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Editors: Jack Thompson, Oliver Thränert

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Authors: Michael Haas, Jeronim Perović, Jack Thompson, Lisa Watanabe

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Editors STRATEGIC TRENDS 2019: Jack Thompson, Oliver Thränert
Series Editor STRATEGIC TRENDS: Andreas Wenger

Contact:
Center for Security Studies
ETH Zurich
Haldeneggsteig 4, IFW
CH-8092 Zurich
Switzerland

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CHAPTER 2

The Eclipse of Western Military-Technological Superiority

Michael Haas

Ever since they grasped the promise of the information revolution in the late 1970s, the United States and its allies have enjoyed a sizeable military-technological advantage over any plausible adversary. Now, as new technologies enter the limelight and competitors become more adept at appropriating or offsetting Western strengths, this qualitative superiority in armaments is eroding. With the underlying trends gathering steam and policy interventions already falling short, Western armed forces will increasingly face a choice of confronting revisionist challengers on even terms – or not at all.

A US Air Force F-22 Raptor fighter jet performs ahead of the International Air and Space Fair at Santiago International Airport, March 28, 2016. *Ivan Alvarado / Reuters*

Even though they may sometimes appear to operate in a world unto itself, military organizations tend to reflect important properties of the societies that build and sustain them. Hence, it should not come as a surprise that Western approaches to conventional deterrence and military conflict, as they have evolved in the late 20th and early 21st centuries, have taken a profoundly techno-centric turn. While the search for engineering solutions to national security problems appears to be a persistent feature of the US cultural setting, in particular, other liberal democracies have exhibited a similar tendency.[1] In parallel with a deep-seated belief in the transformative power of technology in the civilian sphere, the recourse to high-tech solutions across a broad spectrum of military problem sets has become an essential feature of force development and defense procurement in Western-style armed forces.

The considerable success the West has enjoyed in establishing and – for a time – upholding this paradigm of military-technological pre-eminence has had important consequences for the international order. During the 1980s, the financial impact of the intensifying competition in advanced conventional forces arguably hastened the fall of the Soviet Union. In the decades since, the Western capabilities that resulted from late Cold War defense programs have facilitated a US-centric distribution of power, buttressed existing alliances, and enabled wars of choice. They have also set a standard of military modernization to which other countries aspire – and spurred counter-innovation among those who feared that they might find themselves at the receiving end of Western interventionism.

In both regards, Operation *Desert Storm* – the eviction of Iraqi forces from Kuwait – constituted a watershed event. When President George H.W. Bush declared the end of major combat operations against Iraq on February 27, 1991, it became evident that US and allied forces had crushed one of the world's largest armies at astonishingly low cost to themselves. To other military powers, especially those organized according to Soviet or other non-Western principles, the Gulf War appeared to serve notice of a new era in military affairs, in which Western force projection would be extremely difficult to resist by any means currently available to them, short of nuclear weapons.

The West's adoption of a paradigm of guided weapons, signature-reduced platforms like stealth aircraft, sophisticated intelligence, surveillance and reconnaissance (ISR) assets and

pervasive battlefield networking was, as yet, in its early stages. But the military foundations of the United States' preeminent position in the international system seemed assured for decades to come. While the promise of a more collaborative, US-led world order that the Gulf War coalition had appeared to foreshadow soon proved illusory, the reality of Western military superiority was inescapable. According to a 2011 Rand study, the Chinese People's Liberation Army (PLA) was particularly impressed by what it had witnessed: "The 1991 Persian Gulf War sent shockwaves throughout China's military community and accelerated the PLA's modernization and shifts in strategy. The United States' overwhelming dominance in that conflict led Chinese military leaders to push for advanced military technologies."[2] The armed forces of the newly formed Russian Federation also took notice, although their ability to react was curtailed by a chronic lack of resources.

