Introduction: The Emergence of Direct US–China Defense Technological Competition

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The United States has been the world's pre-eminent military technological power since unleashing the full potential of its defense research, development, and industrial base in World War II and the Cold War. When the Soviet Union challenged this superiority in the 1950s and 1970s, the United States successfully responded with technological innovations and cost-imposing competitive strategies.

Beginning early in this decade, Pentagon decision-makers once again worried that their technological superiority was under serious threat.[1] They assessed that the next two to three decades would be defined by intensifying 'great power' strategic competition with China and Russia as their principal adversaries. While the Pentagon is concerned with Russian aggression over the short to medium term, China "embodies a more enduring strategic challenge," according to US Deputy Secretary of Defense Robert Work.[2]

To understand the drivers, dynamics, and implications of this emerging long-term strategic competition between the United States and China in defense technological and industrial development, the University of California Institute on Global Conflict and Cooperation (IGCC), in collaboration with the Center for Strategic and Budgetary Assessments, organized a conference on US–China strategic competition in defense technological and industrial development in July 2016 at UC San Diego. Academic and policy experts from the United States, China, Russia, Singapore, and Hong Kong presented research papers on the macro-level geostrategic, geo-economic, technological, and military context of this strategic competition as well as detailed case studies of specific domains and technological sectors. The papers are summarized in the research briefs presented in Section 2 of this collection. Section 1 contains charts and diagrams that provide up-to-date insights into key aspects of the Chinese defense economy, based on the work of researchers on the Study of Innovation and Technology in China project at IGCC.

The briefs offer an overview of how the US–China strategic military technological competition has emerged in this decade. They start with an introduction to the competitive strategies analytical framework, which outlines some of the key considerations that need to be addressed in any examination of US–China military technological competition. Attention then turns to the US response to the steady erosion of its military technological superiority over China, which is set out in the Third Offset Strategy, and then Chinese views of this burgeoning competition. Case studies provide insights into the competition in the military domains of air, sea, space, and emerging technologies. The final briefs examine the strategic and global implications of this intensification of US–China long-term military technological competition, concluding with a look at the economic rivalry between the two countries and how it might affect China's quest for cutting-edge innovation in technology and industry.

THE COMPETITIVE STRATEGIES FRAMEWORK

While technological capabilities, economic resources, military postures, industrial policies, and geostrategic considerations are critical drivers of the technological competition between the United States and China, defining the evolving nature of their strategic interaction is central to the analysis. One especially relevant analytical approach is the competitive strategies framework outlined in the brief by Thomas Mahnken.

As Mahnken explains, the notion of a competitive strategy refers to:

> the peacetime use of military power to shape a competitor's choices in ways that favor our objectives. That is, it is concerned with the development, acquisition, deployment, and exercising of forces, as opposed to their use in combat.

1 Robert Work, "The Third US Offset Strategy and its Implications for Partners and Allies," Washington, DC, January 28, 2015, http://www.defense.gov/News/Speeches/Speech-View/Article/606641/the-third-us-offset-strategy-and-its-implications-for-partners-and-allies.

2 "Work Outlines Key Steps in Third Offset Tech Development," *Defense News*, December 14, 2015.

A competitive strategy assumes that the choices that the competitors have to make are constrained. A competitive strategy seeks to identify and exploit these constraints.[3]

The competitive strategy framework has a number of features pertinent to assessing the US–China interaction:

1. There is an assumption that interaction between competitors as they make strategic choices is in part because of the actions of the other party. This interaction may or may not be tightly coupled and depends on other factors such as the influence of domestic institutions, bureaucratic politics, and strategic culture.
2. The choices that competitors have open to them are constrained by economic, technological, human, political, alliance, and/or other factors. A competitive strategy seeks to identify and exploit these constraints through cost-imposition strategies. Some of these approaches include strategies of dissuasion.
3. Competitive interactions may play out over decades, which is very likely the case with the United States and China.

