Henrik Breitenbauch
& Tobias Liebetrau

TECHNOLOGY COMPETITION

Strategic implications for the West and Denmark

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Editors' preface

The publications of this series present new research on defence and security policy of relevance to Danish and international decision-makers.

This series is a continuation of the studies previously published as CMS Reports. It is a central dimension of the research-based services that the Centre for Military Studies provides for the Danish Ministry of Defence and the political parties behind the Danish defence agreement. The Centre for Military Studies is subject to the University of Copenhagen's guidelines for research-based services, including academic freedom and the arm's length principle. As they are the result of independent research, the studies do not express the views of the Danish Government, the Danish Armed Forces, or other authorities.

Our studies aim to provide new knowledge that is both academically sound and practically actionable. All studies in the series have undergone external peer review. And all studies conclude with recommendations to Danish decision-makers. It is our hope that these publications will both inform and strengthen Danish and international policy formulation as well as the democratic debate on defence and security policy, in particular in Denmark.

The Centre for Military Studies is a research centre at the Department of Political Science, University of Copenhagen. The centre conducts research into security and defence policy as well as military strategy. Read more about the centre, its activities, and other publications at: https://cms.polsci.ku.dk/english/.

Copenhagen, March 2021
Henrik Breitenbauch & Kristian Søby Kristensen

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Abstract and Recommendations

Increasing competition between the great powers assumes the form of a global, multi-dimensional, long-term struggle for power and position. More specifically, its dimensions include political, economic and military power. Technology plays a key part as a significant, dynamic element in the development and maintenance of these types of power.

This analysis demonstrates how great power competition, inter alia, unfolds as a short- and long-term technology competition with different strategic purposes: ultimately, global (and sometimes regional) economic and military dominance. The competition for militarily applicable technologies accentuates a classic aspect of defence policy: In addition to enabling present-day deterrence and defence, the great powers increasingly compete for who is to dominate the defence of the future. This holds especially true for Sino-American relations, now the most important bilateral relationship in international politics.

In the Euro-Atlantic context, the increased U.S. focus on innovation and technology means that the European NATO member states (and the European Union's endeavours towards militarily and technologically supported strategic autonomy) are subjected to renewed pressure. Meanwhile, the parallel development and diffusion of new, advanced missile and sensor technology have increased insecurity in Europe (Russia-West) and weakened the longstanding Western technological superiority.

For smaller allied countries with advanced economies, including Denmark, the intensified technological competition results in new points of orientation in security politics, new expectations from allies, new challenges in the European and Arctic areas, and even more defence policy cross-pressure bringing about fewer opportunities for specialization in the defence of these countries. Without a clearer technological reform agenda, the Danish Defence is at risk of being disconnected from its close allies, also in the concrete military aspect.

The analysis therefore concludes with an identification of various options for how Denmark can address the challenges brought about by technological competition, including in the forthcoming Danish Defence Agreement.

One opportunity is to determine **a technological benchmark for defence and security policy**. Such a general technological ambition concerning defence policy can secure political attention to the role of technology in the development of the Danish Defence, thereby setting a new framework for military capability development in general. This ambition should at least be to ensure that the Danish Defence is not disconnected from its close allies – not even in five to ten years.

In this context, initiatives launched in connection with the national plan of action regarding the European Defence Fund can be strengthened. For instance, the Military Technological Coordination Forum of the Danish Ministry of Defence can be used as a steppingstone for **strengthened defence planning** involving the Danish Ministry of Defence, the Defence Command and the Danish Ministry of Defence Acquisition and Logistics Organisation to support the evaluation of the demand for military capabilities by continuously comparing the development in technology with defence planning (including the development sketch). Against this background, needs for additional national and international collaboration – similar to the Danish participation in the AI Partnership for Defense – can be identified. Finally, the Military Technological Coordination Forum can be expanded with a public dimension involving both the corporate and academic sectors in a **Military Technological Council**, which can create openness around the subject and input to early, exploratory phases of defence planning.

Another, broader, possibility is to formulate a concrete **Technology Competition Strategy** anchored in the Ministry of Defence that, in addition to the Ministry of Foreign Affairs, includes other ministries relevant to innovation, such as the Ministry of Finance, the Ministry of Industry, Business and Financial Affairs, and the Ministry of Higher Education and Science. Such a strategy will have the potential to frame cooperation between the Danish Defence and the Danish IT sector, including research and development as well as concrete projects with potentially broader economic effects for society. An additional justification for such an initiative is that existing Danish digital strategies (5G, AI) have little if any security policy character.

A third opportunity is to identify a limited number of **Danish technology priorities** based on strategic importance, existing knowledge or research and development capacity (R&D), supply and value chain insecurity as well as commercial possibilities. In this way, a new framework for **the role of defence industry policy in defence policy** can be developed – a framework rooted in a broad utilitarian rationale concerning national innovation policy and international network creation. The politics of the technology priorities will thereby enable a long-term maintenance of technical expertise within the Danish Ministry of Defence Acquisition and Logistics Organisation, R&D, and production capacity within research and industry, which will thereby create political utility value in relation to allies and partners. The coming defence industrial strategy can also address this.

Resumé og anbefalinger

Den øgede stormagtskonkurrence tager form af en multidimensionel, langsigtet kappestrid om relativ magt og position i global forstand. Dens dimensioner involverer særligt politisk, økonomisk og militær magt. Teknologien spiller en central rolle som et væsentligt, dynamisk element i udviklingen og fastholdelsen af alle disse typer af magt.

Analysen viser, at stormagtskonkurrencen derfor blandt andet udfoldes som en kort- og langsigtet teknologikonkurrence, som har forskellige strategiske formål – ultimativt global (og nogle gange regional) økonomisk og militær dominans. Konkurrencen om militært anvendelige teknologier fremhæver et klassisk aspekt ved forsvarspolitikken: Udover at skabe kapacitet til nutidig afskrækkelse og forsvar konkurrerer stormagterne i stigende grad om, hvem der skal dominere fremtidens forsvar. Det gælder især i det amerikansk-kinesiske forhold, som i dag er verdenspolitikkens vigtigste relation.

I euro-atlantisk sammenhæng betyder USA's øgede fokus på innovation og teknologi, at de europæiske NATO-lande (og EU's bestræbelser på strategisk autonomi understøttet militært og teknologisk) udsættes for fornyet pres. Samtidig medfører den parallelle udvikling og spredning af ny, avanceret missil- og sensorteknologi både øget usikkerhed i Europa (Rusland-Vesten), og at den traditionelle vestlige teknologiske overlegenhed svækkes.

For mindre allierede lande med avancerede økonomier, herunder Danmark, resulterer den intensiverede teknologikonkurrence i nye pejlemærker i sikkerhedspolitikken, nye forventninger fra allierede, nye udfordringer i det europæiske og arktiske nærområde og endnu mere krydspres på forsvarspolitikken og dermed færre specialiseringsmuligheder i disse landes forsvar. Uden en tydeligere teknologisk reformdagsorden risikerer det danske forsvar at blive afkoblet fra nære allierede, også helt konkret militært.

Analysen afsluttes derfor med en identifikation af forskellige optioner for, hvordan Danmark – herunder i det det kommende forsvarsforlig – kan adressere udfordringerne fra teknologikonkurrencen.

En første mulighed er at fastlægge et **teknologisk pejlemærke for det forsvars- og sikkerhedspolitiske område**. En sådan overordnet teknologisk ambition for forsvarsområdet kan sikre politisk opmærksomhed over for teknologiens rolle i udviklingen af forsvaret og dermed sætte nye rammer for kapacitetsudviklingen generelt. Ambitionen må som minimum være at sikre, at dansk forsvar ikke afkobles fra nære allierede, heller ikke om fem-ti år.

Herunder kan man forstærke initiativer søsat i forbindelse med den nationale handlingsplan i forbindelse med Den Europæiske Forsvarsfond. F.eks. kan Forsvarsministeriets Militærteknologiske Koordinationsforum anvendes som trædesten til en **forstærket forsvarsplanlægning** med inddragelse af Forsvarsministeriet, Forsvarskommandoen og Forsvarsministeriets Materiel- og Indkøbsstyrelse til at understøtte vurderingen af det militære kapacitetsbehov ved løbende at sammenholde teknologiudviklingen og forsvarsplanlægningen (herunder udviklingsskitsen). På den baggrund kan der identificeres behov for yderligere nationale og internationale samarbejder i stil med den danske deltagelse i AI Partnership for Defense. Endelig kan man udvide Forsvarsministeriets Militærteknologiske Koordinationsforum med en offentlig dimension og inddrage både erhvervslivet og forskningsverdenen i et **militærteknologisk råd**, som kan skabe både offentlighed om emnet og input til tidlige, sonderende faser af forsvarsplanlægningen.

