superiority is eroding because the technologies that underwrote that position have now proliferated widely through the international system. The United States must face advanced integrated air defense systems, stealth technologies, and, most problematically, precision guided munitions. The same technologies on which U.S. forces enjoyed a monopoly for decades are now central to the defense strategies of their opponents. This is *terra* incognita to U.S. defense planners, now several generations removed from their predecessors who worked under the daily threat of a near-peer competitor with global military reach.

While Pentagon leaders deserve credit for drawing attention to this challenge, there remains confusion throughout the defense community as to what is causing the loss of America's military-technical edge and what exactly ought to be done to correct it. Discussions about the Pentagon's "Third Offset Strategy," the focus of this paper, are sometimes conflated with related efforts such as the "De-

fense Innovation Initiative" (DII); the "Long-Range Research and Development Plan" (LRRDP); or the Pentagon's new office in Silicon Valley called the "Defense Innovation Unit – Experimental" (DIUx).

This paper attempts to provide a reasonably concise explanation of the basis of the need to reverse the decline of America's military-technical superiority. It outlines a strategy to ensure that the U.S. armed forces can reestablish qualitative military superiority before it becomes irretrievable. The paper consists of four parts. First, it describes the emerging security environment and how it will shape tomorrow's battlefields; second, it reviews U.S. defense strategy and how former Pentagon leaders dealt with past military-technical competitions; third, it outlines the nature of the upcoming challenges; and fourth, it offers a framework for how policymakers can pursue a coherent military-technical superiority strategy.

Security Trends and the Changing Operational Environment

The erosion of America's military-technical edge is exacerbated by two overarching trends that are driving the emerging security environment and powerfully shaping U.S. defense strategy and planning: the *velocity of geopolitical change* and the *accelerating diffusion of military power*.

The velocity of geopolitical change could very well be unprecedented in the modern era. Several trends here are worth highlighting. First is the erosion of state power, exemplified by the collapse of Arab regimes, and its ramifications throughout the Middle East and Europe. Second is the return of great-power politics, with the rise of China as a global maritime power and the resurgence of Russian determination to maintain continental influence in its near abroad. Third is the rapidly changing geopolitics of energy, as the shale oil revolution positions North America to be a net energy-exporter by the end of the decade. Any one of these trends would alone be sufficient to cause significant disruption in global affairs. That all three are occurring simultaneously will greatly complicate U.S. statecraft and the formulation of a cohesive national security strategy.[2]

These trends are exacerbated by the accelerating diffusion of military power.[3] The very forces unleashed by the Pentagon's Cold War–era research into advanced computer networking helped spur a commercial revolution that thrust the world into the information age. This in turn accelerated the diffusion of military power by lowering entry barriers that had previously prevented other state and non-state actors from acquiring advanced military technology.[4] We are now living in a world where a non-state actor can acquire sophisticated unmanned weapon systems; use GPS to increase the accuracy of munitions; and make use of cloud computing and social networking to assemble sophisticated communications systems.[5]

These ongoing geopolitical trends and diffusion of military power raise the risks of strategic surprise and the resulting consequences. The pace of these changes presents increasingly difficult challenges to defense planners and strategists.

Contours of the Operational Environment

The forces described above will shape what defense planners call the "operational environment" – the space within which military forces will compete with one another in peacetime and within which they would engage in violent action if asked to do so. Assessments of the likely operational environment must inform choices by military leaders as they set priorities for the creation, training, equipping, readiness, and geographic posture of military forces.

The likely security environment outlined above and insights derived from assessments of recent conflicts suggests three trends that will directly shape the battlefields on which future U.S. military forces will fight: the proliferation of precision munitions; the expanding size of battlefields; and adversaries' increasing ability to find and target opposing military forces.

First, precision munitions will dominate battlefields. The United States held a near-monopoly on the use of precision-guided munitions since they were introduced at scale during the 1991 Gulf War.[6] Precision munitions enable military forces to hit targets with near-zero chance of miss; in other words, accuracy

Rami Zayat/Reuters

A rebel fighter of "Al-Sultan Murad" brigade fires an anti-tank missile towards forces loyal to Syria's President Bashar al-Assad near Aleppo's international airport May 9, 2015.

becomes independent of range. The introduction of precision munitions caused a revolutionary change in warfare that is accelerating throughout the international system. Nearly any actor who desires to can employ precision munitions effectively on the battlefield. Defense analysts refer to this dynamic as the ongoing maturation of the precision strike warfare regime.[7] As retired Lieutenant General George Flynn, U.S. Marine Corps, has noted, "the prospect of even non-state actors being able to hit more or less everything they aim at with precision guided mortars, artillery, and short-range rockets is not only worrisome, but unavoidable as relatively inexpensive guided weaponry proliferates world wide."[8] Pentagon planners must now assume that any future adversary will employ precision munitions against U.S. forces.

Second, the size of the battlefield will expand. The proliferation of precision munitions and the battle networks that support them are increasing the effective range of military units. The introduction of guided munitions at all levels of operation will mean that military units can hit what they can see and that they will be able to do so from farther and farther away. U.S. forces have had to deal with the proliferation of precision munitions in the air and maritime domain for some time, but it will pose increasingly serious challenges for ground forces as well. The introduction of precision-guided rockets, artillery, mortars, and even bullets will make ground combat far more lethal: forces' ability to maneuver and to use terrain features to shield themselves from enemy fire will become much harder when the adversary has precision munitions and supporting battle networks. This dynamic will increase the ranges at which opposing forces first engage in violent action across all operating domains.

Third, concealing military forces will be more difficult. More actors are developing sophisticated intelligence, surveillance, and reconnaissance (ISR) capabilities to find and target their adversaries. Capabilities such as space-based surveillance, networked multi-static radars, surveillance drones, and the effective use of cloud computing, commercial imagery services, and real-time analysis of social media are making it harder to conceal military forces and their movements from adversaries who are determined to find them. On future battlefields, finding the enemy will be easier than hiding.[9] Moreover, these characteristics will make future conflicts far more lethal to all combatants.

These trends are distinct in nature, and will interact with one another in different ways in different theaters and domains: air, ground, maritime, or space.[10] The characteristics of the future operating environment – precision munitions, over larger areas, and more transparent battlefields – will require new approaches for force development, military posture, and concepts of operation.