THE US RESPONSE TO ITS ERODING MILITARY TECHNOLOGICAL SUPERIORITY

To address the erosion in US military technological superiority, the Pentagon launched the Third Offset Strategy and the Defense Innovation Initiative in 2014–2015. These aim to identify and invest in innovative ways to regain and sustain US military dominance. The strategies have a number of characteristics, in which China looms large as a 'pacing threat':

1. ***Conventional deterrence against great powers:*** The central tenet of the US strategy is to develop a dominant conventional deterrent against Russia and China that reduces the chances of major military conflict between them.
2. ***Asymmetric competition:*** Avoid competition in quantitative arms races with potential adversaries. Focus instead on developing technologically superior quality to compensate for the numerical superiority enjoyed by these rivals.
3. ***Strategy based, technology oriented:*** While technology is important, operational strategies and organizational constructs are also key elements in gaining advantages against numerically stronger opponents.
4. ***Operational level of war:*** The primary focus of the initiatives is in the operational planning and conduct of campaigns that consist of assigning missions, tasks, and resources to military organizations. The principal operational concerns of the Department of Defense (DoD) are:
   a. the growing vulnerability of its global system of military bases, especially those that are close to major potential adversaries in the Asia-Pacific and Europe;
   b. the increasing ability of opponents to detect, track, and engage US aircraft carriers and other major surface warships at extended ranges from their coasts;
   c. the build-up of modern integrated air defense systems that are making it increasingly difficult for US and allied airpower to enter into contested opposition airspace; and
   d. the militarization of space that means it is no longer a sanctuary from military conflict.[4]

DoD officials have acknowledged that the origins of the Third Offset Strategy come from the threat posed by China. Speaking at a defense forum in November 2015, Secretary Work disclosed that the DoD first began to think about the Third Offset Strategy in the early 2010s when Ashton Carter, Deputy Secretary of Defense at the time, established the Strategic Capabilities Office "focused on the advanced capabilities that we were seeing in the Western Pacific."5 The only country undertaking these developments was China.

While the Third Offset Strategy and Defense Innovation Initiative are still in their preliminary stages of development, they do signal that the United States has taken its first steps in engaging China directly in defense technological competition. From a US defense acquisition perspective, these strategies are being operationalized in the Long-Range Research and Development Program Plan (LRDPP), modeled on an effort started in the 1970s when the United States successfully offset Soviet military numerical superiority with disruptive technological capabilities such as stealth and precision strike.[6]

US Undersecretary of Defense for Acquisition, Technology, and Logistics

3 Octavian Manea, "Lessons from Previous Competitive Strategies: Interview with Thomas G. Mahnken," *Small Wars Journal* 10, No. 1 (January 2014), http://smallwarsjournal.com/jrnl/art/lessons-from-previous-competitive-strategies.

4 See Robert Martinage, *Towards a New Offset Strategy* (Washington DC: Center for Strategic and Budgetary Assessments, 2014), 23–32.

5 Remarks by Robert Work on the Third Offset Strategy at the Reagan Defense Forum, November 7, 2015, http://www.defense.gov/News/Speeches/Speech-View/Article/628246/reagan-defense-forum-the-third-offset-strategy.

6 "DoD Seeks Future Technology Via Development Plan," *DoD News,* December 3, 2014, http://www.defense.gov/

Frank Kendall, who led the LRDPP efforts during the Obama administration, provided a succinct assessment of the military technological threat posed by China at a Congressional hearing in January 2015 in providing the geostrategic context for the renewed innovation drive by the DoD:

> China has developed and fielded advanced weapons designed to defeat US power projection forces. Many more are in development. These systems include a range of capabilities but foremost among them are accurate and sophisticated cruise and ballistic missiles designed to attack high value assets; particularly the aircraft carriers and airfields that we depend upon for power projection. These missiles, fielded in large numbers and coupled with advanced electronic warfare systems, modern air-to-air missiles, extensive counter-space capabilities, improved undersea warfare capabilities, fifth-generation fighters, and offensive cyber weapons, pose a serious and growing threat.[7]

A number of new and emerging high technologies, especially in the areas of artificial intelligence and autonomy, have been revealed as the initial focus of the Third Offset Strategy and Defense Innovation Initiative in order, as Work argued, "to deter" against potential adversaries:[8]

Autonomous 'deep learning' machines and systems: The Pentagon wants to develop these capabilities to improve its early warning and prediction of events.

Human-machine collaboration: This refers to how machines can interface with humans to assist with decision-making. One example is the development of highly advanced helmets for fighter pilots that fuse data from multiple systems for the pilot.