En anden, bredere mulighed er at fastlægge en egentlig **teknologikonkurrencestrategi**, som er forankret i Forsvarsministeriet, og som foruden Udenrigsministeriet inkluderer andre innovationsrelevante ministerier såsom Finansministeriet, Erhvervsministeriet og Uddannelses- og Forskningsministeriet. Strategien ville kunne danne ramme om samarbejde i snitflader mellem forsvaret og det digitale Danmark, herunder forskning og udvikling samt konkrete projekter, som også kan få bredere samfundsøkonomiske effekter). En yderligere begrundelse for et sådant initiativ er, at eksisterende digitale strategier (5G, AI) slet ikke eller kun i begrænset omfang har en sikkerhedspolitisk karakter.

En tredje mulighed er at identificere et begrænset antal **danske teknologiprioriteringer** ud fra strategisk betydning, eksisterende viden eller forskning og udviklingskapacitet (FoU), forsynings- og anden

værdikædeusikkerhed samt kommercielle muligheder. Dermed kan man samtidig sætte nye rammer for **forsvarsindustripolitikkens rolle i forsvarspolitikken** – rammer, der er funderet i et bredt nytterationale om national innovationspolitik og international netværksopbygning. Politikken for teknologiprioriteringerne vil på den måde muliggøre en langsigtet fastholdelse af teknisk ekspertise inden for FMI, FoU- og produktionskapacitet inden for forskning og industri og vil dermed skabe politisk nytteværdi i forhold til allierede og partnere. Den kommende forsvarsindustrielle strategi kan også adressere dette.

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1

Introduction

Technology is central to the development of international politics. The relative importance of technology is increasing dramatically, as international politics is evolving in the direction of increased great power competition, which takes the form of both economic and military technology competition. For Denmark, increased great power competition means that threats and challenges become more intense and complex throughout the territory of the Danish realm[1], its immediate surroundings, NATO territory, as well as vulnerable states and societies outside of the European space, and that allies and partners will have new expectations to Danish defence and security policy, including the technological dimension.

This report analyses the framing role of technology in relation to the international security policy conditions for Danish defence and security policy. Based on the identification of incipient trends, the analysis has a time horizon of up to 20 years. Many of the specific technologies and the general conditions and characteristics of an international politics defined by great power competition will without question remain relevant even longer, even though new developments in international politics, including a return to a more cooperative form, cannot be ruled out; also as a result of a mediation of the conflict on which the analysis focuses.

The analysis is the result of a desk study. It has the character of a synthesis of various forms of existing knowledge coupled with an analysis of the implications for the West and Denmark. The analysis is not an actual technology assessment, but it can serve as a steppingstone for other

1. The Kingdom of Denmark consists of Denmark, Greenland, and the Faroe Islands.

studies of a more technical nature concerning the strategic, operational, or tactical significance of specific technologies for Danish defence and security policy. The report has undergone the Centre for Military Studies' quality assurance, including both internal and external peer review.

The analysis is structured in three chapters between this introduction and the conclusion. The first chapter examines the overall role of technology competition in international politics, revealing how technology in general and historically has been a development variable in international politics, including security policy. It also describes the role that technology plays in the increased great power competition, which, among other things, takes the form of cross-cutting technology competition. Finally, the chapter discusses how 'disruptive' technologies, as defence policy challenges, set a new framework for defence and security policy. The second chapter presents leading-edge technologies and briefly discusses their strategic implications, including military implications. The third chapter moves down to the level of actors, discussing the complex relations between the West and the Euro-Atlantic community, and reviews the long-term strategic objectives of non-Western actors as well as their general and military technology policies.

The conclusion brings together the various threads of the analysis with a view to discussing implications in the form of challenges and opportunities for the West and Denmark, respectively.

2

Technology competition

2.1. Increased great power competition – a multidimensional conflict

The development and application of new technology is a crucial factor in the absolute and relative development of states and economies over time: The best inventor becomes the most prosperous. In terms of security policy, new military technologies are a significant development factor for the global military balance of power, which forms the basis for the global political order. The technology, investments in it, and the ability to prioritize and apply the results are thus important parameters in the long-term, multi-dimensional competition in which the great powers increasingly (again) see themselves and the rest of the actors in global policy captured. With a shift in focus from a relatively cooperative international politics characterized by globalization as economic integration to a relatively competitive international politics with increased economic (production-related) division of labour, investment in and control over the technology of the future becomes an important strategic competitive parameter for the great powers.

The global order is largely shaped by the balance of power. The balance of power shapes the kind of politics prevailing in a given system (the degree of cooperation and trust) and the stability of the concrete constellation of great powers (ultimately measured as the absence of great power wars). It is not so much the constellation (the number of great powers) that affects stability, but rather the *rate of change* in the relative distribution of power (the slower the change takes place, the easier it is to manage), and the degree of *ideological homogeneity* between the great

powers: a heterogeneous order, such as the current situation, where there are great differences in the political views of the great powers, creates greater uncertainty and unpredictability.[2] As international politics are marked by a shift in power towards non-liberal democratic states, international politics are becoming increasingly uncertain and unpredictable. In particular, China's growing role – economically, politically and militarily – is influencing international politics in the direction of more conflicting and less cooperative politics.

A significant result of this change is reflected in a shift in the focus of security policy – from North-South to East-West, and from stabilization and counterterrorism to deterrence and technology competition. The great power competition thus means a re-actualization of fundamental features of the conflict during the Cold War: just as then, the new situation is characterized by a multidimensional, prolonged competition with global reach.[3] There are significant differences between the current situation and the Cold War. Among other things, the trade patterns and economic integration between the major players are now fundamentally more developed.[4] The great power competition will thus not replace

2. Raymond Aron, *Paix et guerre entre les nations* (Paris: Calmann-Lévy, 1984 [1962]), 108-113; Barry Posen, 'Emerging Multipolarity: Why Should We Care?', *Current History* 108(721) (November 2009): 347-352.
3. In the era of globalization, security policy focused primarily on the North-South axis of international politics – on stabilization, anti-terrorism, fragile states and societies, and other challenges that largely stem from the weakness of other actors. Now, the main focus of security policy has shifted back to the East-West axis of international politics – on defense, deterrence and long-term superpower competition, also in terms of current and future military capabilities, all of which are challenges stemming from the strengths of other actors. The great power competition thus entails a re-actualization of fundamental features of the conflict during the Cold War: both are characterized by a multidimensional, lengthy competition of global reach. Robert Strausz-Hupé et al., *Protracted Conflict: A Challenging Study of Communist Strategy* (New York: Harper Colophon Books, 1963); Henrik Breitenbauch et al. 'Orden og afskrækkelse: Vestens håndtering af Rusland efter annekteringen af Krim' [Order and Deterrence: The West's Handling of Russia after the Annexation of Crimea], *CMS Report*, Centre for Military Studies, 2017: https://cms.polsci.ku.dk/publikationer/orden-og-afskraekkelse/CMS_Rapport_2017_Orden_og_afskr_kkelse_opdateret_version_31-08-17.pdf.
4. Bertel Heurlin et al. 'Forværringen af det kinesisk-amerikanske forhold: en strategisk udfordring for Danmark' [The Deterioration of the Sino-American Relationship: A Strategic Challenge for Denmark], *CMS Brief*, Centre for Military Studies, 2020: https://cms.polsci.ku.dk/publikationer/forvaerringen-af-det-kinesisk-amerikanske-forhold-en-strategisk-udfordring-for-dan-mark/CMS_Notat_Strategisk_refleksionsforum_Kina_danske_implikationer_december_2020__002_.pdf.

not replace but rather change and limit globalization and international cooperation. This drawn-out competition plays out in different dimensions and different places in different ways: Security policy-driven clashes with global production and value chains within sensitive and particularly security-relevant and militarily-relevant technologies will unfold alongside collaboration on global issues such as climate change and global health.

The prolonged, multidimensional conflict of the present is therefore not total, but varies within the various dimensions. When the superpowers are assumed to want to cooperate in certain dimensions, more room for manoeuvre is left for the smaller states – and thus also for Denmark.[5]

Finally, it is worth emphasizing that although the outline developed is likely, things can also turn out better (through successful diplomacy and further cooperation) or much worse (e.g., after a Sino-American conflict over Taiwan).

5. Heurlin et al. 'Forværringen af det kinesisk-amerikanske forhold'.

Background: Military technology revolutions in historical perspective

Throughout history, the development of new military technologies – and their subsequent political, economic, social and military exploitation – has been a significant driving force in the construction of a Western-dominated world order.