The Erosion of America's Military Edge and its Challenges

Even a cursory glance at recent newspaper headlines suggests that U.S. defense strategy requires significant modifications. For instance, the caution with which U.S. policymakers have responded to China's unilateral island-building activity in contested areas of the South China Sea is partly due to the fact that Chinese military capabilities have become much more threatening to U.S. military forces than at any time in the past. In March 1996, for example, when China conducted live-fire military exercises and missile tests off the coast of Taiwan, the United States dispatched two aircraft carrier strike groups into the mouth of the Taiwan strait

ON FUTURE BATTLEFIELDS, FINDING THE ENEMY WILL BE EASIER THAN HIDING.

in a significant show of force and resolve.[11] At that time, the United States could do so at relatively low levels of risk, given the immaturity of China's air and naval forces. Now, however, after nearly two decades of investment into modernizing its military forces, China has integrated air defense systems and precision-guided anti-ship ballistic and cruise missiles that could pose serious threats to U.S. air and naval forces. The relative superiority of America's military posture in the Asia-Pacific is now much less pronounced, and thus even traditional displays of military power, such as assertions of freedom of navigation through international waters, have become more complex and potentially dangerous. Through patient and deeply strategic military investments, Beijing has made significant progress in eroding America's military-technical edge in the

AP Photo/ Russian Defense Ministry Press Service

Russian navy ships launch cruise missiles at targets in Syria from the Caspian Sea on November 20, 2015, according to information released by the Russian Defense Ministry.

Asia-Pacific.[12] This dynamic has worrisome implications for regional stability, particularly given the rising military tensions between China and key U.S. allies in the region, including Japan and the Philippines.

The dynamics that are shaping current military competitions in the Asia-Pacific region are also becoming increasingly apparent in other theatres. Russia's aggression in Crimea and eastern Ukraine and its operations in Syria were facilitated by its ability to construct what NATO commander General Philip Breedlove has called "anti-access bubbles" in these areas.[13] The rapid deployment of integrated air defense systems – radars, surface-to-air missiles, and modular ISR architectures – gave Russia the freedom of action in Crimea, at least, to engage in ground operations to take and hold territory. And in eastern Ukraine and Syria, Russia's rapid creation of "no-go" airspace helped to buttress Russia's partners and to increase deterrence against other actors, including the United States and NATO. Russia's recent strikes against targets in Syria by cruise missiles launched from naval vessels far away in the Caspian Sea further demonstrate the ability of America's competitors to employ advanced military technologies heretofore available only to the United States.

It is not only major military competitors such as China and Russia who have made great strides into the guided-munitions warfighting regime: now almost any state or non-state actor could employ them in some way. For instance, Hezbollah employed guided anti-armor and anti-ship munitions to notable effect during the 2006 war with Israel.[14] Currently, U.S.-supported rebel groups in Syria reportedly employ similar weapons against Assad's military forces. There is every reason to expect that any future military actor, state or non-state, will employ advanced anti-armor, anti-ship, and anti-air munitions. This will present great challenges if U.S. forces are asked to engage in sustained military operations against an adversary with access to these types of weapons. Recent large-scale conventional operations in Iraq and Afghanistan may turn out to be among the last sustained U.S. engagements against adversaries not fully able to employ guided munitions and supporting battle networks.

This diffusion of military power is problematic for U.S. defense strategy. The U.S. loss of its near-monopoly on the employment of guided munitions on the battlefield will be a defining feature of the future operating environment for U.S. forces. However, one must not overstate the case: the United States is still the most capable military actor in the international system and will remain so for the foreseeable future, even if levels of defense spending remain constrained as in recent years. The erosion of America's military edge does not mean U.S. forces will be unable to fight and win the nation's wars, but it does indicate that battlefield victories will come at greater cost and risk in blood and treasure.

THE U.S. LOSS OF ITS NEAR-MONOPOLY ON THE EMPLOYMENT OF GUIDED MUNITIONS ON THE BATTLEFIELD WILL BE A DEFINING FEATURE OF THE FUTURE OPERATING ENVIRONMENT FOR U.S. FORCES.

The Guided Munitions Revolution and Cold War Defense Strategy

This is not the first time the Pentagon has successfully navigated dramatic disruptions in military affairs. America embraced nuclear weapons technology in the early years of the Cold War and made a decisive move to guided weapons in the 1970s. Understanding these two notable cases of technological change can help conceptualize the new challenges to U.S. military strategy and guide elements of the U.S. response. To understand both of these cases, it is first necessary to explain why the shift to guided weapons warfare was so fundamental.

Technological Changes in Warfare

Nearly all of human history could be termed the era of unguided warfare: military competitions were basically contests over who could be most lethal over the longest distances. Whether it was stones, spears, or arrows that were flung at the adversary, or cannons, bullets, rockets, or bombs, military competitions throughout history turned on competitors' relative success at what Michael Vickers has called a "quest for reach."[15]

The fundamental characteristic of combat using unguided munitions was that, even over relatively short engagement ranges, most munitions – thrown, shot, fired, launched, or dropped – missed their targets.[16] Accuracy decreased as the range to target increased. To maximize success, commanders often sought to aggregate their forces together in order to achieve superiority in numbers at the point of attack and thus to increase the effectiveness of their bombardments. As a result, war with unguided weapons has an inherent bias toward mass. This has been true in the ground, air, and maritime domains.[17]

During World War II, two new alternatives to unguided weapons warfare presented themselves, both with potentially revolutionary effects. The one with the most immediate and powerful impact was the atomic bomb – a weapon that, even with relatively large aiming errors, delivered enough explosive power to destroy all but the most hardened targets. As the nuclear revolution took hold in the late 1940s, military planners assumed that they would have to disperse their forces for survivability, could mass only when necessary to achieve effects, and must then quickly disperse them again before they were vulnerable to atomic strike. The command and control challenges associated with continually dispersing, massing, and re-dispersing forces under the threat of atomic attack vexed military planners throughout the 1950s.[18] Consequently, once the United States and Soviet Union achieved nuclear parity and the likelihood of tactical nuclear warfare faded, military planners generally reverted to the massed conventional tactics familiar throughout the unguided weapons era.

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The second new alternative to unguided weapons warfare came in the form of guided conventional weapons – weapons that, after being fired, released, or launched, actively corrected their trajectories and flight paths to home in on their targets.[19] Guided weapons have a long history: they were first used in combat in 1943, when German submarines launched passive acoustic homing torpedoes against two allied convoys and sank several merchant ships. In May 1943, U.S. Navy patrol aircraft used acoustic homing torpedoes to score the first U-boat kill. In September 1943, German bombers used six "Fritz X" radio-controlled guided glide bombs to sink the Italian battleship *Roma*.[20] These early weapons proved that even singly or in small salvos, guided munitions could often achieve direct hits. Moreover, guided weapons had the same accuracy whether fired at their minimum or maximum engagement ranges. In other words, the conventional guided munitions of the 1940s had introduced a new combat engagement paradigm: weapons accuracy independent of range.