Almost three decades later, the so-called Revolution in Military Affairs (RMA) touted by American theorists during the 1990s is following the familiar trajectory of earlier spells of military-technological innovation, in that it has produced advantages of limited extent and durability.[3] While many of the innovation processes set in motion during the 1980s and 1990s continue to bolster the capabilities of Western-style armed forces, the so-called guided weapons revolution has entered the stage of global diffusion. And while some of the greatest triumphs of late-Cold War engineering – such as long-range, very-high-precision cruise missiles or stealth aircraft – remain inaccessible to all but the wealthiest and most technologically advanced countries, they are no longer the exclusive domain of the United States and its closest allies.

Although this would in itself constitute a significant development, it is the underlying shift in the patterns of innovation that should give pause to Western decision-makers. Whereas the late-Cold War advances in military technology were critically dependent on government-funded research and development (R&D) to come to fruition, ongoing innovation processes in fields such as biotechnology, nanotechnology, quantum computing, robotics, artificial intelligence (AI), augmented reality, and additive manufacturing are far more reliant on open knowledge economies populated by private actors. Because this knowledge ecosystem is far more transparent and accessible by design, the challengers of Western military preeminence find themselves

operating in an environment from which cutting-edge technologies can be extracted with relative ease. Foreign acquisitions, joint ventures, multinational research programs, and international student exchanges are all part of the same toolbox in this regard, as are industrial espionage and other forms of intellectual property theft.

As a result, the odds that non-Western actors will not only catch up, but actually pull ahead of the United States and its allies in some areas of technology development are set to increase dramatically. As a result of its striking economic growth over the last 20–30 years, this is true of the People's Republic of China (PRC) in particular. Given that the Western advantage in military forces is itself derived from a limited portfolio of key technologies, the formation of pockets of Chinese advantage would amount to an important break with a pattern of incremental progress in military technology development that has marked the past two to three decades. At the same time, the ability of other actors to cancel out existing Western strengths by combining less advanced technologies and asymmetric doctrines has also increased, and this is a function of raw economic power to a much lesser extent. While advantages in military technology have never been static, it seems increasingly likely that another watershed will be reached in the 2020s, with long-term implications not just for Western military policies and force development priorities, but for the international order at large. In the following we will look into the root causes of this dynamic, assess Western policy initiatives designed to offset it, and consider the way forward.

The Crumbling Foundations of Western Advantage

To understand why the military superiority of Western democracies can no longer be taken for granted, as it long had been after 1991, one must ultimately look beyond the field of defense innovation and reckon with two economic megatrends that are altering the underlying parameters of military technology development. The first has been the rapid growth of many non-Western economies, and the spectacular expansion of the Chinese economy in particular. The second concerns the ways in which new technologies are developed and shared within a globalized economic environment.

The rise of the non-Western economies constitutes, without a doubt, the most consequential global transformation of the early 21st century. In 1991, China's share of the world economy was 4 percent. The United

States' share was 21 percent. Today, China's illiberal capitalist model accounts for close to 19 percent of the global economy, whereas the US share has dropped to 15 percent – a trend which looks set to continue. Equally impressively, the advanced economies of 1991 – most of them Western-style liberal democracies – collectively accounted for 63 percent of the gross world product, while developing nations created the remaining 37 percent. Five years from now, according to projections from the International Monetary Fund (IMF), these proportions will likewise have been reversed.

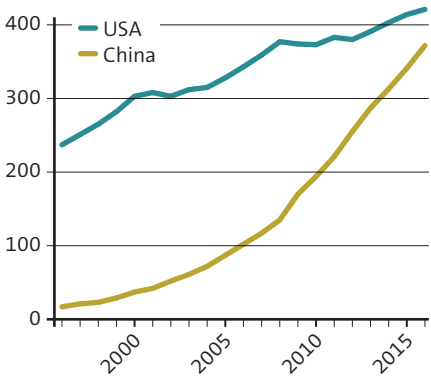
While the relationship between economic potential and military capability is not straightforward, they have usually been strongly correlated in the long term. As Paul M. Kennedy famously argued, "economic prosperity does not *always* and *immediately* translate into military effectiveness, for that depends on many other factors, from geography and national morale to generalship and tactical competence. Nevertheless, the fact remains that all of the major shifts in the world's *military-power* balances have followed alterations in the *productive* balances."[4] Given the profound reversal of the global economic balance of power that has been underway for the last thirty years, it would not be surprising to eventually observe significant knock-on effects in the military sphere. Although the mechanisms that underpin this expectation are complex, advances in military technology primarily depend on two factors: A state's capacity to extract financial resources from the domestic economy and funnel them into military modernization, and its competency in harnessing new technologies through indigenous R&D or by acquiring them from abroad, and fielding them in a timely manner.