Infantry – 1340
Artillery – 1425
Fortifications – 1500
Cannon boats – 1600
Gunpowder and drill formation 1600
Napoleonic warfare – 1800
Trains and telegraphs – 1860
Steam-powered and metal-hulled ships – 1880
Mechanization – 1918
Nuclear – 1945
Precision – 1990

Military technology revolutions based on gunpowder and cannons – and the subsequent consequences for warfare, politics, trade and the structure of society – are said to have created the conditions for continued global Western domination.

The same effect is attributed to the increased transport and communication speeds that occurred with the railroad and telegraph in the mid-19th century. The nuclear revolution later formed the basis of the superpower status of the United States and Soviet Union, while stabilizing the competition between them during the Cold War.

The precision regime is the latest newcomer in a long history – if the next chapter is actively written through the conscious prioritization of new military technologies.

Source: Schaub 2018

2.2. The main features of technology competition

Because the growing great power competition is about relative positions of power, the control and development of new technologies are

important factors in technology in general, but especially within the most security-sensitive dimensions. The development and exploitation of new technologies affect the major dimensions of competition, such as politics, economics, and the military. Moreover, technological developments contribute to shifts in the internal power relations between state, citizenry, and private enterprise.

The China-US digital trade war and the EU's prioritization of technological sovereignty emphasize how global technology competition is already a key focus of international politics. This development reveals how the so-called fourth industrial revolution – where integration between the digital and physical worlds accelerates with the continued development and spread of 5G and 6G networks, the Internet of Things, big data analysis, artificial intelligence (AI), robot technology and quantum technology – has moved from being primarily a matter of developing technological-commercial solutions to becoming a global strategic and security policy battleground.

The great power competition is thus particularly manifest in a general competition over technology, where new technologies are regarded as a source of future political, economic, and military friction between the world's great powers.[6] To a greater extent than in the past, technological development and innovation are now supported by private sector investment, which usually operates across national borders and depends on global markets and supply chains.[7]

6. How technology development will affect the balance of power, the potential for conflict and the military development in the world depends on everything from political and economic priorities over culture and history to people and organizations. This highlights the importance of understanding technological competition in a broad perspective incorporating national differences. The development of new technologies affects society, the economy and the military worldwide; at the same time, however, the technological development is affected by the existing social, political, economic, and cultural conditions. The impact is thus mutual, which is why technological development does not fully determine a particular societal or military development or vice versa. Nevertheless, the technology competition, including military technology competition, has an independent force, which will significantly affect the development of international politics in the decades to come.
7. New technologies are a source with primary origins in the commercial market and which is therefore embedded in global economic competition and trade. Technology and innovation are crucial to the economic competitiveness of states. It is crucial for states to be able to create growth, to promote prosperity and increase welfare. The national meanings of technological development are thus embedded in the global economy; a global economy that binds the countries of the world together and creates interdependencies, but which at the same time forms a breeding ground for competition and conflict.

At the same time, however, a globalized economy covers significant systemic differences across the globe. This is not least due to the fact that the relations between state, market, and individual vary from great power to great power. The liberal-democratic societies are currently confronted by an autocratic state model (e.g., in China), where there is a much closer state-private enterprise relationship and, moreover, a much more unequal state-citizenry relationship. This difference provides different starting points for general innovation and economic development – which is particularly important as pertains to military technology competition.

2.3. Military technology competition

Competition over military technology development has always been an essential aspect of long-term international security policy.[8] The increasing proliferation of existing advanced military technologies together with the ongoing development of new military technologies mean that contemporary defence planning is also a battle for future force posture. Which is why the United States is working purposefully to create (yet another) U.S. military technology leap; hence, the 'disruptive' technologies. In so doing, the Americans seek to undermine the importance of the global spread of technology and to maintain the U.S. position as the world's leading military power.

The renewed American search for such a technological leap capable of propelling revolutionary military technologies and ensuring their integration into the American armed forces gained momentum with the so-called *Third Offset Strategy*. The need to develop strategies and policies that address potentially disruptive technological advances is also seen in China. Several observers point out how, for a number of years, the Chinese government has prioritized long-term and well-funded military technology development, the core goal of which is to catch up to the United States in the military technology race. This Chinese variant of the U.S. strategy above points to the fact that China has announced

8. For a classic discussion, see Schelling's concept of a 'dialogue of competitive armament'; Thomas Schelling, *Arms and Influence* (New Haven: Yale University Press, 1966), 260.

that, by celebrating its 100th anniversary in 2049, the country must have the world's leading military forces.[9]

The fortified focus on the development and management of such disruptive military technologies in the United States and China underscores how concrete defence policy initiatives and investments (in materiel, personnel, and structure) should provide solutions to long-term security policy challenges that go far beyond investments in today's military operations and activities.

Under U.S. leadership, the West has developed and used technologies over the past 50 years that have made it possible to attack quickly and accurately. Targets can be identified and selected by sensors, and information is distributed via communication systems and computers that make it possible to hit targets with long-range precision weapons. Collectively, this is referred to as a *precision strike regime* (PSR), as it consists of a number of mutually complementary technological developments, which together improve military performance. The effectiveness of the military instrument in terms of destructiveness has increased manifold due to the value of the overall network.

Contemporary military technology competition is based on the PSR concept in several ways. On the one hand, Russian and Chinese investments in military technology in particular – including in imitations (of manned and unmanned combat aircraft) and matching technologies (in the field of air defence, for example) – mean that the challengers are likely to gradually acquire military capabilities sufficient to match the PSR, thereby reducing the relative military superiority of the United States and the West.[10]

9. Department of Defense, United States of America, *Military and Security Developments Involving the People's Republic of China. 2020: Annual Report to Congress* (Washington DC: Office of the Secretary of Defense, 2020): https://media.defense.gov/2020/Sep/01/2002488689/-1/-1/1/2020-DOD-CHINA-MILITARY-POWERREPORT-FINAL.PDF.
10. The relative 'catch up' is likely to be in line with the literature on military revolutions, typically following an S-curve; cf. Michael C. Horowitz, *The Diffusion of Military Power* (Princeton: Princeton University Press, 2010); Thomas G. Mahnken, 'Weapons: The Growth and Spread of the Precision-Strike Regime', *Daedalus*, 140, (3 (summer 2011), 45-57. It is worth noting, as we discuss below, that catching up is complicated both by limits to imitation strategies posed by the modern technological paradigm (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(3), Winter (2018/19), 141–189) as well as by efforts, particularly by the United States, to

Here, the competition for new military technologies is about maintaining and expanding the relative lead in PSR. It includes both weapon-specific technological developments (e.g., hypersonic missiles, nuclear missiles, or torpedoes, which are technologies that can affect the PSR balance of power in the short term) and more generally applicable technologies with great potential for economic change, such as AI and autonomation, which at the same time have the potential to significantly further develop the existing PSR towards 2050.

Background: The precision strike regime (PSR) and compensation strategies

The ability of the West to accurately identify, track, attack, and assess the destruction of enemy targets is the culmination of a deliberate military technology strategy aimed at radically improving the ability of military forces to incapacitate the enemy. At the same time, this military technology advantage has a significant impact on, among other things, the ability of NATO to maintain a credible deterrent in relation to Alliance territory, just as it is of great importance for the ability of Western countries to act politically, diplomatically, and militarily in all other parts of world.

With the launch of the U.S. Third Offset Strategy in 2016, this aspect gained renewed attention and became an increased priority in U.S. defence and security policy. The intent behind this and subsequent strategy documents, which are embedded in the idea

'move the target' by further investing in PSR, thus elongating the S-curve, which is what the technology competition ultimately is about. Even so, the competition itself is still motivated in the first order by the potential for catching up. As an aside, the strategic significance of such an erosion of Western military superiority will probably first be ascertainable in third countries, where e.g. the global human rights regime will be further undermined because the marginal security benefits are affected first. Geopolitically, one would expect to see the effects most clearly in marginal areas. Henrik Breitenbauch and Niels Byrjalsen, 'Subversion, Statecraft and Liberal Democracy', *Survival* 61(4 (summer 2019), 31-41 (cf., e.g., Russian investment in relatively small and informal troop deployments in countries such as the Central African Republic); Katja Lindskov Jacobsen, 'Russia's Showy and Shadowy Engagements in Sub-Saharan Africa', CMS Report. Centre for Military Studies, 2020: https://cms.polsci.ku.dk/publikationer/russias-showy-and-shadowy-engagements-in-sub-saharan-africa/CMS_Report_-_Russia_s_Showy_and_Shadowy_Engagements_in_Sub-Saharan_Africa.pdf.

of increased superpower competition, is as a continuation of previous Cold War 'compensation strategies'. The Trump administration de facto continued the Third Offset Strategy in its priorities and, among other things, published a *National Strategy for Critical and Emerging Technologies* in October 2020. The Biden government will also continue along this path.