Having munitions able to correct for aiming errors and reduce miss distances to near zero even across great engagement ranges sparked additional tech-

nological adaptation. Since having an advantage in reach over an adversary is useful in almost any combat situation and operating domain, soon after the first guided weapons appeared, commanders naturally sought munitions with greater and greater maximum effective ranges.[21] As these long-distance engagements required innovations in cueing and aiming, this spurred the development of new battle networks for sensing, tracking, and targeting to direct long-range salvos of guided munitions.[22]

Developing battle networks that could effectively direct the sustained employment of guided munitions at the theatre level took time, and thus it took decades for guided munitions to spark a true revolution in military affairs. While they were employed in important ways during the Vietnam War and in the 1973 Yom Kippur war between Israel and its Arab neighbors, it was not until the 1991 Gulf War that U.S. forces employed guided munitions across an operating theatre as a centerpiece of a major military campaign.[23]

Offset Strategies during the Cold War

The last 65 years of U.S. national security history were significantly shaped by the defense strategies employed by the Pentagon to counter the Soviet Union – what defense analysts have begun to refer to as the "first and second offset strategies."[24] In both cases the United States developed asymmetric responses to counter or offset advantages the Soviet Union enjoyed as a continental Eurasian power relying on massive numbers of conventional military forces, by some measures outnumbering the west three-to-one. These strategies made use of the two technological innovations described above: first, nuclear weapons, and later, guided weapons.

The First Offset Strategy: Emphasis on Nuclear Weapons

As relations with the Soviet Union deteriorated in the years following of World War II, the United States faced a dilemma. The Soviet Union had massive numbers of ground forces available for combat in the European theatre. The Central Intelligence Agenda estimated at that time that the Soviets had 175 active army divisions and could mobilize another 125-145 reserve divisions within a month. The United States had roughly 29 division equivalents between the Army and Marine Corps.[25] Thus, the United States needed a way to counterbalance its significant quantitative disadvantage in order to convince its European allies and partners and also the Soviet Union that America's security commitments could plausibly be defended. The strategy debate in Washington concerned how best to establish a degree of deterrence that could constrain what George Kennan's famous "long telegram" called the Soviet Union's "expansionist tendencies."[26]

During this period, roughly from 1945 to 1955, the United States enjoyed a substantial advantage in nuclear weapons, the long-range bombers capable of delivering them, and a network of bases that could be employed to support nuclear operations against the Soviet Union. So the debate about how best to address the growing Soviet threat centered on whether to root America's defense strategy in a contest of conventional military forces, or instead to

(National Nuclear Security Administration/Nevada Field Office

A 15-kiloton nuclear shell was fired on May 25, 1953, at the Nevada Test Site by a 280mm artillery gun. This was the only time a nuclear artillery shell was ever fired. This was during a period in which the U.S. military planned to use tactical nuclear weapons to enable ground maneuver against the Soviet Union.

attempt to maintain and enhance a nuclear warfighting strategy that would offset the Soviet Union's quantitative advantage.

Upon entering office in January 1953, President Dwight Eisenhower was not convinced that the massive conventional military buildup recommended by the departing Truman administration was wise. He appears to have had two reasons. The first was likely his military experience: "While some of our allies were compelled to throw up a wall of flesh and blood as their chief defense against the aggressor's onslaught," Eisenhower said after World War II, "we were able to use machines and technology to save lives."[27] Second, Eisenhower believed that the strength of America's economy was just as important in contesting Moscow's global challenge, and he was concerned about the economic implications of sustained massive defense spending. Consequently, in December 1953, Eisenhower declared that: "Since we cannot keep the United States an armed camp or garrison state, we must make plans to use the atom bomb if we become involved in a war."[28]

Thus did the Eisenhower administration move to what it called the "New Look" strategy, designed to offset the Soviet Union's conventional military advantages by maintaining and advancing U.S. advantages in the design, production, basing, and employment of nuclear weapons. This strategy was coupled with a declaratory policy asserting that the United States would make no distinction between conventional and atomic weapons, which became known as the doctrine of massive retaliation.[29]

Eisenhower's New Look – the first "offset" strategy – helped, at least for a time, to offset Soviet advantages in conventional military power. By leveraging existing advantages in atomic weapons, long-range air power, and ballistic missiles, the United States was able to establish a nuclear umbrella over its allies and interests, while also bringing defense spending to more manageable levels by drawing down conventional forces from their wartime levels.[30]

The Second Offset Strategy: Development of Guided Munitions

Problems with the Eisenhower-era "New Look" strategy had become apparent by the early 1960s, leading the Kennedy administration to search for alternatives. Chief among them was the Soviet Union's progress in matching U.S. nuclear capabilities, including the quality of nuclear weapons, intercontinental bombers, and intercontinental ballistic missiles (ICBMs). The ability of the United States to deter conventional conflict became, as a result, increasingly uncertain. The resulting Kennedy-era strategy of "flexible response" preserved the goal of nuclear warfighting superiority while it conceded the need to build up conventional military forces based in Europe.

By the mid-to-late 1970s, America's qualitative edge in nuclear weapons and their means of delivery was diminished by the growing size of the Soviet nuclear arsenal and the modernization of its conventional military forces. Across the board, the Soviet Union and its Warsaw Pact allies appeared to be approaching parity in every key measure of military capability upon which the United States and NATO had once depended to offset Moscow's quantitative advantage in conventional military forces.

The Pentagon began an urgent effort to identify new ways in which it could re-establish a qualitative military edge to offset the Soviet quantitative military advantage. Secretary of Defense Harold Brown and his Under Secretary of Defense for Research and Engineering, William J. Perry, explicitly sought a military-technical strategy that could offset Soviet numerical advantages. Reflecting on these years, Secretary Perry described their logic in the following way:

> By the mid-1970s, NATO and the United States were looking at a Soviet Union with parity in nuclear weapons and about a 3-fold advantage in conventional weapons. Many in the United States began to fear then that this development threatened deterrence. So, we looked for some strategy to restore the conventional military balance. This effort was led by then-U.S. Secretary of Defense, Harold Brown. … His approach was to develop high-technology systems that could give

Luc Novovitch/Reuters

Defense Secretary William Perry briefs reporters on September 3, 1996. As Undersecretary of Defense for Research and Engineering from 1977 to 1981, Perry played a major role in shaping a defense-technology strategy aimed at offsetting Soviet numerical advantages.

> our military forces a qualitative advantage able to offset the quantitative advantage of the Soviet forces. Not surprisingly, this approach was called the Offset Strategy.[31]

The offset strategy focused on four "baskets" of military-technology: the fielding of improved guided munitions; new intelligence, surveillance, and reconnaissance (ISR) platforms; the introduction of stealth aircraft; and the use of space-based systems for advanced communications, navigation, and ISR.[32] The latter three comprised the battle networks that supported guided munitions and the platforms that delivered them. Through an aggressive series of experiments and demonstrations, combined with the development of new operational concepts, the Pentagon developed a new and disruptive way to wage war that, again, centered on a qualitative military edge.