The second overarching trend that is contributing to the relative military decline of the West is a radical shift in the patterns of technological innovation itself, which is likely to further undermine existing relative advantages in the medium- to long-term. During the 1970s, when the technological foundations of the so-called Revolution in Military Affairs took form, cutting-edge R&D was preponderantly state-funded and territorially confined. More than half of all R&D funding in the United States typically came out of the federal budget, and no less than 50 percent of every federal R&D dollar went directly into defense projects. As of 2018, the US federal government accounts for less than a quarter of national R&D funding, and civilian applications have overtaken defense projects in the public spending category.[5]

Over the last decade, the trend towards private funding has only become more distinct. In the United States, the overall financial *intensity* of R&D as a percentage of the GDP has remained about the same, at approximately 2.6 percent, but the share of public funding has declined from 1.2 to 0.7 percent.[6] In other words, even though military R&D spending remains a well-funded aspect of the US defense effort, the likelihood that a cutting-edge technology will be developed using private rather than public money – and, therefore, privately owned – is now much higher than it was forty years ago. Given that the US federal tax base will be strained by escalating health care and other entitlement costs, this downward trend is set to continue or even accelerate in the 2020s. Predictably, similar patterns are already asserting themselves in other Western democracies.

Gross Domestic Expenditure on R&D

In constant 2005 billion USD (PPP)



Source: UN Educational, Scientific and Cultural Organization

At the same time, the private technology companies that have taken on the mantle of primary R&D funders have become key players in a global economic model that is based on open exchange and non-discriminatory treatment. As part of deliberate offshoring and outsourcing strategies pursued over the last three decades, many of these same companies have become dependent on complex and highly specialized global supply chains, often centered on manufacturing sites and service providers in China or other emerging economies. In many cases, these dependencies have resulted in the transfer of proprietary knowledge as well as significant know-how, be it surreptitiously or by design. During that same period, Chinese foreign direct investment (FDI), in the form of acquisitions of US companies or assets, has increased from less than 50 million USD per year to a record 44.2 billion in 2016 alone. While the largest influx of Chinese FDI has been into the real estate sector, investments in information and communications technology have come second.[7]

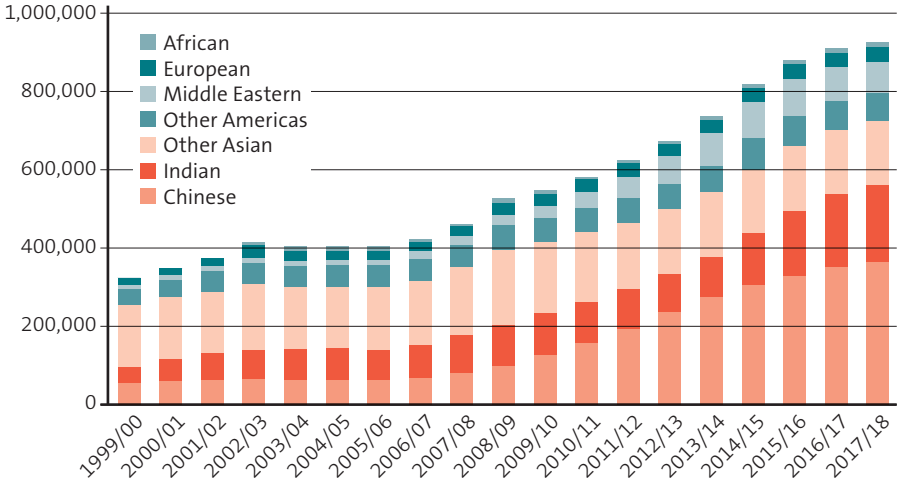
Aside from economic activities, narrowly defined, the transfer of specialized knowledge from advanced,