Compensation strategies

During the Cold War, the United States 'compensated' for a perceived conventional military inferiority to the Soviet Union over two rounds: first, with nuclear weapons under Eisenhower's New Look policy, and then, beginning in the late 1960s, with the first investments in a package of military precision and communications technologies.

With this 'Second Offset', the military technology competition evolved from being a concrete competition over individual weapon systems to embracing the idea of one overall qualitative leap that would fundamentally change warfare. It was initially the USSR that recognized the risk that U.S. investment in advanced communications, sensors, and computer networks, as well as in missile technology and other related technologies combined, could potentially be akin to a military technology revolution. By enabling unprecedented precision and speed, this could trigger a paradigm shift in conventional warfare and give the United States a major – perhaps decisive – lead in the military technological race.

This analysis was adopted by American policy developers and subsequently formed the basis of American technology policy strategy – generally based on the notion of the 'revolution in military affairs' and more specifically on the idea that this American precision regime constituted (and constitutes) a significant strategic advantage justified by a relative technological advantage.

The existence of American military supremacy through this PSR was established via investment in military technology since the 1960s, in its modern form manifested first with the Gulf War in 1991 and subsequently developed and deepened over the following decades.

From the 'revolution in military affairs' of the 1990s to the current 'all-domain warfare'

Although there are 25 years between the idea of the revolution in military affairs and the associated precision regime (40 years, if one counts from the Russian concept of a 'military technological revolution') and the current American concept of 'all-domain warfare' and the related technological project on 'Joint All-Domain Command and Control' (JADC2), there are common features and a common history, which, among other things, is seen in the similar concepts of 'Network-Centric Warfare', 'transformation', and emphasis on 'situational awareness' of the intervening period.

Although there are also different motives behind the changing headings for the strategic development of defence policy, there is a common, continuous focus on the ideas behind the PSR vision – on the technologically driven integration of the military's ability to *observe* possible threats; to *orient*, identifying or determining if something is a threat; to *decide* whether the threat should be engaged (and how); and, finally, to *act* (collectively referred to as the OODA loop): All with a view to increasing the effectiveness of the military instruments by markedly increasing precision and speed of action.

Space infrastructure in the form of communications and sensor satellites is an essential part of the latest dimension of the American PSR, which enables the 'Internet of Military Things' and creates the physical framework for an optimized decision-making circuit, which is the objective of, among other things, JADC2.

Military technology competition is also based on general technologies, but it focuses on their use in connection with completely new forms of military and security policy means of power, such as genetic engineering, other biotechnology and new materials, and new manufacturing techniques, such as 3D printing. Here, the time perspective is longer and the connection to the military capacity developments less narrow, at least in the West.

2.4. The unique, strategic role of digital technologies

The American technology strategies focus particularly on the combination of digital technologies with the potential to further develop PSR – with even higher speeds of target designation, decisions, and combat power. For example, the development of technologies related to big data analysis, AI, and autonomous weapons is expected to reduce or completely eliminate the need for human involvement in the battlefield, thereby significantly increasing the pace, intensity, and effect of war.

The general digital revolution is in many ways a distinct part of the current military technology competition. This is due to its potential for the further development of PSR, but also to the fact that digital technology development closely links general and military technology competition. The development of digital technologies is less state-controlled than has been the case for previous military technology revolutions, creating new challenges for the state actors. The ability to transfer the commercial technological advances associated with the fourth industrial revolution to the military ecosystem will therefore play a key role in future military development and competition.

Thus, the relevance of the general technological development for defence planning and military technological innovation will increase in the coming decades far beyond what has previously been the case, where military technological innovation was created and controlled more via, for example, U.S. Department of Defense investment. The military revolution of the future will increasingly be about the ability of states to govern and cooperate with large private companies. This is especially true in the digital field, where private companies in the United States, China, and Europe are driving technological development.[11] For example, the U.S. Defense AI strategy states that it is the private sector together with the research world that is at the forefront of American AI development, and that the cooperation between the two sectors and the Pentagon must

11. Michael C. Horowitz, 'Artificial Intelligence, International Competition, and the Balance of Power', *Texas National Security Review*, 1(3) (May 2018); Kelley M. Sayler, *Emerging Military Technologies: Background and Issues for Congress*, CRS Report R46458 (10 November 2020).

therefore be strengthened.[12] In addition to the specific technology-related choices, it is thus an important point – explicitly acknowledged by U.S strategy – that organizational ability to create and organize innovation has become a central competitive parameter.[13]

Therefore, the general technology policies (including innovation and research) and attempts at creating market-state synergies also become strategic links between commercial and military technological development and competition. In a broad sense, technology policy becomes security policy.

Overall, competition for innovation becomes a question of a combination of quantity (how many funds, including through the private sector, can be mobilized and prioritized?) and quality (how innovative is the national and/or transnational innovation environment per krone, dollar, or yuan?). The overall 'organizational lifting capacity' of an innovation system thus depends on a combination of the capacity for conceptual development (transitioning from being able to imitate to actual innovation) and the ability to create, in practical terms (transitioning from speculation to actual implementation).[14]

Although there is likely to be a general convergence towards comparable models of state and civil-military cooperation over military innovation, Western innovation systems basically have a built-in advantage,

12. Department of Defense, United States of America, *Summary of the 2018 Department of Defense Artificial Intelligence Strategy: Harnessing AI to Advance Our Security and Prosperity* (Washington DC: Department of Defense, 2018).
13. '[T]he U.S. Department of Defense (DOD) seeks to develop technologically enabled novel operational and organizational constructs that would sustain U.S. military superiority over its capable adversaries at the operational level of war, thereby strengthening conventional deterrence. One particular element, often emphasized by the DOD, is the importance of "institutional agility" – or improving the ability to out-innovate adversaries, rethink how the DOD sources technology and rethink its models for product delivery'. Michael Raska, 'Strategic Competition for Emerging Military Technologies', *PRISM* 8(3) (2019), 75.
14. Assessments of the relative strengths of technology competition must therefore focus on the relative quality of innovation systems, which depend on both quantitative and qualitative factors. Raska, 'Strategic Competition'; Vasily Kashin and Michael Raska, *Countering the U.S. Third Offset Strategy: Russian Perspectives, Responses and Challenges*, Policy Report, January 2017, Singapore: RSIS, https://www.rsis.edu.sg/wp-content/uploads/2017/01/PR170124_Countering-the-U.S.-Third-Offset-Strategy.pdf; Michael Raska and Richard Bitzinger, 'Locating China's Place in the Global Defense Economy', *Forging China's Military Might: A New Framework for Assessing Innovation*, edited by Tai Ming Cheung (Baltimore, MD: Johns Hopkins University Press, 2013).

whereas the Chinese integration model, like the Russian model, is likely less effective.[15]

2.5. The shift in defence policy

From a defence policy perspective, technological competition accentuates the strategic logic of global defence and security policy. The choices accompanying the competition between the great powers become *relative* strategic choices, which are about prioritizing correctly, but also about countermeasures and niche choices, and ultimately about being able to influence the other party through choices that create costs, influence utility expectations, or leave the impression of an insurmountable lead.[16] If the normal function of defence and security policy is to provide replacement capabilities (upgrades to existing platforms or replacing old platforms with new ones) as part of an incremental development of the defence structure, technology competition makes demands in terms of greater inclusion in a competition for future defence postures. A historical example of this is the Reagan administration's decision to invest heavily in the Strategic Defense Initiative space defence project (better known as Star Wars): The decision itself affected the strategic calculations of the Soviet leadership, because keeping up would be too costly.[17]

At the same time, technology competition reinforces the dependence of defence and security policy on the national innovation environment. Because military technology competition depends more on general technological developments – especially digital developments – than has historically been the case, this form of military innovation requires increased collaboration with national innovation environments and the

15. Anja Manuel and Kathleen Hicks, 'Can China's Military Win the Tech War? How the United States Should — and Should Not — Counter Beijing's Civil-Military Fusion', *Foreign Affairs*, 29 July 2020: https://www.foreignaffairs.com/articles/united-states/2020-07-29/can-chinas-military-win-tech-war. Add to this the argument in Gilli and Gilli 2018/19 that catching up is generally more difficult in the current era.
16. Thomas Mahnken, 'Thinking Competitive Strategies', in *Competitive Strategies for the 21st Century: Theory, History and Practice*, edited by Thomas Mahnken (Stanford: Stanford University Press, 2012).
17. Raska, 'Strategic Competition', 77.

surrounding civilian economy, including the private sector, not least the IT sector.