Assisted-human operations: Research is being targeted on how machines can help humans operate more effectively. The Defense Advanced Research Projects Agency, for example, has been developing an experimental 'Iron Man' exoskeleton suit. This research is different from "enhanced human operations" which focus on modifying the human body and brain, and which Work claimed "our adversaries are pursuing, and it scares the crap out of us, frankly."[9]

Human-machine combat teaming: Such initiatives leverage the unique advantages of people and machines, including robotics and artificial intelligence, into hybrid teams with the goal of delivering decisive advantages on the battlefield. This is already being applied, for example, with the teaming up of human operators and unmanned systems such as the US Army's Apache helicopter and Gray Eagle unmanned aerial vehicle or the US Navy's P-8 reconnaissance aircraft and the MQ-4C Triton unmanned carrier-launched airborne surveillance and strike drone.

Network-enabled semi-autonomous weapons hardened for electronic and cyber warfare environments: Many of the US military's weapons and systems are semi-autonomous and connected to vulnerable networks. These will require modification and hardening to prevent being disabled by increasingly sophisticated electronic and cyber warfare attacks, much like protection against an electro-magnetic pulse attack during the Cold War. Work is taking place, for example, to make the Small Diameter Bomb operate without reliance on global positioning system information to direct it to its target.

The research briefs by William Lucyshyn and John Rigilano and by Katherine Blakeley assess the long-term ability of the Pentagon to successfully preserve its technological edge through the Third Offset Strategy in light of significant industrial and financial constraints. Lucyshyn and Rigilano look at the forces shaping the US defense industry and point to the impact of budgetary pressures, downward trends in research investment, growing regulatory burdens, and strong resistance to engaging in international cooperation as major barriers to the maintenance of a vibrant and innovative defense industrial base.

Blakeley focuses on long-term US defense budget trends and the implications for technological innovation and predicts that flat budgets and rising operations and maintenance costs will be a major brake on procurement and research, development, test, and evaluation (RDT&E) spending in the near and medium term. Later-stage RDT&E for the maturation of weapons systems and platforms in development will be especially impacted. Moreover, the concentration on large, expensive, and technologically advanced programs within the RDT&E budget heightens the budgetary and strategic risks of any cost overruns.

CHINESE VIEWS OF US–CHINA DEFENSE TECHNOLOGICAL COMPETITION

Perceptions among Chinese defense and national security policymakers and planners that the United States is becoming a direct military competitor and potential adversary has been gaining ground over the past decade. Intensifying security frictions and competing interests have deepened strategic distrust between the two

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7 Testimony of Frank Kendall before the US House Armed Services Committee, January 28, 2015.

8 Remarks by Work at Reagan Defense Forum. See also his speech at the CNAS Defense Forum, Washington, DC, December 14, 2015, http://www.defense.gov/News/Speeches/Speech-View/Article/634214/cnas-defense-forum.

9 Remarks by Work at Reagan Defense Forum.

countries, although the Chinese, especially official, views are more circumspect. In a 2012 study of US–China strategic trust, Wang Jisi, an influential academic foreign policy adviser to the Chinese leadership, pointed out that

> some high-ranking Chinese officials have openly stated that the United States is China's greatest national security threat. This perception is especially widely shared in China's defense and security establishments and in the Communist Party's ideological organizations.[10]

Such views of the increasingly contested nature of US–China security relations and interests have yet to be reflected in authoritative Chinese strategic and military doctrines and policies that are publicly available. These have tended to be more carefully guarded in their assessments of the United States because China's overarching strategic priority continues to be focused on economic development, which can only be effectively carried out in a non-antagonistic security environment.

In discussing the regional security situation surrounding China, the 2015 Chinese defense white paper pointed out that, "as the world economic and strategic center of gravity is shifting ever more rapidly to the Asia-Pacific region, the United States carries on its 'rebalancing' strategy and enhances its military presence and its military alliances in this region."[11] The white paper is even more circumspect in not mentioning the United States in its assessment of intensifying global defense technological competition and its implications for China's national security:

> The world revolution in military affairs is proceeding to a new stage. Long-range, precise, smart, stealthy, and unmanned weapons and equipment are becoming increasingly sophisticated. Outer space and cyber space have become new commanding heights in strategic competition among all parties. The form of war is accelerating its evolution to informationization. World major powers are actively adjusting their national security strategies and defense policies, and speeding up their military transformation and force restructuring. The aforementioned revolutionary changes in military technologies and the form of war have not only had a significant impact on the international political and military landscapes, but also posed new and severe challenges to China's military security.