Western-style economies to emerging countries has been further accelerated by other forms of legitimate international exchange, especially in tertiary education and the applied sciences. While the net impact of the steady rise in the number of foreign students and researchers is difficult to quantify, there is no doubt that government-run initiatives such as China's Thousand Talents Plan have been designed to siphon off high-value research findings from abroad. Even without such carefully orchestrated activities, however, the repatriation of Western-trained scientists and engineers at the rate of tens of thousands per year constitutes one of the most impressive instances of global knowledge transfer ever undertaken. Because most cutting-edge technologies are now ostensibly commercial in nature, state tools such as classification and export control are often inapplicable and the recourse to effective restrictions difficult to legitimize.

Lastly, Western government bureaucracies, private companies, universities, and other entities are being subjected to a panoply of intelligence and criminal activities. This includes massive cyber incursions as well as other technical collection efforts, along with more traditional approaches to industrial espionage using trained agents or "non-traditional collectors," such as academics and businessmen. These intrusions have frequently been aided by a naïve approach to information security on the part of Western entities, and a corresponding lack of stringent precautionary measures, even among military organizations and defense contractors.[8] Although a small number of high-profile hacks and human intelligence activities have received most of the public attention, the impact of economic espionage goes far beyond these high-profile incidents. The boundaries between such state-sanctioned theft and various non-state criminal undertakings are often fluid, and likely to remain so.

These factors are rendering the idea of tightly controlled – let alone exclusive – government ownership of cutting-edge technologies obsolete and enabling far broader access to the bases of future military innovation. By the same token, they are contributing to the emergence of potent indigenous innovation hubs in a number of emerging economies, among which China has profited the most. Even though other actors – India, Malaysia, Indonesia, the Philippines, Thailand, Vietnam, and Brazil, to name a few – have also made significant gains, Beijing's efficacious exploitation of the open technology ecosystem's opportunities and vulnerabilities is in a category of its own.

International Students at US Universities



Source: Institute of International Education

While concerns about relative gains have long been muted in the commercial sphere and the efficiency of the globalized model of technology development and high-tech manufacturing remains widely accepted, Western democracies are being reminded that the same set of principles may not be equally applicable to matters of national security. From the perspective of the long-term defense planner, the triumph of open, networked supply chains and the prevalence of private-sector R&D in promising fields such as artificial intelligence, biotech or quantum computing take on a different complexion. Unfortunately, the resulting dilemmas are not easily resolved.

The Limits of Policy Interventionism

The trends sketched out above are structural and long-term in nature. If this were not the case, a solution to the problem of relative military decline might entail a selective acceleration of Western technological advances in the defense sector, without impinging on the civilian economy. This would mean that the attempts of strategic rivals to nullify or leapfrog current advantages would be rendered ineffectual simply by outperforming them in the defense segment, without causing any undue collateral damage. Regrettably, such a straightforward solution is not in the cards. To understand why, we must first explore the

relationship between commercial and military technology development in somewhat greater detail.

While contributions to the current debate sometimes seem to suggest otherwise, the dependence on commercial technology in defense innovation is not a new phenomenon, although its full scale and consequences are only now becoming apparent. In fact, advanced weapon systems of the current generation – generally fielded during the late 1990s and 2000s – have long relied on commercial products in key areas. The backbone of the US advantage in air-to-air warfare, the F-22A *Raptor* air superiority fighter, is a case in point. The heart of the F-22's advanced combat capabilities – its computing architecture – was originally based on a microprocessor developed in the early 1980s and never released to the civilian market: the Intel i960MX. However, this changed after the aircraft became operational in the early 2000s, with an upgrade of the entire architecture to the PowerPC standard. Launched by Apple, IBM, and Motorola in the early 1990s, this was a commercial technology, intended not for military use, but for the growing personal computer market. PowerPC microprocessors were used in iMacs and iBooks until 2006. Similarly, the F-22's high-speed serial bus, which transfers data between the various internal components of the aircraft, is a version of Apple's civilian FireWire standard.