THE UNITED STATES THUS LEVERAGED ITS TECHNICAL PROWESS TO DEVELOP A WAY TO OFFSET THE SOVIET UNION'S QUANTITATIVE MILITARY ADVANTAGE; AS A RESULT, THE BASIC STRUCTURE OF THE ENTIRE COLD WAR MILITARY COMPETITION TILTED BACK TOWARD THE UNITED STATES AND ITS NATO ALLIES.

Soviet military leaders understood – sooner than their U.S. counterparts – that their entire operational concept of overwhelming NATO forces with sheer mass would no longer be effective against the emerging American lead in fielding guided weapons.[33] By the mid-1980s, Soviet military theorists had concluded that what they called the emerging U.S.

"reconnaissance-strike complexes" would be able to achieve destructive effects on a scale similar to those of tactical nuclear weapons.

The United States thus leveraged its technical prowess to develop a way to offset the Soviet Union's quantitative military advantage; as a result, the basic structure of the entire Cold War military competition tilted back toward the United States and its NATO allies. Through a coherent investment strategy, these developments were integrated into military strategy and planning. They ultimately provided the operational backbone for the U.S. power-projection capabilities shown to the world during the 1991 Gulf War. Even though guided munitions represented less than 10 percent of all American munitions expended during the war, they demonstrated astounding accuracy and battlefield effectiveness. It appeared that, in future large force-on-force engagements, the new guided-weapon battle networks could dominate unguided weapons warfare. Operation Desert Storm was thus the "defining battle" of the guided munitions–battle network revolution; its successes spurred the American military to move guided munitions to the center of its strategy to maintain a decisive qualitative military edge. By 1999, approximately 30 percent of all air-to-ground weapons employed against Serbian forces during Operation Allied Force were guided. Four years later, during Operation Iraqi Freedom, guided weapons were nearly 65 percent of all U.S. munitions expended.[34] Today the percentage is even higher still.

The Drive for Quality Over Quantity

The importance of the proliferation of guided weapons and its role in driving America's national security and defense strategy resides at the center of the Pentagon's contemporary strategic thinking.[35] The element common to both Cold War–era offset strategies was the strategic need to counter the Soviet Union's quantitative superiority in conventional military forces with a sharp qualitative military edge. This differed dramatically from American strategy in World War II, whose basis had been, in Secretary Perry's words, to "overwhelm the German and Japanese military forces with the sheer numbers of tanks, aircraft, and ships. The principal factor in the Allied victory in World War II was not technology, but America's industrial might."36 The first offset strategy depended on nuclear weapons, while the second offset strategy depended on guided munitions and their means of delivery. Both depended on the United States maintaining a qualitative military edge that could offset Soviet numerical advantages in conventional forces, and hence maintain conventional deterrence.

Whether or not the United States can maintain a qualitative military edge given in the security and operational environment of the future, and whether or not a qualitative military edge can be a sufficient foundation for U.S. strategy and deterrence, are critical questions, discussed next.

The Need to Reestablish the U.S. Military-Technical Edge

The U.S. military is losing technical dominance over its adversaries. Deputy Defense Secretary Robert Work describes the scope and scale of the current challenge:

> Looking back on the [1990s] ... we enjoyed conventional dominance across the spectrum. Our global command and control network was unparalleled and it really wasn't under any type of a cyber attack threat. Our space assets... weren't really threatened. We enjoyed freedom of access on the land, in the air, on the sea, under the sea, in cyberspace. In contrast, we [now] have potential competitors all across the spectrum, developing capabilities and challenges in all domains. Our space assets are now at more risk than they have ever been. Our global command and control system is at more risk than it has ever been. Several nations are developing capabilities that threaten to erode our ability to project power over trans-oceanic distances, which is what makes us the only global military superpower. The so-called A2/AD [anti-access/area-denial] capabilities [of potential opponents] include advanced anti-ship and anti-air missiles, as well as new

> counter-space, cyber, electronic warfare, undersea and air attack capabilities. We are seeing levels of weapons development in other states that we have not seen since the mid-80s, when we faced a near peer military competitor in the Soviet Union.37

The implications of what Secretary Work outlines are far-reaching, striking as they do at the very foundation of U.S. defense strategy and doctrine. Two operational cases are worth closer examination: air and maritime power projection against near-peer competitors and the challenges faced by U.S. forces engaged in ground combat.

The First 1,000 Miles: Air and Maritime Power Projection

First, the increasing transparency of future battlefields, the expansion of engagement ranges, and the prevalence of guided munitions are combining in ways that will affect the ability of the joint force to project striking power against an adversary. An adversary's guided munitions could reach America's forward military assets – whether on land, in the air, or on the sea – much more rapidly than when they were designed and built. Thus, U.S. power-projection capabilities will need to engage an adversary from much greater distances than previously planned.

Consider a U.S. aircraft carrier and its embarked air wing. The purpose of U.S. aircraft carriers designed during the Cold War – the so-called "supercarriers" – was to launch and recover aircraft able to carry heavy ordnance payloads over long distances. This was to enable U.S. naval forces to project power – both conventional and nuclear strike missions – from beyond the engagement ranges of Soviet air and maritime defensive systems. During most of the Cold War, U.S. carrier air wings – bombers, long-range attack aircraft, and air superiority fighters – could perform deep-strike missions at about 1,000 nautical miles from the carrier.[38] Navy operational concepts,

Kyodo via AP Images

Dongfeng-21D anti-ship ballistic missiles are shown for the first time during a massive military parade at Tiananmen Square in Beijing on Sept. 3, 2015. The missiles are designed to attack medium to large surface ships at long distances.

however, prioritized the number of sorties the air wing could generate. This was permitted for a variety of reasons, principally judgments about the favorable security environment in the immediate post–Cold War period: "The campaigns that the nation and the Navy found themselves participating in gave a false sense of permanence. Operation Desert Storm in 1991, operations in Yugoslavia from 1995 to 2000, and the 2003–2012 Iraq War were all conducted in permissive maritime environments that allowed U.S. aircraft carriers to operate just offshore of target nations, maximizing the on-station time of their aircraft."[39] The prioritization of "close-in" operational concepts for carrier operations resulted in air wings whose average unrefueled range is less than 600 nautical miles.

However, operational concepts that presume U.S. air or maritime dominance sufficient to enable close-in engagement ranges now seem quite unrealistic, given the increasing prevalence of long-range guided munitions and battle networks of the type that China, among others, has spent decades procuring.[40] Unless Pentagon and Navy leaders can drive change sufficient to enable long-range strike missions from aircraft carriers, this critical "Day 1" mission will have to be undertaken by other elements of the joint force. This would call into question the very purpose and mission of the aircraft carrier, heretofore at the forefront of U.S. power projection.