While official Chinese documents and policies are silent as to whether China's military developments are in direct response to perceived threats and actions from the United States, there is an emerging debate over these action-reaction dynamics among security analysts, scholars, and writers in institutions affiliated with the military, state, and Communist Party.[12] In their research briefs, Fan Gaoyue and Tai Ming Cheung highlight growing discussion of the Third Offset Strategy by Chinese analysts.

Cheung's brief discusses the nature, dynamics, and direction of increasing US–China military strategic technology competition and how the Third Offset Strategy may influence implementation of Chinese strategies and plans for long-term development of its military technological and warfighting capabilities. Fan points out that Chinese military analysts have divergent views on the rationale and intentions behind the Third Offset Strategy. Some believe it is a trap to lure China into a contest in areas that in which the United States has strong advantages, much like what happened to the Soviet Union in the 1980s. Another school of thought is that the Third Offset is a cover to hide US weaknesses. The official Chinese view is to take a wait-and-see attitude and continue to press ahead with China's development of asymmetric capabilities.

To support this pursuit of increasingly advanced military technological capabilities, the Chinese defense industry is undertaking major reforms, which are detailed in the research brief by Tai Ming Cheung, Eric Anderson, and Fan Yang. These reforms include new long-term plans and institutional arrangements, an emphasis on turnkey technologies and civil-military integration, and capital market access. China's increased ability to forge an independent development path will make it more resistant to US competitive strategies. Cheung, Anderson, and Yang argue that the accelerating pace and intensity of Chinese defense industry developments represent a long-term challenge to US military technological superiority.

US–CHINA STRATEGIC COMPETITION IN THE AIR, SEA, SPACE, AND EMERGING TECHNOLOGY DOMAINS

US–China military technological competition in space and missile, military aviation, naval, and new and emerging technologies are examined in several case studies. Kevin Pollpeter looks at the missile, space, and counterspace domains and argues that China and the United States find themselves in a security dilemma characterized by a competition that could easily turn into an arms race. Both sides, and

10 Kenneth Lieberthal and Wang Jisi, *Addressing US–China Strategic Distrust* (Washington, DC: Brookings Institution, 2012), 13.

11 State Council Information Office, "China's Military Strategy," May 25, 2015.

12 See Michael Swaine, "Chinese Leadership and Elite Responses to the US Pacific Pivot," *China Leadership Monitor* 38 (summer 2012).

especially their navies and air forces, have developed new operational concepts and are emphasizing joint, networked approaches to command and control; investment in technologies and new organizations to ensure the survivability of space capabilities; and development of counterspace capabilities to deny the other the use of space.

In contrast, the indicators of direct competition in the aviation and maritime spheres appear to be more mixed. In their case study of US–China strategic competition in military aviation, Oriana Skylar Mastro and Michael Chase look at three factors—resource allocations, targeted platform development, and airpower employment concepts—to determine the competition's nature and extent. They conclude that while China has been competing with the United States for several decades, it is not until recently that the United States has directly thought about and responded to China.

Jordan Wilson and Bryan Clark examine US–China strategic competition in the maritime arena, where the dynamics seem similar to what has been taking place in aviation. China has been pursuing an asymmetric approach to counter the US Navy since the 1990s that started with investments in long-range radars and cruise and ballistic anti-ship missiles before proceeding to the current focus of a rapid buildup of navy, coast guard, and maritime militia components. The US Navy has primarily continued its investment in long-range, high-endurance "blue water" capabilities to project power far from US shores. Wilson and Clark believe that bilateral maritime strategic competition is on the increase, although it is still in the initial stages of development.

Daniel Alderman and Jonathan Ray focus on US–China strategic competition in artificial intelligence (AI) and emerging technologies. While they see rising competition in the defense and security domains, they point out that the two countries' research and development (R&D) of commercial emerging technologies is becoming deeply integrated and provides mutual benefit to each country's consumer markets. They also offer a basic analytical framework to simplify assessment of the complex bilateral interactions between the two countries in AI and other emerging technologies.