Also in the future, the accumulation of real military capabilities will depend on the capacity to translate general technology development into a specific military context. Being able to achieve such a conversion is about creating synergies between technologies – about connecting, integrating, and applying technologies, including practical and doctrinal technologies. Just as the general technologies are promoted by general innovation environments, military 'conversion' also requires military innovation environments with the ability and space for learning and development.

3

Technologies

Technology competition is about identifying and developing technologies with the greatest possible potential for change – so-called disruptive technologies. Between the major state actors and relevant research institutions, there is a high degree of consensus on these technologies and their potential for change. Based on official strategy documents and research reports, we have chosen to highlight five main technological areas together with a brief mention of a number of 'rising stars'.[18]

Although there is broad consensus that these key technological areas have significant potential, it is possible that the technologies receiving

18. Ministry of Defence, United Kingdom, *Science and Technology Strategy* (London: UK Ministry of Defence, October 2020): https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/927708/20201019-MOD_ST_Strategy_2020_v1-23.pdf; President of United States of America, *National Strategy for Critical and Emerging Technologies* (Washington DC: White House, October 2020): https://www.hsdl.org/?view&did=845571; Secrétariat général de la défense et de la sécurité nationale, *Chocs futurs – Étude prospective à l'horizon 2030: impacts des transformations et ruptures technologiques sur notre environnement stratégique et de sécurité* [Future Shocks – Prospective Study for 2030: Impacts of Technological Transformations and Disruptions on Our Strategic and Security Environment] (Paris: Cabinet du premier ministre, 2017): http://www.sgdsn.gouv.fr/rapport_thematique/chocs-futurs/; Christopher Bidwell and Bruce W. MacDonald, *Emerging Disruptive Technologies and Their Potential Threat to National Security*, Special Report (Washington DC: Federation of American Scientists, September 2018); Sayler, *Emerging Military Technologies*; Kelley M. Sayler, *Artificial Intelligence and National Security*, CRS Report R45178 (10 November 2020); Nathan J. Lucas, *Lethal Autonomous Weapon Systems: Issues for Congress*, CRS Report R44466 (14 April 2016); Kelley M. Sayler, *Hypersonic Weapons: Background and Issues for Congress*, CRS Report R45811 (1 December 2020); Marcy E. Gallo et al., *Advanced Gene Editing: CRISPR-Cas9*, CRS Report R45409 (7 December 2018); Patricia Moloney Figliola, *Quantum Information Science: Applications, Global Research and Development, and Policy Considerations*, CRS Report R45409 (1 November 2018).

less focus and fewer investments – or completely new technologies – will play even greater roles. At the same time, the transformation of a general technology (e.g., AI) into a concrete military application requires both its own form of innovation and, further, more organizational and doctrinal choices in order for it to become a real military capability. Furthermore, the development of technologies and societies is in a relationship of mutual influence, which is why technology development does not determine a particular societal or military development. Against that background, the chapter provides an overall introduction to each of the five selected technological areas. Each section presents the general and military applications of the technology as well as the central actors.

3.1. AI – Artificial intelligence

Artificial intelligence (AI) is an enabling and supportive technology that uses software, data, and algorithms to learn how to make decisions and solve problems similary to people. Today, AI primarily handles specific tasks in defined areas, such as control, prediction, and guidance (narrow AI).[19] Three particular conditions and their mutual convergence are expected to lead to further AI advances: exponential growth in computing power and memory, development of more advanced algorithms, and an explosion in the amount of data generated by, among others, 5G networks and the Internet of Things. This has led to discussion of whether we will one day have AI that can measure up to human intelligence (broad AI). This could potentially have unintended consequences, and it is also not possible to say with any certainty when – or at all – we will reach the point where AI achieves the same complexity as human intelligence.

Today, narrow AI is used militarily in areas such as intelligence, surveillance, logistics, transport, and computer numerically controlled machining (CNC) tasks, freeing up human labour. In addition, the use of technology allows the use of systems that a) respond faster than systems relying on human input, b) can quickly and easily translate an exponential increase in available data, and c) enable new military operations

19. Sayler, *Artificial Intelligence and National Security.*

concepts, such as swarms, where unmanned units (e.g., drones) autonomously coordinate their efforts to form a unified, organized whole.[20]

But the development of AI also raises challenges, as AI can potentially lead to computer-based military decision-making, thus increasing both the scope and speed of military action. In addition, AI can prove particularly sensitive to tampering. Opinions about the future military potential of AI are numerous and divided, but there is widespread agreement that AI will have at least an evolutionary, if not exactly revolutionary, impact on military operations.[21] Despite the fact that it is difficult to accurately predict the development of AI and its security policy and military implications, the future development of AI will clearly be very central in the global great power and technology competition, with the United States[22] and China as the dominant players.[23]

3.2. Robots and autonomous weapons systems

The central position of AI in technology competition owes much to the fact that it is crucial for the development of automated and autonomous systems and robots. Automation often refers to AI taking over monotonous and repetitive tasks that it can perform faster and with fewer errors than humans. Autonomy, on the other hand, refers to AI performing tasks without human intervention by interpreting inputs from the environment and acting on them.

In weapons systems, autonomy can be understood as the degree of human involvement in the military attack process: 1) searching for targets, 2) identifying targets, 3) deciding to attack targets, and 4) attacking targets. Distinction is usually drawn between three degrees of autonomy. The first is 'human in the loop', where a weapon system can search and identify targets, but a human operator is deciding whether to attack the

20. Sayler, *Emerging Military Technologies*, 2.
21. Sayler, *Artificial Intelligence and National Security*.
22. The U.S. National Security Commission on Artificial Intelligence has recently released a 750-page report addressing the issue of national security and AI. Eric Schmidt et al., *Final Report – National Security Commission on Artificial Intelligence*, National Security Commission on Artificial Intelligence, 2021.
23. Horowitz, 'Artificial Intelligence, International Competition'.

target. The second is 'human on the loop', where the weapon itself can make the decision to attack a target. Here, a human operator can observe the process and be able to intervene and stop the weapon's decision. The third is 'human out of the loop', where a weapon acts completely without the involvement of a human operator.

There are currently autonomous weapons systems capable of identifying and attacking targets without human intervention, but they are not deadly. It is expected that states such as the United States, Russia, and China may develop autonomous systems in the future that decide for themselves whether to pull the trigger against a human target. These have been termed 'killer robots'. Killer robots require specially developed algorithms and sensors that support their ability to perform all four steps in the military attack process. The development of killer robots could have major consequences for warfare and defence policy, as they could potentially replace human soldiers and function more efficiently and in new combat environments.[24]

However, there are a number of challenges associated with the development and use of killer robots that render it difficult to predict exactly which direction the development will take. In practical terms, the killer robots must be able to be used in a complex, dynamic, and unpredictable military context. On top of that come technology and security challenges regarding, for example, the manipulation of the systems and bias therein. There are also political and social issues about whether politicians, military personnel and populations fundamentally trust and have confidence in the robots; ethical and moral issues about letting robots decide to kill; and legal questions regarding the use of killer robots.[25]

3.3. Hypersonic means of propulsion

'Hypersonic velocity' is a term used for velocities at least five times the speed of sound (mach 5), and it is usually planes or missiles that are described as 'hypersonic'.[26] The United States, Russia, and China are de-

24. Sayler, *Emerging Military Technologies.*
25. Lucas, *Lethal Autonomous Weapon Systems*; NATO Science and Technology Organization, *Science & Technology Trends 2020-2040. Exploring the S&T Edge* (Brussels, 2020).
26. Sayler, *Hypersonic Weapons*.

veloping weapons[27] using hypersonic propulsion technology, but states such as France, the UK, Japan, and Australia are also working to develop the necessary knowhow.[28] The use of hypersonic technology makes it possible to attack targets from a safe distance so quickly that the weapons cannot be stopped by existing air and missile defences. In addition, similar to cruise missiles, hypersonic weapons can fly low shortly after firing and manoeuvre in the attack phase, making them even more difficult to track and defend against. Hypersonic weapons can improve the possibility of high-range precision attacks and impair the ability to defend against them, shorten decision-making processes, and increase the value of the 'first strike'.[29]

There is disagreement regarding the potential impact of hypersonic weapons on both strategic stability and the leadership and competitive advantage of the U.S. military, but the United States has invested further in technology in recent years to keep up with developments in China and Russia.[30] The development of hypersonic weapons can make crises more unstable. This is particularly due to the combination of the unpredictability of their trajectory and objectives and the short response time, which can increase the likelihood of miscalculation and unintentional conflict escalation. It has been pointed out, however, that the strategic implications of hypersonic weapons will be small, as the great powers can already hit each other with volleys of intercontinental ballistic missiles that break down existing missile defences.[31]

