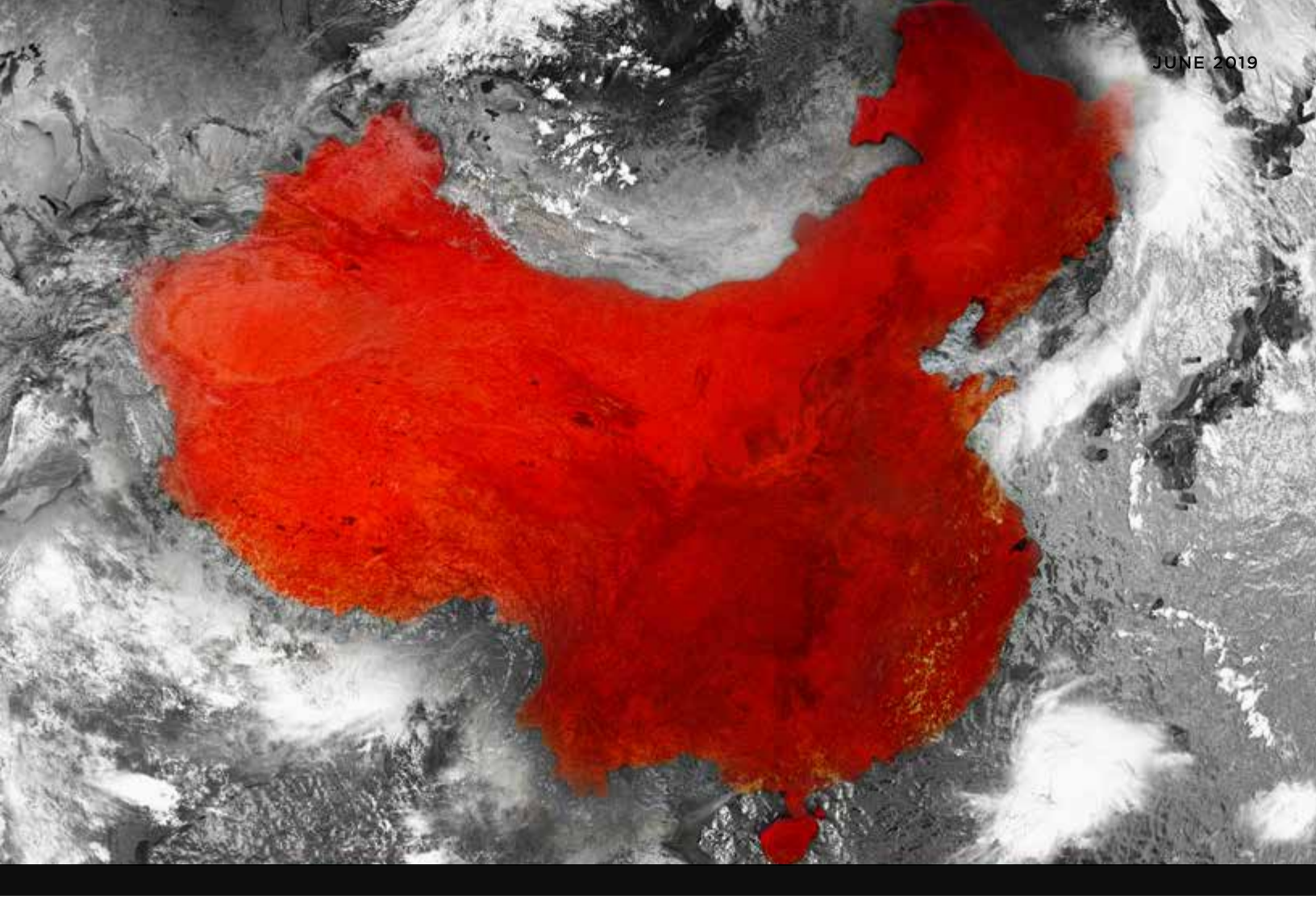

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Beating the Americans at their Own Game

An Offset Strategy with Chinese Characteristics

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CNAS

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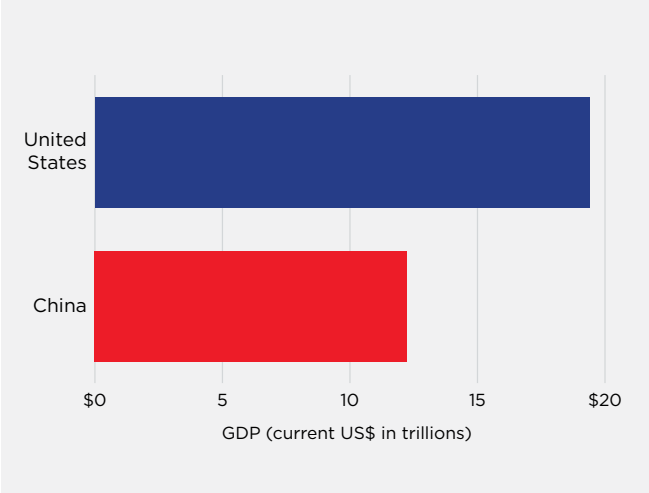
Over the past 10 years, CNAS has defined the future of U.S. defense strategy. Building on this legacy, the CNAS Defense team continues to develop high-level concepts and concrete recommendations to ensure U.S. military preeminence into the future and to reverse the erosion of U.S. military advantages vis-à-vis China, and to a lesser extent Russia. Specific areas of study include concentrating on great-power competition, developing a force structure and innovative operational concepts adapted for this more challenging era, and making hard choices to effect necessary change.

Cover Art
Getty Images (adapted by CNAS).

Introduction

During the Cold War, the U.S. military relied on technological superiority to "offset" the Soviet Union's advantages in time, space, and force size. Our military-technical edge allowed the U.S. Joint Force to adopt force postures and operational concepts that largely compensated for the Soviet military's numerical conventional advantage without needing to match it man-for-man or tank-for-tank. After the Cold War ended, this same military-technical advantage provided the U.S. military a decisive conventional overmatch against regional adversaries for over two decades.

Now, however, the "rogue" regional powers that have preoccupied U.S. attention for so long have been replaced by two great powers with substantially greater capabilities. A resurgent and revanchist Russia and a rising, increasingly more powerful China are taking aggressive actions that threaten regional security and stability and challenge the existing international order. Without question, of these two great-power competitors, China poses the greater challenge over the long term. Since about 1885, the United States never has faced a competitor or even group of competitors with a combined Gross Domestic Product (GDP) larger than its own. China surpassed the United States in purchasing power parity in 2014 and is on track to have the world's largest GDP in absolute terms by 2030. In comparison, our Cold War adversary, the Soviet Union, was hobbled by unsustainable economic contradictions that ultimately crumbled under pressure. At the height of its power, its GDP was roughly 40 percent the size of the United States'.[1]



The United States has not faced a competitor with a GDP greater than 40 percent of its own since 1885.[2] According to 2017 figures, China's economy measured roughly 63 percent of the U.S. economy when comparing GDP.[3]

If that is not concerning enough for U.S. strategic planners, Chinese technological capabilities are growing as rapidly as its economic power. The Soviets were never able to match, much less overcome, America's technological superiority. The same may not be true for China—certainly not for lack of trying. Indeed, China is keenly focused on blunting the U.S. military's technological superiority, even as it strives to achieve technological parity, and eventually technological dominance.

Chinese strategists do not explicitly describe their aims in this manner. Nevertheless, after considering what the Chinese military has accomplished technologically in little more than two decades and what they plan to do in the decades to come, any objective assessment must at least consider the possibility that the U.S. Joint Force is close to becoming the victim of a deliberate, patient, and robustly resourced military-technical offset strategy. The purpose of this paper is to describe this strategy and outline its key lines of effort.