What is of interest here, though, is not that the basic technologies underpinning the F-22's advanced data processing were commercial in nature. Rather, it is the extreme lengths to which the prime contractor and various subcontractors had to go to fully embed these technologies and make them suitable for combat-critical military use.[9] While it is tempting to assume that these intricate and time-consuming requirements will apply to a lesser extent to current commercially-driven technologies in fields like computer vision and machine learning, the opposite is bound to be true: as the level of complexity of embedded commercial technologies continues to rise, the need for extensive adaptation, systems integration, and testing will further increase. Because the systems architectures of advanced military platforms are at the heart of their cutting-edge capabilities, this work will be highly classified and performed by specialized defense contractors, as it has been in the past. In other words, there is every reason to believe that leading tech firms will continue to provide the technology base and the defense industry will continue to provide the capability. Whereas the former will spread

around the globe with ease, development of the higher tiers of future combat systems will still require the costly services of capable systems integrators and other specialized contractors that are available only to a select few in the international system.

Although this may sound like good news, it raises serious questions for the West's attempt to prolong its military superiority. Even though many Western observers assume that liberal democracies will continue to outperform any strategic rival where the integration of commercial and military technologies is concerned, this is not inevitable. Given that their economic model is based on free enterprise, limited state interference and the rule of law, the ability of the Western democracies to co-opt or coerce private corporations headquartered on their territory to do their strategic bidding generally comes in the form of standard financial incentives. The same is mostly true of their relationship with major defense contractors.

Unfortunately, this does not necessarily apply to rivals that may be able to combine the advantages of the market in fostering innovation and allocating resources with state interference to further a particular conception of the national interest. Hence, the US and Chinese defense-relevant industrial bases may both be inefficient, but Beijing's tight grip on providers of strategic goods and services within a framework of "civil-military fusion"[10] means that inefficiencies barely matter once political priorities get in the way of market mechanisms. Skyrocketing cost, in other words, may not function as an effective restraint on a system like China's. Overall, state capitalism may not be better at fostering innovation but it would appear to be more effective at distorting specific segments of the economy in line with current strategic priorities. While the net economic impact of such distortions may well be negative, in the context of this discussion, it is beside the point.

This should lead us to rethink Western policy interventions designed to arrest the ongoing slide in military capability. The most obvious example of such an initiative is the Pentagon's so-called Third Offset Strategy. Launched in 2014 by then-Secretary of Defense Chuck Hagel, it was described as a "department-wide effort to identify and invest in innovative ways to sustain and advance America's military dominance for the 21st century."[11] Modeled on two Cold War-era offset strategies, which sought to balance the numerical superiority of the Warsaw Pact, first with a broad variety of nuclear weapons and later with guided munitions, long-range

sensors and battle networks, this was primarily intended to address growing US-China competition in the Western Pacific.

In 2015, the architect of the Third Offset, Deputy Secretary of Defense Robert O. Work, set out a number of technological priorities clustered in the fields of artificial intelligence, machine autonomy, learning systems, and human-machine interfacing. These were expected to play a central role, especially during the first phase of the initiative. To gain direct access to the commercial actors at the forefront of this anticipated revolution, the Department of Defense set up a Defense Innovation Unit Experimental (DIUx) in Silicon Valley. As of 2016, the Department expected to spend only 18 billion USD on Third Offset priorities over a five-year time frame.