3.4. Quantum technology

Quantum computing has the potential to increase the computing power of computers exponentially, which can render unbreakable encryption outdated. Unlike traditional computers, which operate with bits that can have the value 1 or 0, quantum computers use quantum bits (qubits)

27. Both China and Russia are believed to possess an operational capability. Sayler, *Hypersonic Weapons*, 1.
28. NATO Science and Technology Organization, *Science & Technology Trends 2020-2040*, 89.
29. Sayler, *Hypersonic Weapons*, 2-4.
30. Sayler, *Hypersonic Weapons*, 1.
31. Sayler, *Emerging Military Technologies.*

that assume the value 1 and 0 at the same time – superposition – due to quantum physical properties. Quantum computers already exist today, but the conventional qubits are so fragile that the existing quantum computers have yet to live up to the potential for quantum computation.[32] Configuring and further developing quantum computing will continue to require large investments, and they will likely first be commercially available in 2025 at the earliest.[33]

In short, the nation that first develops a universal quantum computer will be able to break the encryption of opponents and access sensitive information, although this is not expected to happen until around 2040.[34] Nevertheless, quantum technology is expected to have major consequences for cyber and information security before then.[35]

Militarily, quantum computing is expected to be useful in terms of compromising enemy information systems and accessing sensitive data, which could affect target identification, missile launches, etc. In addition, the development of extremely sensitive quantum sensors could have numerous military applications. In the longer term, for example, the sensors are expected to be able to take stealth and radar technology partially out of the game.[36] The expected impact of quantum computing on national security and the economy means that several states consider the development of quantum technologies to be strategically important. The United States, China, and the EU currently have the largest quantum research programmes,[37] but private companies and universities form the backbone of the development of quantum computing and usable quantum computers.

32. Figliola, *Quantum Information Science.*
33. Figliola, *Quantum Information Science*, 3.
34. NATO Science and Technology Organization, *Science & Technology Trends 2020-2040*, 69-72.
35. See, e.g., David C. Gompert and Martin Libicki, 'Towards a Quantum Internet: Post-Pandemic Cyber Security in a Post-Digital World', *Survival*, 63(1) (2021), 113-124.
36. Sayler, *Emerging Military Technologies*, 21.
37. Sayler, *Emerging Military Technologies*.

3.5. Space technology

Space technology spans a range of different materials and technologies that are adapted to the special conditions of space with respect to pressure, temperature, and friction. Space technology includes, among other things, special sensors, antennas, and fuel cells.[38]

In 2019, NATO formally recognized space as a new military domain (after land, sea, air, and cyberspace) and at the same time adopted the Alliance's first space strategy. That same year, the United States created the world's first actual 'space force': the United States Space Force.[39] Both decisions indicate the increased operational and strategic importance of capacities in outer space. The precision regime depends on rapid and extensive communication that takes place via space, just as large amounts of intelligence are obtained from space via satellites.

Cold War arms control agreements generally kept outer space free of militarization. The Outer Space Treaty (1967) prohibits weapons of mass destruction in outer space, but not 'space weapons', as such. China, the United States, Russia, and India have all demonstrated the ability to shoot down satellites. According to the U.S. Defense Intelligence Agency, China and Russia in particular are developing a number of anti-space capabilities, which in the event of a conflict could attack U.S. space capabilities. This applies to capabilities that can jam or hack satellites (electronic warfare and cyber tools), electromagnetic weapons (directed energy), weapons placed in orbit, and ground-based, anti-satellite missiles.[40]

At the same time, a number of other countries are developing space programmes on different levels. The international spread of civilian space programmes may have security policy implications. If more states are present in space, American and European capacities are in principle more vulnerable. In addition, the technology behind a rocket that can lift satellites into space can also produce an intercontinental ballistic

38. NATO Science and Technology Organization, *Science & Technology Trends 2020-2040*, 75-85.
39. United States Space Force, https://www.spaceforce.mil/ (accessed 13 January 2021).
40. Defense Intelligence Agency, United States of America. *Challenges to Security in Space*, 2019: https://www.dia.mil/Portals/27/Documents/News/Military%20Power%20Publications/Space_Threat_V14_020119_sm.pdf.

missile. Any space programme that contains lifting capacity is therefore, in principle, also a security policy concern.

3.6. Other potentially disruptive technologies

Directed Energy

Weapons based on Directed Energy (DE) use concentrated electromagnetic energy rather than kinetic energy to deactivate, damage or destroy enemy equipment, facilities, and/or personnel. Among the potential advantages of DE weapons over kinetic weapons are precision and low costs per shot. Among the basic limitations are decreasing beam intensity and limited range. Countries such as the United States, China, Russia, and Israel are currently working on a range of electromagnetic weapons and defence systems.[41]

Genetics and biotechnology: the optimized human

Efforts to optimize and strengthen human physical and mental abilities have disruptive potential. The boundary between biological beings and machines will likely become blurred in the future, as the potential for being able to manipulate and optimize our bodies in new ways will grow. This can be about computer implants that help us get more out of our bodies. Continued advances in synthetic biology – such as CRISPR technology, which makes it possible to modify DNA in every conceivable organism both more cheaply and more precisely than existing technologies – can have security and military consequences. In the future, we will probably be able to get sharper vision, better memory, stronger bones, and much more using various optimizing technologies.[42]

New materials and manufacturing techniques

The development of materials with unique properties and new manufacturing techniques (e.g., based on processes from nanotechnology and 3D printing) could possibly affect security and defence policies. These

41. Andrew Feickert, *U.S. Army Weapons-Related Directed Energy (DE) Programs: Background and Potential Issues for Congress*, CRS Report (12 February 2018): https://crsreports.congress.gov/product/pdf/R/R45098.
42. Gallo et al., *Advanced Gene Editing*.

materials will often be lighter, stronger, and more energy efficient, which could result in coatings with extreme heat resistance, strengthened body and vehicle armour, more powerful explosives, and increased storage capacity for batteries.[43]

Neurotechnology and human – machine interfaces

Neurotechnology can be used to influence and target human brain activity so that cognitive skills are improved, degraded, or manipulated. At the same time, neurotechnology can be used in conjunction with computers, sensors, and robotic systems to create human-machine hybrids (cyborgs) that integrate brain and computer capabilities. This can optimize response times and situational awareness, for example. A recent study by Katrine Nørgaard and Mikael Linden-Vørnle explores some of the military implications of this.[44]

43. Michael E. O'Hanlon, *Forecasting Change in Military Technology: 2020-2040* (Washington DC: Brookings, 2018); NATO Science and Technology Organization. *Science & Technology Trends 2020-2040*.
44. Katrine Nørgaard and Mikael Linden-Vørnle, 'Cyborgs, Neuroweapons, and Network Command', *Scandinavian Journal of Military Studies*, 4(1), 2021: 94-107; NATO Science and Technology Organization 2020.

4

The West and the challengers

4.1. Actor types and technology competition

The general and military technology competition is primarily driven by the great powers. The great powers' policies for general and military technology competition are formulated and unfolded along the lines of their existing strategic objectives, just as they are conditioned by their economic capacity and shaped by their models of society, including the relations between state, market, and citizens. The actors' relative social conditions are thus included as a variable in the technology competition. While societies with free institutions and markets will in principle be relatively more innovative, at the same time they have less opportunity to control the course of innovation.[45]

45. In security policy threat analysis, threats are classically defined as capabilities plus intent (cf. David J. Singer, 'Threat-Perception and the Armament-Tension Dilemma', *Journal of Conflict Resolution* 2(1) (1958), 90-105). In practice, however, the focus is usually on capacities, because intent is more cumbersome to measure. Understanding the conditions of the technology competition requires the entire Singer approach. The main differences here are about locally legitimate configurations of the relations existing between state and market and between state and citizen. Drawing on inspiration from Mira Rapp-Hooper and Rebecca Lissner, *An Open World: How America Can Win the Contest for Twenty-First-Century Order* (New Haven: Yale University Press, 2020), it therefore makes sense to distinguish between two types of societies: open societies, which largely have a business community without direct state control, and which in their policy form limit the power of the state vis-à-vis the citizens; closed societies, which largely have a business community operating under direct state control and without clear restrictions on the power of the state vis-à-vis the citizens. The technology competition has different preconditions in open and closed societies. The closed societies basically have better opportunities to prioritize and target strategic investments through the control of the production sector, whereas open societies basically have

This chapter's three main sections focus on the West (USA and European countries), non-Western actors (China and Russia), and other state and non-state actors. Each section briefly describes the actor's strategic objectives together with their general and military technology policy.