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U.S. Cold War Offset Strategies

Since World War II, the United States has relied on a decisive edge in the military-technical balance to offset the numerical advantage in conventional forces often enjoyed by its adversaries and competitors. This preference grew out if its experience fighting the Axis powers. Dwight Eisenhower put it well, saying shortly after World War II, "While some of our Allies were compelled to throw up a wall of flesh and blood as their chief defense against the aggressors' onslaught, we were able to use machines and technology to save lives."[4]

With respect to state-on-state warfare, a military-technical advantage contributes to a comfortable conventional military overmatch at the tactical and operational levels of war. And the stronger the perceived conventional overmatch, the stronger one's conventional deterrence posture. Having a decisive overmatch is especially important when confronting nuclear-armed great powers, where a weakened conventional deterrence could prompt more aggressive strategic probing that might lead to an overt confrontation, with the attendant risks of nuclear escalation.

During the Cold War, the Soviet Union pursued a deterrent approach reliant on overwhelming numbers in conventional forces, embodied in the old military adage that "quantity has a quality all of its own." But from the outset of the Cold War, President Eisenhower refused to pay the economic penalty associated with trying to match the Soviet Union man-for-man or tank-for-tank. Instead, Ike leaned on his World War II experience—as well as the early U.S. nuclear monopoly—to confront Soviet conventional numerical superiority with a smaller military armed with missiles, rockets, and artillery shells tipped with low-yield atomic warheads. In other words, Eisenhower turned to *battlefield atomic weapons* to deter a Warsaw Pact *conventional attack*.[5] This was America's first Cold War Offset Strategy.

By the early 1970s, the deterrent power of the First Offset Strategy was being undermined by two developments. The first was that the Soviet Union's nuclear arsenal was every bit as powerful as that of the United States. Under these circumstances, early use of tactical nuclear weapons was no longer a credible threat; the danger of nuclear escalation was simply too great. Second, during the 1960s and 1970s the Soviets modernized their already numerically superior conventional assault forces arrayed along the inter-German border, adding thousands of new tanks, armored personnel carriers, air-defense missiles, aircraft, and artillery that were qualitatively equal to their NATO counterparts.

The late Secretary of Defense Harold Brown (pictured here), together with Director for Defense Research and Engineering William Perry, recognized in the 1970s the need for a Second Offset Strategy, which centered around the revolution in precision-guided conventional munitions. (Department of Defense)

Secretary of Defense Harold Brown and William Perry, his Director for Defense Research and Engineering, therefore concluded NATO's deterrent posture was eroding, and drastic action was needed to restore it. One idea was to attack and reduce the massed Warsaw Pact tank armies before they reached NATO's front-line defenses, making it more likely those defenses could hold. Brown and Perry thus looked to several emerging technologies then under development to give the U.S. Joint Force and its NATO allies the ability to "look deep and shoot deep." The result of these efforts is now referred to as the Second Offset Strategy.[6]

The Second Offset Strategy was the offspring of the Pentagon's Long-Range Research and Development Planning Program (LRRDPP). After considering and rejecting a new family of nuclear weapons and studying the use of conventional guided munitions in Vietnam and the Middle East, the members of the LRRDPP concluded that the United States should pursue conventional weapons capable of "near zero miss." Their report was complemented by a 1976 Defense Science Board study that proposed developing a "deep strike system" able to target and attack Warsaw Pact forces still far from NATO front lines with conventional guided munitions dispensing tank killing sub-munitions.[7]

Airborne targeting radar, such as that provided by the E-8 Joint Surveillance Target Attack Radar System, underwrote the Second Offset Strategy's deep strike kill chain. (Defense Advanced Research Projects Agency)

In 1978, Perry directed the Defense Advanced Research Projects Agency (DARPA) to integrate the various deep strike technologies and demonstrate their battlefield potential. The resulting "Assault Breaker" program combined the Pave Mover airborne targeting radar, missiles, and air-delivered bombs with guided anti-armor submunitions, and a ground-based data processing station that linked the two. The data processing or "attack coordination center" was derived from the joint services' developmental Battlefield Exploitation and Target Acquisition (BETA) project—an early attempt to demonstrate the feasibility of processing tactical battlefield information, fusing it into actionable intelligence, and passing accurate targeting information in near-real time to Army missile attack units.[8]

All these components came together in 1982, when Assault Breaker demonstrated on a small scale what U.S. force designers now refer to as an operational battle network employing conventional guided munitions. And, as historian Norman Friedman noted, Assault Breaker was nothing less than a disaster for Soviet strategists who now "believed that their American rivals were scientific magicians; what they said they could do, they could do."[9] The Soviet General Staff concluded the appearance of operational battle networks that employed guided munitions— what they called reconnaissance-strike complexes—had triggered a new military-technical revolution. In this new warfighting regime, accurately directed *conventional* guided munitions could achieve battlefield effects comparable with *tactical nuclear weapons*. Its emergence thus helped strengthen NATO's conventional deterrence and end the Cold War without the need for a major NATO force buildup. As Brown put it: "[the U.S.] is better at technology than we are at mass."[10]

Thankfully, the U.S. military never had to test this proposition in an all-out battle against Soviet forces in Europe. But it did demonstrate the potential power of a guided munitions battle network against a capable Iraqi Army equipped with Russian and Chinese weapons and trained in Soviet doctrine. During Operation Desert Storm in 1991, Iraqi heavy formations were virtually reduced to an array of targets and aim-points waiting to be serviced. The 100-hour ground war that followed five weeks of aerial bombardment with both guided and unguided munitions was a rout. And even though only 8 percent of all conventional weapons employed in battle by the United States were guided, armies the world over immediately grasped that a new military paradigm had emerged—and the U.S. Joint Force had a powerful conventional warfighting advantage that would be hard to duplicate, much less match in scope and scale.

After the fall of the Soviet Union, the Second Offset Strategy served the U.S. military well; it afforded the Joint Force a dominant conventional overmatch over any potential regional opponent for more than two decades. But the nature of strategic competitions is that serious competitors do not simply cede military advantage to their rivals. This is especially true of emerging and great powers, which understood if they were to compete against U.S. operational battle networks they would have to develop a counter to them first, and then develop reconnaissance-strike complexes of their own. That is exactly what China, determined to break from its status as a second-rate military power, set out to accomplish.

A U.S. F-14A Tomcat aircraft flies over an oil well fire set by retreating Iraqi troops during Operation Desert Storm. The brief ground war demonstrated the might of U.S. operational battle networks to both the U.S. Joint Force and its adversaries. (Lt. Steve Gozzo, Department of Defense)

A PLA parade commemorates the force's 90th anniversary in September 2017. The PLA's massive modernization programs seek to counter U.S. technological advantages. (Defense Intelligence Agency)

An Offset Strategy with Chinese Characteristics

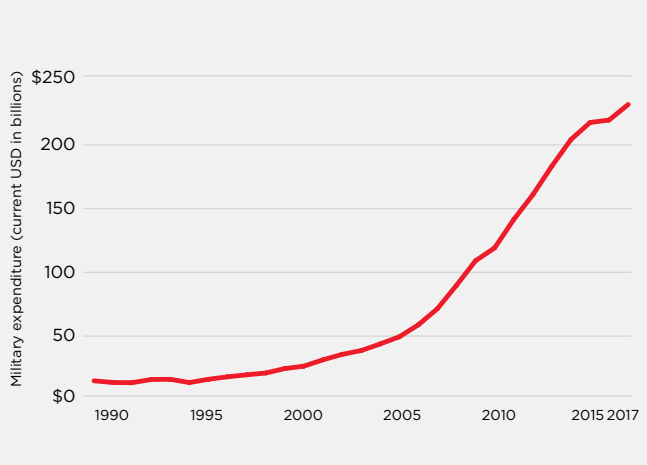
Although China was a de facto strategic partner of the United States during the latter two decades of the Cold War, the collapse of the Soviet Union automatically made the United States the pacing strategic threat for Chinese military planners. Soon thereafter, in 1993, with America's impressive demonstration of military might in Desert Storm fresh in mind, President Jiang Zemin directed the People's Liberation Army (PLA) to prepare to fight "local wars under high technology conditions."[11] He did not have to name the country that represented the most likely potential adversary; the recent stunning results of Desert Storm made that plain.