As some observers have since noted, the strategy appears to have shed its primarily techno-centric approach in favor of nearer-term operational concerns, in accordance with the broader defense priorities of the Trump administration.[12] While it is not yet clear in which direction the next Secretary of Defense will take the United States' defense innovation efforts, four years into the initiative its bureaucratic momentum appears to have stalled. Given the limited resources it has so far been able to mobilize, the ability of the US defense bureaucracy to shape technological innovation in the commercial sector appears limited. The controversy surrounding Google's participation in the now infamous Project Maven – a machine learning initiative that was publically linked to the United States' targeted killing programs – illustrates the point.[13]

Hence, those who had placed their hopes in the technological *deus ex machina* of a Third Offset have largely fallen silent. As Robert Work noted, there is reason to believe that it is, in fact, still the United States that is being offset in the Western Pacific.[14] To the extent that similar techno-centric efforts are under way in other Western nations, their chances of success inspire even lower levels of confidence. There is a chance, of course, that the Third Offset may be revitalized or that more circumscribed initiatives will succeed.

That said, the underlying issue may be more fundamental in nature than many observers – in particular in the Euro-Atlantic sphere – acknowledge. Western-style market economies may be capable of unsurpassed efficiency in creating the conditions for rapid commercial innovation. But when it comes to mobilizing the commercial sector to advance the state's strategic

priorities, the dirigiste measures available within the state capitalist framework may prove more effective from the standpoint of medium-term advances in military technology.

The Future of the Military Balance

How will these trends impact the military correlation of forces and shape major combat operations? In this regard, two aspects deserve particular attention: The first is the growing ability of actors like China, Russia, and India to press for parity in some established areas of Western advantage, such as air and missile power. The second concerns the question of whether – and to what extent – longer-term trends in technology development can be offset by effective force employment and superior fighting skill.

The technological advantage of Western military forces has long been reflected in operational, if not always in strategic, outcomes. As we have seen, the Persian Gulf War was a landmark event in this regard. Notable operational successes have forced non-Western actors to come to terms with the realities of Western military dominance and to seek long-term options to offset it that go beyond cheap, asymmetric fixes. One option has been to aim for an advantage or for rough parity in at least some categories of guided munitions that can undergird a determined territorial defense. This has included air-to-air missiles (AAMs) and surface-to-air missiles (SAMs), but also conventionally armed ballistic and cruise missiles designed for attacks against enemy air bases, ports of entry, and command and control facilities.

Though Russia has long been held back by its weak economy, late-Soviet and Russian technology has played a key role in offsetting the Western advantage in the air and at sea. Long-range, "double-digit" SAMs like the SA-10 *Grumble* (S-300P) and SA-20 *Gargoyle* (S-300 PMU-1/2) form the backbone of the air defenses of many non-Western military powers. The newer SA-21 *Growler* (S-400) complex is now also being offered up for export. Similarly, Russian technology has played a significant role in non-Western AAM development, including the new Chinese PL-10 and PL-15 missiles.[15] Meanwhile, Russian cooperation with India has resulted in the high-supersonic *Brahmos* anti-ship missile and similar collaborative armaments programs may enable the move towards hypersonic munitions in the coming decade.[16]

Meanwhile, in the field of conventionally armed ballistic missiles, China has made the most impressive advances. The PLA now fields a large

and diversified arsenal for potential use against Taiwan as well against US and allied air fields in the region. While many of these developments have been discussed under the moniker of anti-access/area denial (A2/AD), China's focus, in the event of a conflict, appears to have shifted from raising the cost of any US intervention to defeating it outright.[17] China also appears to have pulled ahead of Russia in stealth and counter-stealth technologies. While the problems China has encountered in pursuing these capabilities have long been touted as a sign of its inability to catch up, the innovation dynamics of the past should not be automatically extrapolated into the future. The recent advances the China Electronics Technology Group Corporation claims to have made in the field of quantum radar, which would render current approaches in low-observable aircraft design largely ineffectual, should serve as a wake-up call in this regard.[18]