The aircraft carrier is not the only element of America's power-projection force that is increasingly vulnerable. Advances in air defense systems make stealth aircraft easier to detect; America's space-based satellite constellations are more vulnerable to attack and disruption; and U.S. military bases in and around contested regions are more exposed to higher volumes of accurate ballistic missiles that could stress even the most advanced defensive systems. Continued erosion of these essential advantages of U.S. military power will significantly undermine the credibility of our global network of alliances and partnerships, which are central to stability in critical regions.[41]

The Last 100 Yards: Ground Combat

These trends will also cause profound disruption in ground combat. While U.S. ground forces are and will remain the most effective in the world at the core mission of closing with and destroying the enemy, the U.S. Army and Marine Corps are likely to undergo a very disruptive period. The guided munitions revolution has not yet fully been realized at the level of the individual Soldier or Marine, but the kinds of revolutionary air and maritime capabilities that became apparent to the world in the 1991 Gulf War – smart munitions and sensor grids – are now emerging rapidly in infantry combat. We are now seeing the emergence of precision-guided infantry weapons, such as:

- Lightweight anti-personnel drones carried and employed by infantry squads that can dive-bomb targets from above;
- Handheld laser-guided grenade launchers whose integrated electronics enable precise detonation to maximize lethality;

(Raytheon Company)

"Pike" is a 17-inch-long, semi-active laser-guided precision weapon, measuring 40 mm in diameter and weighing two pounds. Fired from a rifle-mounted grenade launcher, the miniaturized munition can travel one and a half miles and hit within five yards or less of a target.

- Miniature guided missiles that can be launched from currently fielded grenade launchers to hit targets more than 2 kilometers away;
- Large-caliber rifle rounds that can maneuver during flight to hit laser-designated targets; and
- Firearms with integrated fire control systems to counteract the effects of the shooter's movement and greatly increase accuracy.[42]

Although such emerging technologies will likely first be employed by U.S. or allied forces, they will rapidly proliferate globally, in part because many of these capabilities are derived from commercially available products. These technologies will expand the engagement ranges for mounted and dismounted infantry and will significantly complicate or neutralize the ability to use terrain features for cover and concealment, making the battlefield far more lethal. All the while, the ongoing proliferation of anti-tank guided munitions will continue, as will the evolution of sophisticated anti-personnel devices such as IEDs (improvised explosive devices) and EFPs (explosively formed projectiles) used in Iraq and Afghanistan.

In both of these cases – air and maritime power projection and ground maneuver warfare – and in others, the loss or relative decline of long-relied-upon U.S. advantages will necessitate major changes in operational concepts and in the capabilities required to execute them.

THE GUIDED MUNITIONS REVOLUTION HAS NOT YET FULLY BEEN REALIZED AT THE LEVEL OF THE INDIVIDUAL SOLDIER OR MARINE.

Vectors for Developing the Future Force

New operational concepts must be developed to address emerging U.S. vulnerabilities. Operational concepts define the ways in which U.S. military forces plan to employ military means to accomplish desired political ends. They enable effective theater and operational planning, and guide the Pentagon's force development priorities. The credibility of these concepts undergirds U.S. deterrence just as much as the capabilities inherent in specific military platforms. "The United States must be able to give some sense of how it can make war against opponents who can contest U.S. military superiority in their regions," argues defense analyst Elbridge Colby, "and how it can make such war in a way that the costs and risks of the conflict would in some reasonable sense be correlated with the gravity of the interest at stake."[43]

Most current operational concepts presume that qualitatively superior U.S. forces will be able to operate outside of adversaries' engagement zones, penetrate those zones if required, locate and surprise the enemy, and prevail even over numerically superior forces by concentrating precision munitions at the point of attack. However, whether the issue is air and maritime power projection or ground combat scenarios, the likelihood is rapidly rising that U.S. forces will soon face adversaries that could, in temporary or sustained ways, achieve a degree of parity or overmatch. Thus existing operational concepts must be updated and revised to ensure U.S. forces can operate effectively and succeed on future battlefields.

Given that future battlefields will be much more transparent, precision munitions much more ubiquitous, and engagement zones much larger, future U.S. operational concepts will require greater focus on the following characteristics:

- **Range.** U.S. forces in any domain will need to be able to target and engage adversaries over longer engagement ranges.
- **Persistence.** U.S. forces, particularly in the air domain, will need to stay within contested zones

for longer periods of time to find and engage an adversary's mobile assets.

- **Disaggregation.** Future military forces will often need to disaggregate into multiple smaller components in order to present adversaries with more complex targeting challenges.
- **Dispersion.** Forces will need to spread those disaggregated units across wider geographic areas to make best use of networked sensors and fires.
- **Mass.** Dispersed forces will still need to find ways to concentrate firepower and/or platforms at particular points to overwhelm an adversary.
- **Concealment.** Military forces will need to enhance concealment capabilities by, for example, improving core stealth technologies (such as reducing radar cross-sections); shifting emphasis within a warfighting domain (such as using submarines as primary attack platforms instead of more vulnerable surface ships); and creating innovative ways to distract or spoof an adversary's means of detection (such as with advances in electronic attack and cyber capabilities).

If opposing forces are at roughly qualitative parity (for even a short period of time), battlefield outcomes may increasingly turn on which adversary can generate quantitative superiority – greater mass – at key points. Such superiority will stem from different platforms depending on the scenario, but success will ultimately depend on the quantity of munitions that can be thrown against an adversary, whether by long-range missiles, bomber aircraft, or shells fired by armor or infantry units. Battlefield outcomes featuring roughly equal opponents will, as in most of warfare's history, depend on which side can bring more mass to the fight.

It is important to underscore how different this dynamic is from much of current U.S. military strategy and force planning, which has spent decades planning and executing operations with technically superior forces that can detect, target, close with, and engage a surprised adversary with the overwhelming application of precise force. U.S. defense leaders must do all they can to maintain a qualitative military edge, for the modern history of U.S. military strategy suggests that competing for numerical superiority with an adversary may plays to its their strengths, not ours.[44]

Implications of the Third Offset Strategy for Military Platforms and Posture

For nearly a year, the Pentagon, under the leadership of Secretary Ash Carter and Deputy Secretary Robert Work, has been developing the contours of such an approach. The FY2017 budget deliberations inside the Pentagon may soon result in a clear and visible commitment to address the challenges outlined above. High on the list of priorities should be three major areas. First, the United States must shore up its air and maritime power projection capabilities. This has several major components:

- Develop long-range unmanned strike platforms, land-based and carrier-based, that can penetrate sophisticated integrated air defense systems, locate mobile targets, and deploy significant munitions payloads. With automated aerial refueling, unmanned platforms could be game-changers, significantly extending the striking distance of U.S. military forces.
- Emphasize submarines that can attack an adversary from concealed positions, using platforms with larger payload capacities (an example would be the planned Virginia Payload Module, designed to triple the current strike capacity of *Virginia*-class submarines).
- Develop dispersed undersea sensor grids and unmanned attack platforms that can persist inside an adversary's contested zones for months at a time, posing the credible threat of surprise close to an adversary's shores (DARPA and the Office of Naval Research are experimenting with long-duration unmanned underwater vehicles and so-called "upward-falling payloads").
- Ensure that the new Long-Range Strategic Bomber (LRS-B) is procured in numbers large enough to constitute a credible ability to sustain

Steve Helber/Associated Press

The Navy experimental unmanned aircraft, the X-47B, taxis to a launch position on the flight deck aboard the nuclear powered aircraft carrier USS Theodore Roosevelt*, off the Virginia coast, Sunday, November 10, 2013.*

power-projection missions over the course of a long-duration air campaign (the planned buy of 100 planes is in the right range).