Planning for local wars under high technology conditions would be shaped by two key assumptions, First, the wars would be limited in geographic scope, duration, and objectives. Second, the wars would be dominated by high-technology weaponry, particularly by guided weapon attacks like those demonstrated during Desert Storm. The implications of these two assumptions focused the subsequent development of PLA strategy and doctrine on short, intense, highly destructive wars. And a key lesson China took from the 1991 Desert Storm campaign was to strike hard and fast during war's earliest stages, as initiative once lost would be all but impossible to regain against an opponent capable of 24-hour, all-weather guided munitions bombardment.[12]

From the very beginning, then, although not referred to in such a way, the Chinese decided to develop an offset strategy with Chinese characteristics. Instead of pursuing an offset to counter U.S. numerical advantages, it would instead aim to offset the American technological advantage in some way. These plans were given new urgency due to American actions early in the post—Cold War era. In 1996, in response to Chinese missile tests over and into the waters surrounding Taiwan, the United States assembled the biggest naval show of force in the Western Pacific since Vietnam. It sent two carrier battle groups steaming through the Taiwan Strait, demonstrating in vivid fashion that the Chinese were incapable of even tracking U.S. naval surface groups, let alone possessing the means to stop a U.S. intervention to defend Taiwan.[13] Then, on 7 May 1999, during the NATO bombing campaign against Serbia, the US. forces dropped five guided bombs on the Chinese embassy in Belgrade, killing three Chinese citizens and wounding another 20. The United States apologized for the incident, saying it had provided the bombs with incorrect coordinates. The

Chinese rejected the apology, believing U.S. joint battle networks incapable of making such a mistake.[14]

Both national humiliation and anger caused Chinese leaders to accelerate their plans to offset the U.S. military-technical advantage. But the events in the Taiwan Strait and over Yugoslavia underscored to Chinese military planners just how far they had to go before they could hope to face the U.S. Joint Force on equal footing. Their sensor grids were incapable of long-range targeting; their command, control, communications, and intelligence (C3I) grids were incapable of sensor fusion and directing effects-based operations; and their effects grids relied almost entirely on unguided or unsophisticated guided weapons.[15] Fixing all these problems would take time.



PRC Defense Expenditures[16]

Annual Chinese defense spending jumped by at least 620 percent in real terms between 1996 and 2015—an average annual increase of 11 percent.

With the benefit of hindsight, then, it seems evident a critical aspect of China's offset strategy was the recognition in the mid-1990s by PLA senior leadership that they were engaged in a long-term military-technical competition with the United States, and their strategic aims would necessarily be achieved through a series of distinct temporal phases:

- Phase One would see the Chinese military compete with the United States from a position of technological inferiority. Chinese military writings in the late 1990s and early 2000s explored and emphasized ways to defeat a more technologically advanced adversary, until such time that their modernization efforts were able to narrow the advantages enjoyed by the U.S. military. In particular, the PLA would have to accommodate some period of time in which it lacked "deep and multidirectional strike capabilities" comparable to those of the U.S. military.[17]
- Phase Two would occur when the Chinese achieved a position of rough technological parity in guided munitions and battle network warfare, making it far more likely China might be able to deter a U.S. military intervention in the East Asian littoral.
- And Phase Three would represent the desired end state, when the Chinese military would establish a position of outright technological superiority over U.S. military forces, enabling the PLA to confidently move out of its first island chain bastion and push U.S. forces out to the second island chain and even beyond.

The temporal phasing of China's military-technical offset strategy would be supported by a sustained, robust increase in Chinese military spending. Annual Chinese defense spending jumped by at least 620 percent in real terms between 1996 and 2015—an average annual increase of 11 percent.[18] Such a massive increase in military spending was bound to translate into real improvements in military capability and capacity. But these improvements proved strikingly more effective because the PLA's prioritization of approaches, systems and forces were shaped and guided by a disciplined and coherent military-technical offset strategy. The focus of that strategy was to dramatically raise the costs to the United States of intervening in Chinese military operations in the Western Pacific so that Washington would deem such action prohibitive. In this regard, an analysis of the precise investments made by the PLA since 1996 suggests China's offset strategy has five reinforcing lines of effort. These are:

- Industrial and technical espionage and civil-military fusion to rapidly acquire comparable military capabilities to those developed over decades by the United States so that the PLA could compete operationally on something approaching an even footing.
- Developing the capabilities and concepts to conduct "systems destruction warfare," —the crippling of the U.S. battle network's command, control, communication, and intelligence systems.
- Attacking effectively first by amassing an arsenal of long-range precision missiles and advanced targeting systems that provide a high probability of penetrating U.S. battle network defenses in the opening stages of a conflict.
- Developing "Assassin's Mace" capabilities—what DoD terms "black capabilities"—that are held in

reserve until unveiled in the event of war, to surprise the adversary with attacks from unexpected vectors.

- Becoming the world leader in artificial intelligence and then deploying that technology for military superiority.

The following sections address each of these lines of effort in turn.

Industrial and Technical Espionage and Civil-Military Fusion

The central aim of the Chinese offset strategy was to catch up with the United States in the technological competition as quickly as possible. This goal established the foundation for all Chinese offset efforts: industrial and technical espionage.

As a recent report on Chinese industrial espionage stated, this leg of the Chinese offset strategy would be a "deliberate, state-sponsored [effort] to circumvent the costs of research, overcome cultural disadvantages and 'leapfrog' to the forefront by leveraging the creativity of other nations."[19] Senior U.S. government officials recently reported that the Chinese penetrated the network of a U.S. defense contractor and recovered a trove of sensitive data on U.S. Navy undersea warfare capabilities.[20] This is just the latest instance of one of the most widespread, relentless, and successful industrial and technological espionage programs in history.

Espionage efforts are both supported and exploited by a process identified in Chinese writings as "civil-military fusion," whereby Chinese officials work to routinize licit and illicit transfers of technology for military applications through academic and commercial interactions with the United States and other technologically advanced Western states. As the U.S. State Department reported, since 2009, this effort has accelerated and is now a "whole-of-nation, national-level strategy to 'fuse' the Chinese military and civilian industrial complexes, from top to bottom."[21]

Chinese leaders are forthright about the aims of these efforts. Speaking to China's civil-military fusion, a State Department official recently said:

> Driving this enormous effort is an acute Chinese perception that their country's 19th century downfall resulted from falling behind along the technology and doctrinal curves that defined the "revolutions in military affairs" (RMA) that dominated and shaped warfare across the 20th century

PLA troops participate in an armored vehicle training exercise, 2018. (VCG/Getty Images)

> . . . China is determined not to be left behind in the *next* RMA, which Chinese officials believe to be already under way.[22]

In other words, Chinese leaders see industrial and technical espionage and civil-military fusion as the key means to jump-start Chinese technical advancements, without having to invest in costly R&D of new technologies. In this regard, studies have concluded that the time to move from a prototype to a fielded system takes about the same time in both China and the United States. For equivalent systems, however, industrial and technical espionage has helped the Chinese military reduce the time and money spent going from concept to research and development and prototyping. As a result, illicit transfers of cutting-edge technology, reverse engineering, and civil-military fusion have enabled the Chinese to field advanced technical capabilities much faster than U.S. intelligence agencies originally expected.[23] It's no coincidence that the PLA's newest front-line fighters mimic design features of the U.S. built F-22 Raptor or F-35 Lightning II, or that some of their unmanned aerial vehicles are the spitting image of the Predator and Reaper drones. In effect, by stealing and exploiting U.S. and Western technical secrets, they have been able to level the technological playing field with the U.S. Joint Force, in some key military capabilities, in little less than two decades—a relative blink of an eye in a peacetime, long-term strategic competition.[24]