To get a sense of the past dynamic of military capability development, the "pacing" Taiwan scenario continues to offer an excellent benchmark for the growth of China's regional military power. The shifting tone of Western analyses of such a conflict over the past three decades is instructive. While the Taiwan crisis of 1996 reinforced Chinese vulnerability, two decades later, the PLA's capability level has evolved in line with the 750 percent increase in its defense budget. According to one study, the US would still be able to wrest air superiority from the PLA Air Force, but as early as 2010 the forces required to do so had increased tenfold and the vulnerability of US bases in the region had grown exponentially. By 2017, according to one RAND study, "continuous improvements to Chinese air capabilities [made] it increasingly difficult for the United States to achieve air superiority within a politically and operationally effective time frame, especially in a scenario close to the Chinese mainland. These developments also raise the probable cost of a war in terms of lives and equipment."[19] Given that the PLA could achieve this shift while still relying on limited technological means, most of which belonged to the era of the highly successful Second Offset Strategy, there is little doubt that the relative standing of the United States in such a scenario will continue to deteriorate.

In this regard, it is useful to consider the United States' reliance on stealthy aircraft like the F-22 and the semi-stealthy F-35, which is believed to have been compromised by PLA cyber espionage. While neither the indigenous Chinese J-20 and J-31 semi-stealth aircraft, nor the Russian

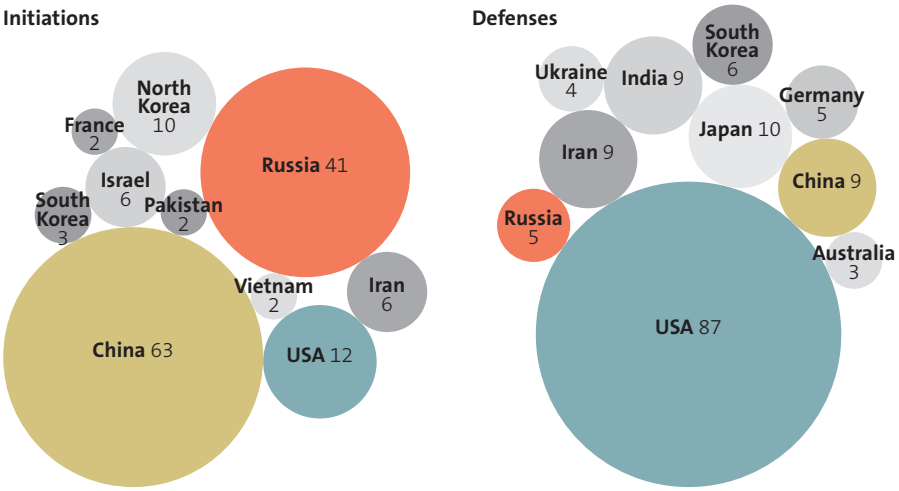
Su-57 are fully operational or available in significant numbers, the US philosophy of "first look, first shot, first kill" is already being undermined by improved air defense search radars operating outside the frequency range that is effectively countered by current stealth technology.[20] Further increases in processing power, long-range infrared sensors, passive radar, and improved missile seekers are going to further exacerbate this situation – even if the promise of quantum radar, which would rely on entangled photons for unambiguous detection at longer ranges, fails to materialize.

Given that air-to-air combat and strike warfare have long been areas of Western strength, it seems likely that the overall exchange rates between Western and non-Western forces in future conflict scenarios would be more balanced than at any time since World War II. Due to the growing lethality of opposing forces, Western militaries may become more likely to avoid costly confrontations and correspondingly less likely to heed their alliance commitments.

Nor is the prospective decline of the Western margin of superiority limited to these specific fields. Russia and China are highly capable in the cyber domain, and continue to invest in anti-satellite capabilities. Given the projected massive investments in the coming years, it has been argued that China's advances in a broad range of artificial intelligence technologies should constitute a "Sputnik moment"[21] for the United States, with implications far beyond the defense field. Although their economic bases are less impressive, other non-Western actors are likely to follow suit. While the use of long-range weapons, unmanned and autonomous systems, and improved electronic warfare and cyber support can all serve to lower costs and casualties, the upshot is that similar options will likely be available to capable opponents. Moreover, a military such as the PLA may be in a position to employ the same technologies, with many fewer constraints, than Western-style armed forces.