4.2. The West and the transatlantic relationship

For the first time since the end of the Cold War, the rule-governed world order and the ideal regarding the liberal-democratic form of government are in retreat. A significant strategic challenge for the political and strategic community, which together form the 'global West', is therefore to set the strategic compass to be able to think defensively – both in the domestic national territories, in various forms of struggle for influence in the rest of the world, and last but not least in relation to the overall cohesion of the West.

The actors comprising the global West differ greatly in size and in their access to advanced infrastructure and R&D-heavy industries. The technology competition therefore has different consequences for different players. For four years, the Trump administration displayed and exacerbated the schisms in the West. The disagreements between the Western countries about dealing with the climate and migration crises as well as the importance of the liberal international order challenges the very idea of the global West.

The key question here is the extent to which the other Western countries will follow the American technology competition objectives. There will probably be close transatlantic coordination within the most sensitive – security policy-related – aspects of technology competition; and at the same time, increasing European focus on also preserving and developing separate production and research in defence technology de-

better opportunity to innovate effectively. At the same time, closed societies can unify the flow of information and, as in the case of China, rely on imitation as a conscious strategy to take advantage of the innovation of others. To this can be added a third category, namely fragile societies (which can be more or less open or closed), where state reach is limited, and where the control of the state apparatus is also subject to international competition, meaning that they largely also become arenas for great power competition. Breitenbauch and Byrjalsen, 'Subversion, Statecraft and Liberal Democracy'.

velopment, especially among the major European countries, supported by the EU. The EU's ambition to strengthen its technological and digital sovereignty is seen in its attempt to reduce the dependence of the EU member states on U.S. and Chinese technology; a difference in the approach to data processing across the EU, the United States, and China; and a stronger link between, on the one hand, industrial and business policy, and on the other hand security policy. The new security policy significance of civil technology development and business promotion is an important aspect of the transatlantic relationship, and for Denmark, because the EU emerges as a clearer security policy actor.

The technology policies of the Western countries manifest themselves neither in the same way nor at the same pace. As researcher Daniel Fiott points out, the new U.S. course constitutes a significant challenge for European countries, which risk lagging behind the technology leap announced by the United States, which in turn risks undermining the possibility of a genuine, strategic Western partnership.[46] In recent years, on behalf of its member states, the EU has launched a security-policy motivated civilian and military technology policy through the European Defence Fund. This is an expression of an incipient, strategically separate European investment in defence technology – and potentially a tool that can be staged later and with more resources if ambitions develop within the EU to use this framework as a stepping stone to keep up with the United States and China.[47]

The challenge for the non-US part of the West, including in particular NATO as a Euro-Atlantic forum, is twofold. It is partly a practical exercise in not lagging behind the United States and other great powers, partly a strategic exercise in preserving the military quality – and thus the strategic relevance – of NATO seen through American glasses,

46. Daniel Fiott, 'A Revolution Too Far? US Defence Innovation, Europe and NATO's Military-Technological Gap', *Journal of Strategic Studies* 10(3) (2017), 417-437; Daniel Fiott, 'Europe and the Pentagon's Third Offset Strategy', *The RUSI Journal 161*, (1) (2016), 26-31.
47. Kristian Søby Kristensen and Niels Byrjalsen. 'Aktiv Afventning: Nordiske perspektiver på europæisk forsvars- og sikkerhedspolitisk samarbejde' [Active Waiting: Nordic Perspectives on European Defense and Security Policy Cooperation], CMS Report, Centre for Military Studies, 2020: https://cms.polsci.ku.dk/publikationer/aktiv-afventning-nordiske-perspektiver-paa-europaeisk-forsvars--og-sikkerhedspolitisk-samarbejde/CMS_Rapport_-_Aktiv_afventning__Nordiske_perpektiver_p__europ_isk_forsvars-_og_sikkerhedspolitisk_samarbejde.pdf.

which is also a lever for influence for the European countries vis-à-vis the United States.

The increased focus in the NATO context on maintaining the strategic 'edge' provided by the overall technological superiority of the Alliance is hardly surprising. During the NATO Leaders Meeting in London in December 2019, the Heads of State and Government therefore adopted an *Emerging and Disruptive Technologies Roadmap*, and in March 2021, the Foreign Ministers endorsed an *Implementation Strategy on Emerging and Disruptive Technologies*. The topic must be expected to have a significant position in a possible new strategic concept.[48] The increased focus on technology content in military capabilities also creates new challenges for NATO's own defence planning, because it will also be necessary to include the quality of the individual capabilities. Seen through defence planning eyes, for example, a frigate is not just a frigate; instead, the hull is completely dependent on the sensor and missile packages it is equipped with and on the network in which it manages to be a part.

Underlying the EU and NATO coordination efforts is the fact that it is the member states with national defence and security industries that together form a defence technology and industrial base, which in turn is unequally distributed between countries and especially across the Atlantic. How they are supported and staged by public investment, including the types of international cooperation that are promoted or prevented, is a fundamental and long-term strategic issue – as encapsulated in the controversial notion of whether European countries should strive for 'strategic autonomy'. Many of the choices that Western countries make in relation to military technology competition are, from the outset, both alliance and partner policy choices.

48. NATO News, 'New Focus on Emerging and Disruptive Technologies Helps Prepare NATO for the Future', 3 March 2021, https://www.nato.int/cps/en/natohq/news_181901.htm; North Atlantic Council. *London Declaration*, Leader's meeting statement, Press Release 115, London 3-4 December 2019: http://www.nato.int/cps/en/natohq/official_texts_171584.htm; Gordon B. Davis Jr., 'Leveraging Investment and Innovation to Accelerate Capability Development and Delivery', Europe's Edge, CEPA (17 February 2021): https://cepa.org/leveraging-investment-and-innovation-to-accelerate-capability-development-and-delivery/; cf. also the expert group, NATO 2030.

4.3. Non-Western actors

The global challengers occupy the same position in relation to the common project of the liberal-democratic societies: They reject further political integration, which they fear will lead to a convergence of the political systems towards liberal democracy. Instead, authoritarian states have regime continuity as their fundamental strategic objective. The legitimacy inadequacies of the form of government drive a need for expanded state control over the citizenry. This is particularly evident in the cyber policies of these countries, which largely block or control access to the Internet and facilitate the comprehensive surveillance of citizens. State interest in developing general and military cyber technology is also closely linked to this issue, which is therefore relevant, although it is only to a limited extent directly linked to weapons development.

4.4. China's strategic goals

The overall strategic goal of the Chinese government is regime continuity. Over the past three decades, China has moved from being a developing country without any great international significance to now being an international economic growth locomotive and a military great power. Measured in terms of purchasing power parity, China is now the world's largest economy. China's authoritarian state capitalism has simultaneously evolved into a political and economic model that is emerging as an actual alternative to Western liberal market democracy. The primary strategic focus of the Chinese government is to maintain the regime's position of power by ensuring continued economic progress together with social and political stability.

However, the domestic political focus has not prevented China under Xi Jinping from acting more confidently and confrontationally on the international stage. China's 'rise' and its international action therefore challenge the rules and norms of the international system, which are based on liberal-democratic ideals and capitalist market logic. The Chinese are unlikely to try to build a competing international system, as the Soviet Union did during the Cold War; rather, China will likely increasingly orient itself towards both self-sufficiency and work for geo-

strategic influence, among other things through the 'digital silk road'.[49] This will be achieved via continued selective Chinese decoupling from areas of major political, economic, and military interest.[50] In terms of security policy and the military, China is committed to becoming a global military power before 2050, a goal that is interpreted as achieving military parity with or overtaking the U.S. military advantage. At the same time, China has significant objectives for local military supremacy in areas close to their own borders.[51]

4.5. China's general and military technology policy

In China, technological and economic developments are closely intertwined. Through state governance, the Chinese are able to launch and coordinate national and international techno-economic mega-projects spanning the public and private sectors, as well as the industrial and military sectors. In addition, the Chinese government and Chinese companies can benefit from a protected single market of over one billion consumers when it comes to technology development and data collection. Most analysts view the Chinese unitary approach as providing a competitive advantage. Critical voices, however, point out how the Chinese public finance system is inefficient and corrupt, which distorts the distribution of state funding.[52]

For a number of years, China has focused on strategic investments in technological development and innovation that have followed the country's economic growth. Thus, Chinese spending on technology R&D increased from $19 billion to $376 billion between 1991 and 2015, placing China's investments ahead of those of Japan, South Korea, and

49. Meia Nouwens, *China's Digital Silk Road: Integration into National IT Infrastructure and Wider Implications for Western Defence Industries*, The International Institute for Strategic Studies, 2021: https://admin.govexec.com/media/china_digital_silk_road_-_iiss_research_paper.pdf.
50. Heurlin et al., 'Forværringen af det kinesisk-amerikanske forhold'.
51. Department of Defense, United States of America, *Military and Security Developments Involving the People's Republic of China. 2020. Annual Report to Congress.*
52. Elsa B. Kania, *Battlefield Singularity: Artificial Intelligence, Military Revolution, and China's Future Military Power* (Washington DC: Center for New American Security, 2017).