Illicit technology transfers and civil-military fusion have enabled China's rapid technological advances, including in fifth generation aircraft such as the Chengdu J-20. (Sino Defence)

Systems Destruction Warfare

The Chinese offset strategy's second line of effort gives operational focus to Chinese espionage efforts and helps prioritize PLA investments. It is informed by the PLA's conception of high technology warfare. The PLA describes "traditional" modern military operations as occurring in linear fashion with clear front lines. Just as the Soviets had planned to do against NATO, attacking forces strive to penetrate and strike into the enemy's vulnerable rear areas. But in high technology warfare, attacks are not restricted by geographical boundaries; combat operations occur simultaneously across space, air, sea, land, cyberspace, and electromagnetic domains.[25] In this multi-domain battle space, war is less of a battle of annihilation between opposing military forces and more of a battle between opposing "operational systems," what Chinese strategists refer to as "systems confrontation." And "system destruction warfare" reflects the PLA's theory of victory against a high technology opponent like the United States.[26]

U.S. operational systems, or battle networks, have four interlocking grids. A multi-phenomenology, multi-domain *sensor grid* observes the battle space from under the sea to outer space; a C3I grid makes sense of the observations and data coming from the sensor grid, determines the effects needed to further campaign objectives, develops and selects courses of action, and disseminates orders to the *effects grid,* which employs and directs the application of both kinetic and nonkinetic effects in accordance with the direction from the C3I grid. A fourth grid—a *sustainment and regeneration grid*—supports all three of the aforementioned grids and keeps them functioning during combat operations. Working together, the sensor, C3I, and effects grids form theater "kill chains" to find, fix, and finish intended targets.[27] And, as PLA planners saw during Operation Desert Storm and again over Serbia and Kosovo, the U.S. military assembles its various expeditionary battle network grids and effectors in the theater of operations and connects them via an extensive and high-bandwidth communications and data architecture, with the strike elements and supporting logistics assembled at nearby bases. To make this concept as efficient and economical as possible, the U.S. armed forces centralize the elements of their battle networks. While effective, this centralized construct presented multiple vulnerable single points of failure, each of which China has targeted with advanced capabilities.[28]

The Chinese understood that to have any hope of defeating a U.S. intervention, especially during the period when the PLA was clearly outclassed technologically,

they would need to paralyze the functions of the American battle network. This is the key aim of system destruction warfare—to cripple the

> . . . enemy's operational system, command system, weapon system, support system, etc., and the internal links within each system. Destroying these links results in the enemy carrying out isolated instead of concerted campaign operations, [thus] degrading the enemy's overall combat capabilities.[29]

Should this crippling campaign have its intended effects against the U.S. battle network, the Chinese would expect to achieve information superiority, which they consider to be the "most important operational method of modern wars," and the "core precondition for achieving supremacy dominance" in the air, at sea, and on the ground".[30] So important is this core precondition that Chinese military theorists add a fifth, *information contestation grid* to their design of operational systems. Consistent with the overall theory of system destruction warfare, its purpose is to

> . . . achieve and maintain information superiority for the operational system while simultaneously seeking to degrade or undermine an adversary's operational system in the information battlefield. . . . The information contestation system comprises two major component systems: the information attack system and the information defense system.[31]

PLA troops parade in 2015 to commemorate Japan's defeat in World War II. (Kevin Frayer/Getty Images)

Given its centrality to PLA strategic thought, system destruction warfare has become a dominant driver behind PLA force structure decisions and modernization priorities. It explains heavy Chinese investments in counter-battle network capabilities and the means to conduct "informationalized warfare"—the use of electronic warfare, cyber, computer network attack, information operations, and deception to destroy the integrity of any U.S. battle network. For example, the Chinese have developed some type of electronic warfare capability to threaten every U.S. system and data link; one must presume they also have developed cyber-attack tools. And, given U.S. reliance on space-based support for its expeditionary battle networks, the PLA is intently focused on a space campaign to "blind and deafen the enemy" as a central part of systems destruction warfare.[32] This helps explain China's heavy investment in a range of counter-space weapons, including direct ascent missiles, directed energy weapons, and co-orbital weapons.[33] The emphasis on systems destruction warfare also helps to understand the reasoning behind the PLA's new Strategic Support Force, a system-of-systems organization designed to better integrate space, cyber, and electronic warfare capabilities into PLA operations.[34]

Attack Effectively First

The Chinese believe the dominant operational approach in systems confrontation involves long-range, multidimensional precision strikes by guided munitions that shatter an enemy's ability to mount a coherent defense.[35] The Chinese offset strategy's third line of effort thus involves developing the doctrine, systems, platforms, and weapons to allow the PLA to attack any opponent effectively first. "To attack effectively (by means of superior concentration) and to do so first (with longer-range weapons, an advantage in maneuver, or shrewd timing based on good scouting)" is a cornerstone of both Chinese military thought and guided munitions warfare.[36] And it is the second dominant driver behind PLA force structure decisions and modernization priorities.

China's Defensive Layers
China's multiple layers of anti-access missiles exploit range and precision targeting to challenge U.S. naval and air power projection. (CNAS)

A general focus on attacking effectively first explains the PLA's obsession with having weapons that "out-stick" their opponent's—that is, that have a greater effective range. Assuming two opposing forces are equally capable in scouting, defined as "actions taken to get weapons within range and [aim] them"—the side with longer range weapons should be able to more often concentrate its fires on portions of the enemy force to great effect. And, if one side enjoys an advantage in scouting in a guided munitions duel, these effects will be even more powerful.

It therefore comes as no surprise that the Chinese offset strategy emphasizes weapons that generally have a greater effective range than their American counterparts. For example, the Harpoon, the standard U.S. antiship missile,

has a maximum range of about 75 nautical miles (nm). In contrast, the Chinese YJ-18 can hit targets out to 290 nm, nearly four times as far.[37] And if it cannot outrange an American weapon, the PLA strives to achieve at least range parity. It should then have a fighting chance to achieve something close to a one-to-one exchange ratio in a guided munitions duel, something the Americans are not used to accepting. This very dynamic is playing out now. U.S. tactical air forces have long enjoyed a range advantage in air-to-air combat with the 100 nm-range Advanced Medium Range Air-to-Air Missile, or AMRAAM. Now, however, China's new PL-15 air-to-air missile matches its range. Even that is enough to unnerve U.S. combat pilots, who have grown accustomed to being able to fire at opponents far beyond the range of their own weapons. They are now clamoring for a missile that "out-sticks the PL-15.[38]

The Chinese focus on attacking effectively first also explains why the PLA has embraced what has been termed a "projectile-centric strategy" based around long-range ballistic and cruise missiles, as opposed to the airborne platform-based means of U.S. long-range strike.[39] The Chinese extensively studied the U.S. use of air power in Desert Storm and over Bosnia and Kosovo. Rather than try to build a symmetrical, high-quality air force, the Chinese opted to pursue a high-quality missile force, with a focus on road-mobile ballistic missiles fired from transporter-erector-launchers. From the Chinese perspective, such a force structure approach makes great sense:

- A ballistic missile force is less expensive to build, train, and maintain than a high-quality air force, the primary U.S. delivery mechanism for long-range strikes.
- Pursuing ballistic missiles exploits a competitive asymmetry: Until recently, the United States was bound by the Intermediate Nuclear Forces Treaty, limiting land-based missiles to a range less than 500 kilometers. Having never been a party to this treaty, the Chinese were able to develop and field large numbers of land-based missiles without any self-imposed constraints on range.
- In a range competition, it is generally easier to extend the range of missiles, by building a larger missile body able to carry more propellant, than it is to extend the unrefueled range of manned aircraft.
- It is easier and quicker to generate massed missile strikes than aircraft strikes—and with far less warning—which is key to Chinese doctrine of firing effectively first.
- And, as the U.S. difficulties in hunting and destroying

The PLA Rocket Force parades the Dong-Feng 26 intermediate-range ballistic missile through Tiananmen in 2015. The road-mobile, dual-capable missile is one of several strike platforms that comprise the PLA's projectile-centric force structure. (Andy Wong/Pool /Getty Images)

> Iraqi Scud missiles during Desert Storm suggested, should a shooting war start, a deployed mobile ballistic missile force would be much harder to hunt and kill than the large fixed bases necessary to support sustained air operations.[40]

China's commitment to its projectile-centric strategy is also reflected in the late 2015 creation of the PLA Rocket Force (PLARF), making it a fourth armed service equal in status with the PLA Army, Navy, and Air Force. The PLA Rocket Force grew out of the Second Artillery Corps, which since 1985 had been responsible for the country's land-based intercontinental nuclear deterrent. Importantly, however, the PLARF gained the responsibility for intermediate range nuclear and conventional strikes against land and sea targets around China's periphery. The PLARF's missile program is the most active in the world and now is developing some of the most advanced cruise and ballistic missiles of any force.[41] Moreover, it trains relentlessly. According to a former U.S. Pacific Command commander, China launches more than 100 missiles a year for training and research and development.[42]

When seeking to fire effectively first, an emphasis on ballistic missiles also makes sense in another way. When employing unguided weapons, most of which miss their targets, one has to rely on massive salvos to ensure even a single target hit. In contrast, when employing guided munitions, one has to fire only enough weapons to saturate the defense; any single "leaker" is likely to hit the target. Defending against any guided munitions attack thus puts a very high burden on defenses, and that burden is made even more stressful when defending against weapons that are specifically designed to penetrate defenses or are inherently difficult to shoot down. Generally speaking, air defenders find ballistic missiles tougher to defeat than aircraft and cruise missiles. This is particularly true of advanced versions with multiple maneuvering warheads, decoys, and jammers.[43]

The Chinese emphasis on weapons that have a high probability of penetrating U.S. battle network defenses extends beyond just ballistic missiles to include supersonic missiles of all types. This explains China's early pursuit of Russian weapons like the supersonic SS-N-22 *Sunburn* and the more advanced SS-N-27B *Sizzler* antiship cruise missiles, both of which are specifically designed to defeat the U.S. Navy's top-of-the-line Aegis combat system. These Soviet designs have been followed by the indigenously produced long-range YJ-12 supersonic antiship cruise missile, in both air and ship-launched versions.[44] These supersonic missiles,

An illustration of the U.S. Falcon Hypersonic Test Vehicle. In December 2018, Undersecretary of Defense for Research and Engineer Mike Griffin stated that "In the last year, China has tested more hypersonic weapons than we have in a decade." (DARPA/DOD)

and others like them, are inherently more difficult to shoot down. They are made more so with the addition of other features that improve their chances of defeating terminal defenses, like weaving attacks and advanced millimeter wave seekers that U.S. electronic warfare systems cannot spoof. Supersonic antiship missiles are used in conjunction with the world's first antiship ballistic missile, China's DF-21D—the "carrier killer" —with a nearly 1,000-mile range and a maneuverable warhead. This ballistic missile soon will be joined by the even longer-range DF-26, able to reach U.S. airfields on Guam and to threaten U.S. aircraft carriers operating between the first and second island chains.

And now, as Mike Griffin, the Undersecretary of Defense for Research and Engineering, told Congress in early 2018, the Chinese are adding hypersonic and hypersonic glide vehicles to their already formidable mix of ballistic and cruise missiles. Hypersonic weapons fly through "near space," an operational domain not well covered by current U.S. sensors or effectors.[45] Moreover, they can maneuver at speeds greater than five times the speed of sound and make very steep, "coning" terminal dives from altitudes. All of these characteristics make hypersonic weapons a very stressing target for U.S. battle networks to contend with.[46]

Having weapons that both outrange an opponent *and* have a good chance of penetrating their defenses provides a potentially war-winning advantage in high technology warfare characterized by intense guided

munition duels. In addition to having the upper hand in salvo battles, the side with these advantages will have an easier time launching surprise preemptive first strikes. Such attacks are especially attractive when fighting a technologically superior foe such as the United States. Surprise strikes therefore play a central role in PLA doctrine. And, whether part of a preemptive first strike or subsequent strikes, Chinese military doctrine always preaches heavy, concentrated strikes. PLA officers severely criticized Iraq after Operation Desert Storm for firing "Scud missiles like spraying pepper."[47] In contrast, they emphasize the need to make "concentrated use of advanced technology arms to launch focused, super-intensive surprise attacks within limited time and space" against "key-point targets" such as command centers, communication hubs, and information processing centers.[48]

Retired Navy Captain Wayne P. Hughes Jr., who writes extensively about guided munitions warfare at sea, would consider these latter types of targets to be part of an adversary's "anti-scouting" operations—those actions taken to counter an enemy's efforts to detect, track, or target friendly forces.[49] The Chinese would see them as natural targets of their information contestation grids and system destruction warfare writ large. Indeed, system destruction warfare and attacking effectively first are properly seen as two sides of the same operational coin in the Chinese offset strategy.

Given the U.S. lead in guided munitions-battle network warfare in the late 1990s, an early emphasis on system destruction warfare made great sense from the Chinese perspective. If successful, these efforts would prevent an American battle network from effectively exploiting its advantage in long-range precision strike. However,

The USS Ronald Reagan in the South China Sea in July 2016. The PLARF missile program makes U.S. surface ships exposed and vulnerable, challenging access to a potential theater of operations. (Nathan Burke/U.S. Navy)

A Standard Missile-3 Block 1B interceptor from the USS Lake Erie in the Central Pacific in 2013. China's projectile-centric competitive strategy imposes disproportionate costs on U.S. missile defense systems. (U.S. Navy/Flickr)

the Chinese always have been intent on beating the Americans in a guided munitions salvo competition. Accordingly, even as it emphasizes deconstructing U.S. battle networks to gain a decisive information advantage, the PLA hopes to cripple U.S. operating forces through punishing guided munitions strikes. In fact, these two approaches are mutually reinforcing, as precision kinetic strikes against key-point targets in U.S. battle network grids only hasten their destruction.

China's projectile-centric strategy has two additional deleterious *peacetime* impacts on the U.S. military. It's an effective "cost imposition" strategy that has forced the United States to develop and deploy enormously expensive missile defense systems to protect its network of land and sea bases. And, it forces U.S. military thinking into an overly "defensive" mindset focused on protecting forward deployed assets from Chinese guided munitions, instead of what should be more of an "offensive" mindset that focuses intently on exploiting an adversary's operational vulnerabilities.

"Assassin's Mace" Capabilities

The first three lines of effort of China's technologically enabled offset strategy are clear to see; they are reflected in Chinese doctrine, the fielding of PLA military capabilities, and the organization and training of its armed forces. This is consistent with all offset strategies, which reveal or hint at capabilities in hopes of deterring a would-be adversary. Indeed, the fundamental aim of any offset strategy is to avoid a war. Importantly, however, offset strategies ultimately are designed to provide a war-winning advantage if deterrence fails. So, in addition to the capabilities revealed for deterrence, offset strategies typically conceal other capabilities that might surprise an opponent and provide a potential war-winning edge in the event of hostilities. The U.S. military refers to these as "black" capabilities or special access programs, protected by the highest security protocols.