Technology-focused approaches may not constitute the best solution to this dilemma. Given the high levels of education, technical competency, and relatively high tolerance for independent decision-making that are often seen as characteristic traits of Western democracies, an emphasis on superior combat training, distributed command authority, and creative force employment may represent a more promising avenue for a new offset strategy. Insofar as techno-centric initiatives can contribute to such a shift, human-machine teaming has

Initiators and Defenders in Major Cyber Theft Incidents, 2000 – 2018



Sources: CSIS; DCID

the potential to amplify any pre-existing skill differentials. That said, it should not be taken for granted that liberal societies will enjoy inherent advantages in the utilization of this particular cluster of technologies in the future – nor should any one family of emerging technologies be unduly emphasized over others.

Protecting the Defense Knowledge Base

While an exclusive focus on technological solutions is unlikely to accomplish the aim of maintaining Western military superiority, the question of whether an advantage in key areas can be retained in the long run remains relevant. Several recent developments are worth mentioning in this regard. For one, an increased application of national security instruments to knowledge-intensive industries is already taking shape, especially in the United States. Hence, the Trump administration has taken a hard line on Chinese property theft and introduced measures to ensure a higher level of protection for a so-called National Security Innovation Base.[22] The Trump approach is instructive, in that it has both increased the United States' freedom of action in countering Chinese intrusions and stoked a debate about the abuse of national security instruments for commercial advantage, or even to tactically shape the domestic political discourse.

A limited and targeted application of additional protections designed to avoid the transfer of sensitive knowledge to potentially hostile actors will be unavoidable if some level of economic and military advantage is to be retained in the long run. That said, the danger that such instruments will be inappropriately applied to other, less sensitive sectors of the economy clearly cannot be discounted. A broad-based recourse to state interference would almost certainly have a stifling effect on the civilian economy. The dilemma of balancing national security and economic liberty is thus likely to remain with us for the foreseeable future.

The ability of Western democracies other than the United States to follow suit and impose controls on their knowledge ecosystems will be limited by pragmatic economic interests and concerns about economic freedom. Nonetheless, the pressure to act will continue to build. Following domestic initiatives in a number of member states, the European Union has already resolved to implement additional measures to ensure better screening of FDI. Since national security concerns remain for the individual member states to sort out, the impact of any such regulations will remain uneven. While investment screening is a step forward, it appears unlikely that the proposed measures will suffice in the longer term. Any further steps will be much more difficult to negotiate, in part due to increasingly effective foreign lobbying efforts.

It is likely that knowledge-based advantages in the defense field will continue to decline, even though the West retains options to minimize them. The combination of targeted research in more tightly controlled environments, limited interventions in the market, and expanded counterintelligence programs could contribute to the maintenance of narrower, but nonetheless meaningful, advantages for the foreseeable future. Whether such programs can be successfully implemented remains to be seen, especially in the highly fragmented European context. Balancing state interventions in the free exchange of knowledge with legitimate civilian imperatives will remain a delicate matter. Finally, while many in the West appear impervious to the historical record in this regard, broad-based technological superiority is not a necessary precondition for maintaining highly capable armed forces.

Although the danger should not be overstated, a failure to arrest the ongoing slide towards conventional military parity could further weaken US alliance commitments and security assurances in the face of revisionist

challengers. This may be true even in the absence of any major crises or military conflict. While the effects on the international order would be primarily indirect and difficult to fathom, growing pressure for US military retrenchment is difficult to reconcile with the maintenance of an alliance system based on a presumption of indivisible security. A focus on the mechanisms of technology diffusion will be necessary to minimize further losses in comparative military advantage. At the same time, a techno-centric approach may no longer be sufficient to arrest this dynamic. How best to draw on non-material advantages in an age of intense technological competition, and how to emphasize them as a viable foundation for deterrence vis-à-vis future peer competitors, should be major concerns for strategic and operational-level theorists.

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