- Push emerging guided munitions capabilities down to the levels of squads and individuals.
- Experiment with robotic ground systems that can obviate the need to risk humans in many dangerous logistics and surveillance missions and some "advance-to-contact" tasks.
- Ensure that unmanned aerial systems are pushed down to the levels of platoons and squads to enable dismounted troops to find and engage adversaries over longer ranges.
- Develop platforms that can deploy with dismounted units to provide greater protection from an adversary's guided rockets, artillery, missiles and mortars.

Third, U.S. forward bases and deployed forces must have better capability to defend against an adversary's guided munitions. To this end, the United States should:

- Aggressively fund continued research and development of directed energy and electromagnetic railgun systems that can defend against guided rockets, artillery, missiles, and mortars.
- Explore innovative basing concepts that could allow U.S. military forces to disperse across larger geographic areas (for example, by prepositioning equipment in austere locations that could be reinforced rapidly when needed).

The transition from a world in which the United States has a clear qualitative military edge to one in which our military forces have lost their advantage must be prevented. A major focus for Congress, the Pentagon, and all those interested in preserving military-technical superiority for U.S. forces should be the development of a comprehensive bipartisan strategy.

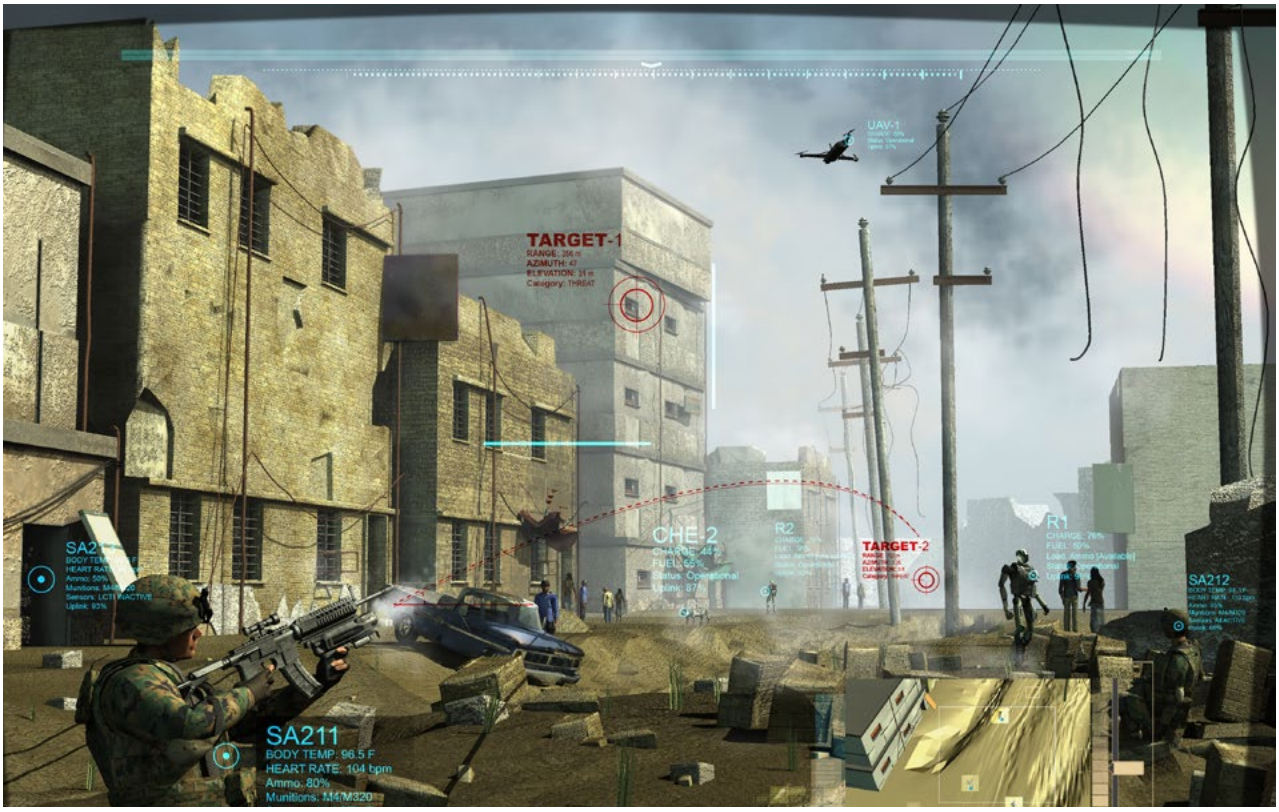
Sustaining and Sharing a Sharper Military-Technical Edge

The Pentagon's "third offset strategy" must focus on the trends in the operating environment and the specific operational challenges that U.S. forces must be prepared to encounter. Put simply, deciding what the shape of the future force ought to look like must be the primary force development priority for the Pentagon and the Secretary of Defense. The question of how to develop and acquire capabilities for this force is a critical separate issue, beyond the scope of this paper. However, several points are worth highlighting:

First, each and every technological edge will be fleeting. The United States enjoyed about a decade of advantage during the early nuclear era, and arguably several decades during the evolution of the guided weapons era. But adversaries will always catch up. The dynamics of the modern global economy and the accelerating diffusion of military power will compress the time during which any new military technology will give the advantage to one actor over another. Thus defense planners must assume that the emergence of any new disruptive military technology, will be met and matched within a decade.

Second, a greater proportion of disruptive technology will emerge from outside the defense sector than from within it. During the Cold War era, Pentagon-directed research and development efforts spurred both the nuclear and guided-weapons revolutions. Now, however, the Pentagon will be as much an importer of technology as an exporter

DARPA artist's rendering



This artist's rendering depicts DARPA's Squad X program, a series of experiments to increase the distance U.S. infantry forces might be able to detect and engage adversaries on future battlefield

of it. Many new technologies that will emerge from the commercial sector will have profound impacts on global military-competitions. A greater proportion of commercial actors now ride similar waves of technological innovation that military actors are relying on as well, such as computing power; machine learning; global positioning, navigation, and timing; and space-based communications and imagery.