The thinking behind "reveal (capabilities) for deterrence, conceal (capabilities) for warfighting advantage" was a key aspect of the United States' Second Offset Strategy. The United States revealed its intent and demonstrated selected capabilities to convince the Soviet Union it had the technological wherewithal to field an operational battle network employing long-range guided munitions. However, it concealed the development of stealth aircraft, central to the Joint Force's version of system destruction warfare, under a cloak of secrecy. In fact, although there was widespread speculation about the development of stealth aircraft in the press, the United States did not officially acknowledge their existence until 1989—seven years after the Assault Breaker demonstration.

The Chinese appear to be following this very same playbook. As President Xi himself has said: "advanced technology is the sharp weapon of the modern state . . . it's been aptly put that 'The sharpest weapon of a state should not be revealed.'"[50] Chinese writers sometimes refer to these potentially war-winning secret weapons as "Assassin's Mace" or Project 995 weapons—the latter project having started in May 1999 soon after the bombing of the Chinese embassy in Serbia. Enabled and guided by China's industrial and technical espionage, Chinese "black" capabilities might include such things as directed energy weapons, advanced space weapons, electromagnetic railguns, high-powered microwave weapons, or even more exotic arms. As one analyst of Chinese weapons development noted, the PLA is pursuing "leapfrog development" to gain a decisive warfighting edge in "strategic front-line" technologies that the United States has not yet realized.[51]

Given the heated military-technological competition it finds itself in, preparing the Joint Force to shake off and fight through technological surprise may be as important as developing new "black" capabilities in the first place.

U.S. military planners must assume Chinese weapons developers are pursuing such leapfrog capabilities as aggressively as their American counterparts. And the "Assassin's Mace" and Project 995 programs are nearly two decades in the making; it seems likely they have produced some successes. As a result, while the specific secret capabilities are operational wild cards, the Joint Force must be prepared for some unpleasant technological surprises should it wind up in an armed conflict with China. Indeed, given the heated military-technological competition it finds itself in, preparing the Joint Force to shake off and fight through technological surprise may be as important as developing new "black" capabilities in the first place.

Exploiting Artificial Intelligence for Military Superiority

Each of the aforementioned lines of effort can be tracked back to the late 1990s. Recently, however, the Chinese have added a fifth line of effort, one designed to accelerate the attainment of their ultimate goal—to gain a dominant technological advantage over the U.S. military. The impetus has come from Chinese President Xi himself, who has pushed a massive restructuring of the PLA and called for accelerated innovation in weaponry. As President Xi has said: "A new technological and industrial revolution is brewing, a global revolution in military affairs is accelerating, and the pattern of international military competition is experiencing historic changes."[52] He and the PLA are determined not to be left behind.

In this regard, the Chinese believe artificial intelligence (AI), big data, human-machine hybrid intelligence, swarm intelligence, and automated decision-making, along with AI-enabled autonomous unmanned systems and intelligent robotics, will be the central feature of the emerging economic and military-technical revolutions. Google DeepMind's AlphaGo defeat over Lee Sodol in Spring 2016, considered the greatest *go* player of the past

China intends to leverage rapid commercial-sector advances in artificial intelligence technology for national defense. (Kevin Frayer/ Getty Images)

decade, was a "Sputknik moment" for Beijing's leadership, and sparked a marked acceleration of China's efforts to dominate the AI competition.[53]

This is especially true for PLA planners, who aim to inject AI into every grid in their operational systems at all levels in order to exploit this "strategic front line" technology and create a step increase in military capability.[54] For example, an object of intense PLA study has been "Deep Green," a DARPA program from the mid-2000s that aimed to provide commanders AI-enabled predictive capabilities.[55] China is exploring AI as a force multiplier in not just command decision-making but in weapons systems performance. As one analyst highlights, there has been a marked increase in Chinese research into developing neural network-enabled hypersonic missile systems.[56] Indeed, Chinese military thinkers believe AI likely will be the key to surpassing the U.S. military as the world's most capable armed force, and along a faster timeline than first envisioned in the late 1990s.

In support of these plans, in July 2017, China's State Council published the "Next Generation Artificial Intelligence Development Plan" which articulates an ambitious agenda for China to lead the world in AI by 2030. This plan is the poster child for civil-military fusion, as it seeks to ensure AI advances in the commercial sector can be rapidly leveraged for national defense—through a process China terms "leapfrog development" of critical technologies.[57] The Chinese government is investing billions of dollars in the associated technologies, companies (both domestic and foreign), and human capital to enable those ambitions. And, if data is the fuel of AI, then China may have a structural advantage over the rest of the world in the AI race. As seen with the backlash against Facebook's sharing personal data with third parties, Western democracies are both wary and cautious about governments and companies massing personal data. Those same qualms don't exist among Chinese consumers and certainly not the Chinese government, which is embracing AI as a tool for law enforcement and population control. For example, in November 2017, Yitu Tech, a Chinese facial recognition start-up, took first place in the Facial Recognition Prize Challenge hosted by the Intelligence Advanced Projects Agency.[58]

A clue on how serious the Chinese are in pursuing the military applications of AI is their recent decision to shift their doctrinal and analytical focus from systems confrontation to "algorithms competition," and their belief that "achieving superiority" in algorithms will produce 'warfighting' superiority."[59] It also may signal that the Chinese now are confident they have achieved technological parity with the U.S. military and are ready to move to their third phase of activities—achieving outright technological superiority over the U.S. Joint Force.

How these activities play out over the next decade or two is difficult to foretell. The United States is by no means out of this competition, and, given the effort, easily can come out on top. Under any circumstances, however, it seems a sure bet that AI and the autonomous operations they will enable will have a wide-ranging impact on legacy sensor, C3I, effects, and sustainment and regeneration grids, and potentially spark a new military-technical revolution. It is clear the Chinese are intent on being an aggressive first mover in this new warfighting regime and hope to exploit it in order to surpass the U.S. military as the most powerful on earth.

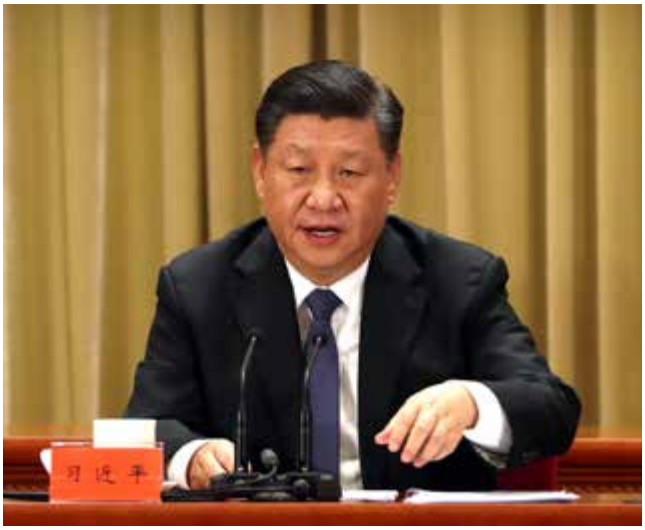
Chinese military thinkers believe AI likely will be the key to surpassing the U.S. military as the world's most capable armed force.