STRATEGIC AND GLOBAL IMPLICATIONS

Another cluster of research briefs examines the strategic and global implications arising from an intensification of US–China long-term military technological competition. Vasily Kashin offers a Russian perspective on the Third Offset Strategy and its implications for Sino-Russian cooperation. Kashin points out new patterns of defense technological cooperation between Russia and China, which might be deepened and accelerated in response to the US Third Offset Strategy. The first trend is the growing role of Russian companies as subcontractors in Chinese defense industrial R&D and production projects. A second trend is the start of major joint projects, such as joint development of a wide-bodied commercial airliner. The third trend is the start of significant imports of major Chinese components for Russian military platforms and systems. Overall, Kashin believes that Russia and China may be moving to a mutually dependent military industrial alliance.

Richard Bitzinger addresses the implications of the Third Offset Strategy for the global arms industry. His assessment is that the United States will likely have to pursue the strategy on its own for the near to long term because it is the only country with the strategic requirements, resources, and advanced technological capacities to engage in such a capabilities/technologies approach. Bitzinger argues, however, that the United States might find a receptive audience among its key allies in Europe, Japan, South Korea, and Israel if it were to take the lead in promoting international initiatives toward developing third-offset capabilities. These partners might be motivated to take part by lucrative benefits such as jobs and access to advanced technologies.

Evan Montgomery looks at the implications of the US–China military technological competition for the long-term regional and global balance of power. He argues that the emerging technologies associated with the Third Offset Strategy, such as robotics, directed energy, hypersonic propulsion, additive manufacturing, large-scale data analytics, and autonomous operating systems, could significantly change the dynamics of the competition. Montgomery points out that it is difficult to predict at present which country will gain and which will lose. Key factors to consider when assessing the long-term implications of these new technologies are local versus global effects, evolutionary versus revolutionary dynamics, hardware versus 'software' capabilities, perceptions versus reality, and conventional versus paramilitary versus nuclear competition.

Finally, it is important to situate the emerging US–China military technological competition in the broader context of the economic, financial, and industrial relationship between these two great powers, which is the focus of Julian Snelder's research brief. While the United States is still the world's largest economy and far more productive than China, especially in terms of labor productivity, Snelder points out that with a projected 6–7 percent annual growth in GDP, China will eventually overtake the United States to become the world's biggest economy. In finance and trade, the once-cordial US–China relationship is turning more acrimonious because of rising protectionist and neo-mercantilist policies on the Chinese side and to a lesser level on the US side. Foreign companies are becoming less

enthusiastic about investing in China because of growing restrictions, while Chinese investment abroad is surging. These investments face rising scrutiny, especially in the United States and in sensitive sectors such as high and emerging technologies. At the same time, China is seeking to challenge the US-dominated global commercial system by creating its own financial institutions and questioning the workings and standards of the international financial order in areas such as accounting, transparency, and other regulatory mechanisms.

Snelder argues that this intensifying financial rivalry is spilling into the industrial arena, especially with Beijing's active pursuit of interventionist industrial policies to turn the country into an advanced manufacturing and high-end innovation power. In conclusion, Snelder believes that the economic, financial, and industrial gap between the United States and China will continue to close over the long term. Washington faces the risk of becoming commercially marginalized as Japan did in the 1990s and 2000s as China systematically takes over leadership of a broadening array of industrial sectors. But China also faces the growing risk of spiraling into the debt trap that has left Japan increasingly stagnant.

CONCLUSIONS

The election of Donald Trump makes deepening US–China frictions and strategic competition more ominous than ever. Although there is a real possibility that the new administration may not retain the Third Offset Strategy under its existing moniker, there is a good chance that it will be retained, renamed, and adjusted so that the Trump administration can claim it as its own brainchild.

One likely, and large, difference between the Obama and Trump administrations regarding military strategic competition with China is that the former administration sought to keep the military technological and industrial rivalry separate from a more constructive economic and trade relationship. This separation could disappear under Trump as his administration seeks to pursue far more assertive and economic nationalist international economic and trade policies. This can only add fuel onto the already combustible military technological and industrial competition between the United States and China.