Third, any military-technological edge must also help America's allies and partners. For a variety of reasons – not least of which are resource constraints and reductions in forward-deployed forces – the United States will rely more on its partners to be important battlefield actors capable of supporting key elements of a military campaign. Unfortunately, the United States has, over time, been a less than satisfactory partner in this respect; it must do more sharing of key technologies and systems that can enhance the effectiveness of partner militaries and make it easier to operate together.

Fourth, America's long-standing military strategy of establishing qualitative advantages over adversaries has depended on its ability to recruit and retain the "best and brightest" of its citizens. Discussions about the necessity of investing in military technology can too often imply a bias toward machines or platforms over people, but this is a false choice. The shift into the guided-weapons era in the 1970s and 1980s, and the extension of America's monopoly on these technologies well after the end of the Cold War, were due at least as much to the emergence of the All-Volunteer Force as to the construction of particular platforms and systems. U.S. military personnel innovate, build, and operate military capabilities in creative ways. Ensuring that the Department of Defense can reestablish and sustain a military-technical edge depends as much on the people it recruits and retains as on the systems it builds.

Arrest the Erosion While We Can

America's military-technical advantage is eroding, and the window within which U.S. policymakers have an opportunity to arrest this trend is closing. The consequences of failure are troubling. The maintenance of a military-technical advantage is fundamental to American defense strategy and must remain so. For decades, and certainly after the 1991 Gulf War, America's adversaries were convinced that U.S. forces would be able to see them first and shoot them first due to the overwhelming U.S. advantage in precision-guided munitions and the means to deliver them at a time and place of our choosing. If the erosion of this advantage is allowed to continue, the credible deterrent power of America's military forces will lessen as well, potentially causing significant disruptions to balances of power around the world.

The likelihood that America's adversaries will employ sophisticated guided munitions against our forces and those of our allies and partners necessitates far-reaching changes to overall U.S. defense strategy, force development and modernization efforts, concepts of operation and contingency planning, and global basing and posture. An adversary that can establish even temporary advantages in guided munitions and means of delivery could potentially put itself on an equal qualitative footing with US. forces. This would return the need to generate quantitative battlefield advantages to the forefront of military preparations, a challenge that many of today's defense planners would find extremely difficult to meet.

Fortunately, senior Pentagon leaders understand the scale and scope of this challenge. They are building on the strong history of previous attempts to offset an adversary's military advantages to do the same in time to prepare for future conflicts. Congress must support the Pentagon's efforts, and hold its civilian and uniformed leaders accountable for making the necessary changes in defense strategy and planning before it is too late. Preserving military-technical superiority for U.S. forces requires a comprehensive strategy and bipartisan support. The stakes could not be higher, for they concern nothing less than the foundations of American military power and the stability of the global order.

Endnotes

1. See the report of the 2014 National Defense Panel, Ensuring a Strong U.S. Defense for the Future (Washington DC: U.S. Institute of Peace, 2015), The report argues in part: "In this rapidly changing environment, U.S. military superiority is not a given; maintaining the operational and technological edge of our armed forces requires sustained and targeted investment." 2.

2. See National Intelligence Council, *Global Trends 2030: Alternative Worlds*; Elizabeth Rosenberg, *Energy Rush: Shale Production and U.S. National Security (*Washington DC: Washington DC: Center for a New American Security, 2014); Robert Kaplan, *Asia's Cauldron: The South China Sea and the End of a Stable Pacific* (New York: Random House, 2014).

3. See Michael Horowitz, *The Diffusion of Military Power: Causes and Consequences for International Politics* (New Jersey: Princeton University Press, 2010).

4. Among the first to talk about the "democratization of violence" was Fareed Zakaria, *The Future of Freedom: Illiberal Democracy at Home and Abroad* (New York: W.W. Norton, 2003).

5. For an excellent discussion of how non-state actors are increasingly using sophisticated technologies, see David Kilcullen, *Out of the Mountains: The Coming Age of the Urban Guerrilla (*New York: Oxford University Press, 2013).

6. Early antecedents of guided munitions include the wake-homing torpedoes that emerged near the end of World War II. See Barry Watts, *The Evolution of Precision Strike* (Washington DC: Center for Strategic and Budgetary Assessments, 2013). Also see Robert Work and Shawn Brimley, *20YY: Preparing for War in the Robotic Age* (Washington DC: Center for a New American Security, 2014).

7. See Andrew Krepinevich and Barry Watts, *The Last Warrior: Andrew Marshall and the Shaping of Modern American Defense Strategy* (New York: Basic Books, 2015).

8. As quoted in Barry Watts, *The Maturing Revolution in Military Affairs* (Washington DC: Center for Strategic and Budgetary Assessments, 2011), 11.

9. This dynamic is explained well in Michael Vickers and Robert Martinage, *Future Warfare 20XX Wargame Series: Lessons Learned Report* (Washington DC: Center for Strategic and Budgetary Assessments, 2001).

10. Many of the dynamics apparent in the physical domain may have analogs to dynamics in the cyber domain but, for the purposes of this argument, I focus only on the physical warfighting domains.

11. This episode is described in detail by former Secretary of Defense William J. Perry in "Dealing with a Rising China," Chapter 3 in Ashton B. Carter and William J. Perry, *Preventive Defense: A New Security Strategy for America* (Washington DC: Brookings Institution Press, 1999), 92–122.

12. "China's military modernization has the potential to reduce core U.S. military technological advantages." Office of the Secretary of Defense, *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China* (Washington DC: 2015), i.

13. Thomas Gibbons-Neff, "Top NATO general: Russians starting to build air defense bubble over Syria," *The Washington Post* (September 29, 2015).

14. "[W]hen the IDF crossed swords with Hezbollah [in 2006], they were caught by surprise. Hezbollah fighters were armed with advanced anti-tank missiles, thousands of long-range rockets, Chinese-made Silkworm anti-ship missiles, advanced man-portable anti-air missiles, and unmanned aerial vehicles (UAVs). They had very simplistic, but very effective battle networks to employ them. They practiced irregular warfare, but at the same time maneuvered effectively against Israeli armored columns, proved proficient in indirect fire, and they used swarms of heavy anti-tank missiles to great effect." Deputy Secretary of Defense Robert Work, in an April 2015 speech at the Army War College. Robert Work, Speech to U.S. Army War College Strategy Conference (Carlisle, PA, April 8, 2015).

15. See Michael Vickers, *The Structure of Military Revolutions* (Baltimore MD: Johns Hopkins University, unpublished dissertation 2010, 88–93. Vickers outlines (at p. 90) three "strategies of overthrow" by which an actor will attempt to change the fundamental rules of the game: "the quests for reach, rapid decisive victory, and to reorder … have recurred as general sources of motivation across the history of revolutionary change in war."