Upsetting the Chinese Offset

In November 2014, after 13 years of sustained combat and counterterrorism operations in the Middle East, the Department of Defense announced a new Defense Innovation Initiative. Key to this new initiative was a call to pursue a Third Offset Strategy to arrest the erosion of U.S. conventional deterrence against a resurgent Russia and a rising, and increasingly powerful, China.[60]

In hindsight, this announcement may have undersold the challenge posed by these two great powers, particularly China. Announcing the pursuit of a third post—World War II offset strategy suggested that the United States had both the technological lead and the initiative to develop the new offset strategy on its own time line. However, after considering what the Chinese military has accomplished technologically in little more than two decades, and what it plans to do in the decades to come, any objective assessment must at least consider that the PLA may hold the initiative and control the time line, and that the U.S. Joint Force itself may be close to becoming the victim of a deliberate, patient, and robustly resourced military-technical offset strategy. And those who reject this rather sobering assessment need only examine the results of extensive wargaming the Department of Defense has undertaken in recent years, modeling military action between the United States and China. The outcome of those wargames indicate that, absent fundamental changes to DoD's planned capabilities and current warfighting concepts, the U.S. Joint Force could face defeat at the hands of the Chinese military in plausible scenarios.[61]

Then-Secretary of Defense Chuck Hagel announces the Defense Innovation Initiative to pursue a Third Offset Strategy (Kevin O'Brien/DOD)



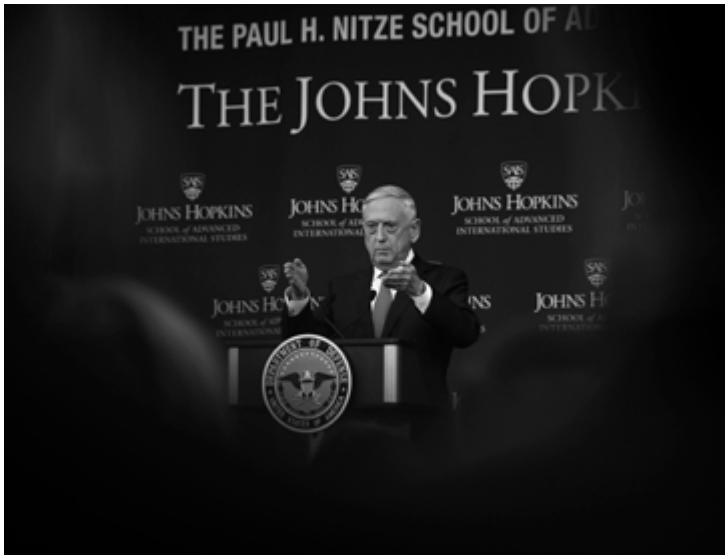
President Xi has devoted personal attention to PLA modernization, declaring that "advanced technology is the sharp weapon of the modern state." (Mark Schiefelbein/Pool/Getty Images)

China's leadership has laid out its goals for a fully modernized PLA by 2035, and elevating the PLA to the world's premier military force by the 100th anniversary of the People's Republic of China in 2049, one capable of winning informatized wars. Xi's personal attention to achieving this goal of surpassing the U.S. military along with China's defense spending patterns indicate that China is likely to realize its military modernization ambitions sometime between 2020 and 2049.[62] The Next Generation Artificial Intelligence Development Plan sees China being the world leader in AI and associated technologies by 2030, a crucial step in the path to achieving an "intelligentized force." China's drive to develop a military optimized to fight and win what it calls "intelligentized warfare" explains its aforementioned doctrinal shift from systems confrontation to algorithmic competition, which PLA leaders see as their pathway to outright technological superiority.[63]

In hindsight, then, former Secretary of Defense Hagel's November 2014 announcement may have been more effective if it had said the key aim of the Defense Innovation Initiative was to "upset the Chinese Offset Strategy." This formulation would have better conveyed that the U.S. military-technical lead had been significantly reduced; the Chinese, not the United States, likely enjoyed the technological initiative; and if the United States wanted to regain a dominant technological advantage, it would need to take prompt and aggressive action.

When pursuing such action, the Pentagon also might warn that the United States no longer can afford to pursue deterrence through its traditional approach of

brute economic and military superiority. Whatever the U.S. response, it must account for the steadily increasing size of China's economic power and the velocity of the country's technological pace of change. As discussed earlier, should China maintain its remarkable economic growth, the IMF estimates China's economy will displace that of the United States by 2030, in nominal GDP terms.[64] Moreover, Chinese spending on technology is increasing at the same heady pace as the Chinese economy. China's R&D expenditure has seen "an almost 30-fold increase from 1991 to 2015—from $13 billion to $376 billion—spending more on R&D than Japan, Germany, and South Korea combined."[65] As mentioned earlier, this is a very different strategic situation than that which existed during the Cold War, when the United States competed against an economically hobbled Soviet Union. The United States also was advantaged during the Cold War in that it was able to drive the military-technical competition in technology areas where the Soviet Union was known to be weak—in microelectronics, for example. That advantage is unlikely to exist in the competition with China. Coupled with its policy of civil-military fusion, China is no longer just a technology fast follower—true "Made in China" innovation now is leading across a range of new technologies, including quantum computing, robotics, and gene editing, to name just a few. As a result, the United States will be unlikely to be able to spend its way out of the Chinese technological challenge. Instead, it will need to out-innovate and out-offset the Chinese.



Then-Secretary of Defense Jim Mattis rolls out the 2018 National Defense Strategy, which identifies inter-state strategic competition as the priority of U.S. national security. (DoD/Flickr)

This is the explicit message of the 2018 National Defense Strategy (NDS). The strategy concludes the United States is emerging from a period of strategic atrophy, meaning, in part, that the Joint Force's post—Cold War dominant overmatch against regional powers suppressed any considered thought about how that overmatch might be eroding as a result of the steadily growing capabilities of resurgent and rising great powers. Therefore, the NDS declares that DoD must make "difficult choices and prioritize" resources in order to avert the decline of deterrence in the United States' long-term strategic competitions with China and Russia that are "the principal priorities for the Department."[66]

Competing against two great powers intent on leveling the military-technical playing field against the United States will mean the U.S. Joint Force will be challenged in ways it hasn't been since the end of the Cold War—if ever. In a thinly veiled reference to Russia and China, the strategy declares, "Some competitors and adversaries seek to optimize their targeting of our battle networks and operational concepts" and the security environment is being affected by "rapid technological advancements and the changing character of war."[67] Under these circumstances,

> We must anticipate how competitors and adversaries will employ new operational concepts and technologies to attempt to defeat us, while developing operational concepts to sharpen our competitive advantages and enhance our lethality.[68]

This is a clear call for action, and a good diagnosis of the challenge the U.S. Joint Force now faces. It is long past time for the Department of Defense to craft a measured response. It must develop the operational concepts, systems, and platforms to allow the Joint Force to prevail against concerted Chinese attempts to deconstruct and destroy U.S. operational battle networks. It must develop the operational concepts, systems, and platforms to allow the U.S. Joint Force to fire first, effectively, and to ride out Chinese guided munitions salvos if it cannot. It must respond to the Chinese AI challenge and ensure it remains ahead in this critical technological competition. More broadly, China appears to be driving the military-technical competition in critical areas such as quantum science, biotechnology, hypersonics, and ballistic and cruise missiles. The Joint Force must compete more aggressively—and better yet, create new competitive technologies. The unpleasant reality is that the United States has not created many new competitive

military advantages since it exploited the technologies to create operational battle networks and conduct long-range precision strikes in the 1980s and 1990s. The U.S. Joint Force needs to recreate the technological "magic" that so flummoxed its Soviet competitors during the long Cold War.

To do so, the Pentagon must devote far more intellectual energy identifying asymmetries in China's Offset Strategy that can be exploited for competitive advantage. It also should develop a strategy for guiding the demonstrations and revelations of new capabilities or concepts of operation designed to weaken China's confidence in their ability to achieve military outcomes. Such military demonstrations need be based on our understanding of Chinese leadership's decisionmaking calculus, the identification of our own desired end states, and rigorous Red Team emulations to assess China's theory of victory and how to counter it. Critical to such an effort is a detailed understanding of how China views its own strengths and weaknesses. It bears remembering that the Pentagon and U.S. Joint Force did all these things as a matter of course during the long Cold War against the Soviet Union. It simply has to start exercising and restoring these strategic muscles.