16. This part of the paper draws heavily from Robert Work and Shawn Brimley, *20YY: Preparing for War in the Robotic Age* (Washington DC: Center for a New American Security, 2014), esp. 10–16.

17. Obviously there are numerous other variables at play; good strategy depends on understanding one's own strengths and weaknesses relative to an adversary and using the capabilities at hand and the geography of the battlefield to advantage. But the contest between adversaries over who can first effectively engage the other has considerable effect on battlefield outcomes.

18. For a good description of Army thinking in the early atomic age, see A.J. Bacevich, *The Pentomic Era: The U.S. Army Between Korea and Vietnam* (Washington: National Defense University Press, 1986).

19. Christopher J. Bowie, as cited in Barry Watts, "Six Decades of Guided Munitions and Battle Networks: Progress and Prospects" (Washington DC: Center for Strategic and Budgetary Assessments, 2007): 1.

20. Watts, "Six Decades of Guided Munitions and Battle Networks," 3–5.

21. Indeed, in 1945 – just two years after the first guided weapons were employed – a U.S. patrol aircraft, while operating safely beyond the range of a Japanese destroyer's defensive battery, struck and nearly sank it at a range of 20 nautical miles with a radar-guided anti-ship glide bomb. See David R. Mets, "The *Force* in U.S. Air Force*," Aerospace Power Journal* (Fall 2000), 58, 62.

22 . See Wayne P. Hughes Jr., *Fleet Tactics and Coastal Combat* (Annapolis, MD: Naval Institute Press, 2000), 285.

23. See Abraham Rabinovich, *The Yom Kippur War: The Epic Encounter That Transformed the Middle East (*New York: Schocken, 2005). Also see Marshall Mitchell III, *Clashes: Air Combat over North Vietnam, 1965-1972* (Annapolis: Naval Institute Press, 2007).

24. Robert Work, (Speech to U.S. Army War College Strategy Conference, Carlisle, PA, April 8, 2015).

25. This section draws from an excellent paper by Robert Martinage, *Toward a New Offset Strategy: Exploiting U.S. Long-Term Advantages to Restore U.S. Global Power Projection Capability* (Washington DC: Center for Strategic and Budgetary Assessments, 2014).

26. Telegram, George Kennan to George Marshall (The "Long Telegram"), February 22, 1946. Harry S. Truman Administration File, Elsey Papers. Available from the Truman Library website: https://www.trumanlibrary.org/whistlestop/study_collections/coldwar/documents/pdf/6-6.pdf.

27. Dwight D. Eisenhower, Address to Industrial Associations, Chicago, Illinois, January 17, 1947. Available from the Dwight D. Eisenhower Presidential Library: http://www.eisenhower.archives.gov/all_about_ike/speeches/pre_presidential_speeches.pdf.

28. President Dwight D. Eisenhower to National Security Council, December 1953, quoted in Richard A. Melanson and David Mayers, *Reevaluating Eisenhower: American Foreign Policy in the 1950s* (University of Illinois Press, 1987), 53.

29. This evolved into the requirement for U.S. nuclear forces to be able to maintain a secure second-strike capability, as Soviet investments in atomic weapons made U.S. first-strike options unrealistic by the late 1950s.

30. Between FY 1954 and 1961, defense spending as a percentage of the total federal budget fell from 66 to 49 percent and, as a percentage of GDP, from 13 to 9 percent. Martinage, *Toward a New Offset Strategy,* 11.

31. William Perry, "Technology and National Security: Risks and Responsibilities," Paper presented at France-Stanford Center for Security Studies (April 7–8, 2003), http://stanford.edu/dept/france-stanford/Conferences/Risk/Perry.pdf.

32. See Martinage, *Toward a New Offset Strategy,* 14.

33. See Barry Watts, *The Evolution of Precision Strike* (Washington DC: Center for Strategic and Budgetary Assessments, 2013.) Also see Michael Sterling, *Soviet Reactions to NATO's Emerging Technologies for Deep Attack* (Washington DC: RAND Corporation, August 1985).

34. Watts, "Six Decades of Guided Munitions and Battle Networks: Progress and Prospects," 20.

35. Robert Work (U.S. Army War College Conference, Carlisle, PA: April 8, 2015): "[D]uring the Cold War, we pursued two broad technological offset strategies to counter Soviet conventional authority. The first one … relied upon nuclear weapons. … We explicitly decided to rely upon tactical nuclear weapons as an offset for numbers. In the 1970s, when the Soviets achieved strategic nuclear parity with the United States and the threat of tactical nuclear warfare was no longer an effective deterrent, we went after … what everybody knows today as smart guided munitions."

36. Perry, "Technology and National Security: Risks and Responsibilities."

37. Robert Work, Speech to McAleese / Credit Suisse Defense Programs Conference (Washington DC: March 17, 2015).

38. Jerry Hendrix, *Retreat from Range: The Rise and Fall of Carrier Aviation* (Washington DC: Center for a New American Security, 2015).

39. See Hendrix, *Retreat from Range*, 50. See also Seth Cropsey, Bryan McGrath, and Timothy Walton, *Sharpening the Spear: The Carrier, the Joint Force, and High-End Conflict* (Washington DC: Hudson Institute, 2015).

40 . This realization was the basis for the call in the 2010 Quadrennial Defense Review for the Navy and Air Force to develop a joint AirSea battle concept. See also Jan Van Tol with Mark Gunzinger, Andrew Krepinevich, and Jim Thomas, AirSea Battle: A Point-of-departure Operational Concept (Washington DC: Center for Strategic and Budgetary Assessments, 2010).

41. See Andrew Krepinevich, "The Pentagon's Wasting Assets: The Eroding Foundations of American Power," Foreign Affairs (July/August 2009).

42. I am indebted to my CNAS colleague Paul Scharre, and to his work in Scharre, Uncertain Ground: Emerging Challenges in Land Warfare (CNAS, forthcoming). It provides context and details of these trends and their implications for strategy, planning, and procurement. Another recent publication worth examining is Michael O'Hanlon, The Future of Land Warfare (Washington DC: Brookings Institution Press, 2015).

43. Elbridge Colby, "America Must Prepare for Limited War," *The National Interest* (October 2015).

44. However, some notable recent defense research is exploring ways in which the United States could attempt to generate numerical or quantitative battlefield advantages by fully embracing the emerging contours of robotic warfare. See Paul Scharre, *Robotics on the Battlefield*, Part 1: *Range, Persistence and Daring* (Washington DC: Center for a New American Security, 2014); and Paul Scharre, *Robotics on the Battlefield*, Part 2: *The Coming Swarm* (Washington DC: Center for a New American Security, 2015).

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