And as it rebuilds its strategic muscles, the Joint Force must recognize a key lesson from its First and Second Offset Strategies: In a hotly contested long-term military-technical competition, having the best technology is not enough. Examining military innovation before and during World War II, the historians Williamson Murray and Allan Millet concluded, "[T]he critical issue is achieving a better 'fit' between hardware, concepts, doctrine, and organizations than do one's prospective adversaries."[69] This important thought is picked up in the 2018 National Defense Strategy, when it says:

> Modernization is not defined solely by hardware; it requires change in the ways we organize and employ forces. We must anticipate the implications of new technologies on the battlefield, rigorously define the military problems anticipated in future conflict, and foster a culture of experimentation and calculated risk-taking.[70]

The Joint Force needs to take this observation to heart. The Chinese People's Liberation Army has been patiently stalking the U.S. military for two decades. It has studied the preferred American way of war and devised a strategy to exploit its weaknesses and offset its strengths—particularly its military-technological strengths. It appears increasingly close to achieving technological parity with U.S. operational systems and has a plan to achieve technological superiority. In this emerging security environment, where both China and the United States seek a dominant military-technical advantage, the side that finds the better "fit" between technology and operational concepts likely will come out on top.

History shows that the U.S. Joint Force has proven adept at finding the most competitive "fit." It has a demonstrated ability to question the status quo, to take risks and experiment, and adopt new technologically enabled operational concepts that confound its opponents. If it hopes to upset the Chinese offset, it will need to do so again.

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7. Final Report of the Advanced Technology Panel, ARPA/DNA Long Range Research and Development Planning Program, 30 April 30, 1975, vii; DARPA Technical Accomplishments Institute for Defense Analyses, April 1991, Volume II, 4-5.

8. Barry D. Watts, *Six Decades of Guided Munitions and Battle Networks: Progress and Prospects* (Washington: Center for Strategic and Budgetary Assessments, 2007), 28-30; DARPA Technical Accomplishments, Institute for Defense Analyses, April 1991, vol. II, 4-5. Assault Breaker demonstrated on a small scale the three interlocking grids of any battle network: Pave Mover was the surrogate for a multi-phenomenology *sensor grid* to observe the battle space; the BETA ground processing node was the surrogate for a C3I grid to make sense of the observations and data coming from the sensor grid, determine the effects desired to further campaign objectives, develop and select courses of action, and disseminate orders; and the missiles represented *effects grid,* which employs and directs the application of both kinetic and nonkinetic effects in accordance with direction from the C3I grid. A fourth grid – a *sustainment and regeneration grid* that supports all three of the aforementioned grids and keeps them functioning during combat operations – was not demonstrated in Assault Breaker.

9. Quoted in Colin Gray, *Strategy for Chaos: Revolutions in Military Affairs and the Evidence of History*, (London: Routledge, 2004), 218.

10. Watts, *Six Decades*, 14.

11. Roger Cliff et al, *Entering the Dragon's Lair: Chinese Anti-access Strategies and Their Implications for the United States* (Santa Monica, CA: RAND Corporation, 2007), 21.

12. Ibid., 19-23.

13. J. Michael Cole, "The Third Taiwan Strait Crisis: the Forgotten Showdown between China and America," *National Interest,* March 10, 2017, https://nationalinterest.org/feature/the-third-taiwan-strait-crisis-the-forgotten-showdown-19742.

14. Ironically, this was the only target in the entire campaign organized and directed by the Central Intelligence Agency. The CIA was aiming at what it thought was the Yugoslav Federal Directorate for Supply and Procurement. The Agency was on the same street, but at a different location.

15. Cliff, *Dragon's Lair*, 23-25.

16. "Military Expenditure (current USD), China," The World Bank, 2017, https://data.worldbank.org/indicator/MS.MIL.XPND.CD?end=2017&locations=CN&start=1989&view=chart.

17. See "Strategic Principles for Defeating a Technologically Superior Adversary" in Cliff, *Dragon's Lair*, 27-44.

18. Eric Heginbotham et al., *The U.S.-China Military Scorecard: Forces Geography, and the Evolving Balance of Power, 1996–2017*, (Santa Monica, CA: RAND Corporation, 2015), 26.

19. William C. Hannas, James Mulvenon, and Anna B. Puglisi, *Chinese Industrial Espionage: Technology Acquisition and Military Modernization* (London: Routledge, 2013).

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21. Remarks by Dr. Christopher Ashley Ford, Assistant Secretary, Bureau of International Security and Nonproliferation, U.S. Department of State, October 24, 2018, https://www.state.gov/t/isn/rls/rm/2018/286889.htm.

22. Ibid.

23. This was a key conclusion made by Frank Kendall, Undersecretary of Defense for Acquisition, Technology and Logistics in the Obama administration.

24. In a recent academic paper, two researchers challenge the assertion that China can easily copy foreign technology and thus rapidly catch up to the United States in the military-technical competition. See Andrea Gilli and Mauro Gilli, "Why China Has Not Caught Up Yet: Military-Technological Superiority and the Limits of Imitation, Reverse Engineering, and Cyber Espionage," International Security, 43 no. 3 (Winter 2018/19), 141-189. Their theory is that the entry barriers to advanced weapons development are too insurmountable and point to the challenges China's aerospace industry has faced in developing fifth-generation low observable aircraft as well as high-performance turbofan engines for its fighter planes. Yet, starting from what was a very low baseline, the impressive strides China's aerospace industry has made in just two decades of developing advanced fighter aircraft would contradict that theory. Moreover, until recently, the PLA Air Force did not receive the prioritization in terms of resources and support that China dedicated to its ballistic missile, space, and nuclear programs. That has changed under Chinese President Xi Jinping, and China's military is now prioritizing development of aerospace power. See Scott W. Harold, Defeat Not Merely Compete: China's View of Its Military Aerospace Goals and Requirements in Relation to the United States, (Santa Monica, CA: RAND Corporation, 2018). With its ballistic missiles, hypersonics, and long-range air-to-air missiles, China's military industry has demonstrated that when it prioritizes development of certain programs, the advances it is able to make in a short period of time are remarkably impressive. The authors also would note that absent access to classified information on PLA weapons performance, any assessment of individual systems will be incomplete.

25. Gilli and Gilli, "Why China Has Not Caught Up Yet," 141-189.

26. Jeffrey Engstrom, *Systems Confrontation and System Destruction Warfare* (Santa Monica, CA: RAND Corporation, 2018), 10-15.

27. The Chinese sometimes add a fifth *information confrontation grid*.

28. Dr. William Roper, Director, Strategic Capabilities Office, Department of Defense, Testimony Before the Senate Appropriations Subcommittee on Defense, May 3, 2017, 2-3.

29. Cliff, *Dragon's Lair*, 37.

30. Ibid., 12.

31. Engstrom, *System Destruction Warfare*, 66.

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36. Captain Wayne P. Hughes Jr. (USN, Ret.), *Fleet Tactics: Theory and Practice* (Annapolis: Naval Institute Press, 1986), 34.

37. Lyle J. Goldstein, "China's YJ-18 Supersonic Anti-ship Cruise Missile: America's Nightmare?" *The National Interest*, June 1, 2015, https://nationalinterest.org/feature/chinas-yj-18-supersonic-anti-ship-cruise-missile-americas-13010; "Boeing (McDonnell Douglas) AGM/RGM/UGM-84 *Harpoon*," http://www.designation-systems.net/dusrm/m-84.html.

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