Germany combined.[53] China is now a leader in the development of parts of a range of technologies, such as quantum computer technology and genetic engineering. In addition, China is home to tech giants Baidu, Huawei, Alibaba, Tencent, and Xiaomi (which together go under the abbreviation BHATX).

In 2015, China presented the country's overall strategic objectives for industrial and technological development: 'Made in China 2025'. The strategy makes clear that the Chinese want to secure China's position as a global powerhouse for high-tech development. By investing purposefully in their own technology development and innovation, the Chinese will create a basis for strengthening China's global economic competitiveness, reducing dependence on foreign technology imports and achieving global superiority in selected technologies.[54] China will meet these objectives by further integrating industry, manufacturing, and technology as well as by focusing on the development of new digital technologies.[55] The preliminary implementation of the plan emphasizes how, due to their authoritarian form of government, China has the capacity to plan and implement significant national strategic investments to develop specific civilian and military technologies.[56]

53. Martijn Rasser and Megan Lamberth, *Taking the Helm: A National Technology Strategy to Meet the China Challenge*, Center for a New American Security (CNAS), 13 January 2021: https://www.cnas.org/publications/reports/taking-the-helm-a-national-technology-strategy-to-meet-the-china-challenge.
54. The Chinese government's latest five-year plan confirms this objective; Arjun Kharpal, 'China Spending on Research and Development to Rise 7% per Year in Push for Major Tech Breakthroughs', *CNBC,* 4 March 2021: https://www.cnbc.com/2021/03/05/china-to-boost-research-and-development-spend-in-push-for-tech-breakthroughs.html; Arjun Kharpal. 'In Battle with U.S., China to Focus on 7 'Frontier' Technologies from Chips to Brain-Computer Fusion'. *CNBC,* 5 March 2021: https://www.cnbc.com/2021/03/05/china-to-focus-on-frontier-tech-from-chips-to-quantum-computing.html.
55. The State Council, The People's Republic of China, 'Made in China 2025: Plan Issued', The State Council of the People's Republic of China (19 May 2015): http://english.www.gov.cn/policies/latest_releases/2015/05/19/content_281475110703534.htm.
56. Through e.g. the three-year action plan to promote the development of the next generation of AI industry presented in December 2017; Paul Triolo and Jimmy Goodrich, 'From Riding a Wave to Full Steam Ahead', *New America,* 28 February 2018: https://www.newamerica.org/cybersecurity-initiative/digichina/blog/riding-wave-full-steam-ahead/). The Chinese government has set itself the goal of becoming the world leader in AI innovation and development by 2030. Among other things, this includes an ambition to build an AI industry to a value of approx. 145 bn USD. China's rapid growth and strong positioning in AI are supported by massive state support for the country's major technology companies (BHATX). The Chinese government's objective regarding AI dominance was presented in 2017 in the

To meet the ambitious military objectives mentioned, the Chinese government is practicing a long-term, funded, and sustainable military technology strategy. The vision for this effort is integrated cooperation between military authorities and civilian companies and research environments in a 'civil-military fusion'.[57] According to analysis from the Center for a New American Security, China's military technology policy has five overarching objectives.[58] The first involves a fundamental consolidation of society's resources in the form of civil-military fusion, which, in combination with systematic industrial espionage, must make it possible 'relatively quickly to acquire capabilities that the US itself has spent decades developing, so that the Chinese defence is operationally comparable to that of the US'.[59] The model for civil-military cooperation has developed into an instrument to also create general technological development and thus economic growth.[60] By coordinating otherwise separate organizations, the approach creates a framework for comprehensive innovation, which would otherwise not be present, but which is reminiscent of the state governance that characterized major development projects during the Cold War.[61]

The second objective is the development of capabilities and concepts that will make it possible to 'fight systems' (*systems destruction warfare*);

National Chinese Strategy for AI (The State Council 2017). The strategy touches on a wide range of societal development aspects related to AI, and it proclaims AI to be 'the strategic technology that leads the future' (ibid., 2).

57. Manuel and Hicks, 'Can China's Military Win the Tech War?'.
58. Work and Grant, *Beating the Americans at their Own Game*, 5-6.
59. 'The key aim is to accelerate China's "absorptive capacity" to recognize, assimilate, and utilize external knowledge in the development of China's advanced technologies in both civil and military domains. China calls this strategy "Indigenous Innovation" – first set in the '2006-2020 Medium and Long-Term Defense Science and Technology Development Plan'. By pursuing Indigenous Innovation, China aims to circumvent the costs of research, overcome international political constraints and technological disadvantages, and 'leapfrog' China's defense industry by leveraging the creativity of other nations. This includes exploitation of open sources, technology transfer and joint research, the return of Western-trained Chinese students, and, of course, industrial espionage, both traditional and increasingly, cyber-exploitation – i.e. systematic hacking'. Raska, 'Strategic Competition', 70; Rasser and Lamberth, *Taking the Helm*.
60. Raska, 'Strategic Competition', 70.
61. The strong focus on civil-military cooperation, R&D investment and technology development is confirmed in the Chinese Government's latest five-year plan: Fenella McGerty. 'China's New Five-Year Plan and 2021 Budget: What Do They Mean for Defence?" *IISS,* 8 March 2021: https://www.iiss.org/blogs/analysis/2021/03/chinas-new-five-year-plan-and-2021-budget.

that is, to neutralize the American command and control network in a broad sense (generally command, control, computers, intelligence, surveillance, and reconnaissance or C4ISR, but aimed at the development in the upcoming Joint All-Domain Command and Control or JADC2 system). The third objective is to be able to 'attack first through the accumulation of long-range precision missiles and advanced targeting systems with a high probability of penetrating American network defences in the early stages of a conflict'.[62] The fourth objective is to develop secret capabilities which, by first being revealed in the event of war, will fundamentally surprise the adversary. Finally, the fifth objective is to become a world leader in AI – and to exploit this status to achieve military superiority.[63] These intentions largely reflect the corresponding American objectives and are thus indicative of the Chinese ambition regarding a world-class military.

The Chinese point of departure is such that the country's innovation system is less developed than that of Russia in terms of conceptual innovation, and at the same time quite distant from the United States in terms of conceptual innovation and the practical exploitation of ideas.[64] China's strategy seeks to address existing weaknesses in two ways: to strengthen domestic innovation and to develop military capabilities similar to PSR.[65] China has greater potential than Russia to develop a well-functioning innovation culture – but the question in the coming decades will not merely be the extent to which China will be able to either copy or even develop new technologies, but whether China will be able to translate them into functional military capabilities.[66]

4.6. Russia's strategic goals

Over three decades, Russia has transitioned from being the core state of the Soviet superpower to a political and institutional collapse together

62. Work and Grant, *Beating the Americans at their Own Game*, 5.
63. Rasser and Lamberth. *Taking the Helm*.
64. Raska, 'Strategic Competition', 72.
65. Raska, 'Strategic Competition', 70.
66. New technologies are likely even more difficult to adopt through imitation strategies, Gilli and Gilli, 'Why China Has Not Caught Up Yet'.

with partial economic liberalization and political democratization to a renewed domestic political consolidation towards an authoritarian state with a more assertive foreign policy in the years since the turn of the millennium. Measured in terms of purchasing power parity, the Russian economy, which is dominated by commodity exports, is the world's sixth largest.[67] Russia is now significantly more integrated into the world economy than the Soviet Union ever was.[68] On the basis of large export revenues from, among other things, oil and natural gas, Russia has initiated and implemented a significant modernization of its armed forces since 2008.[69] The more modern military forces have enabled a Russian *revanchism* in the former Soviet republics, Ukraine in particular, as well as an increased military activism in the Middle East and Africa.

Through tangible centralization and control over the political apparatus, President Putin has demonstrated that the government's overall strategic goal is domestic policy, namely regime continuity. This objective entails a number of domestic and foreign policy activities centred around the systematic undermining of the political opposition and possible political challengers to the Putin regime, including assasinations at home and abroad and intensive political control of the public sphere – including the establishment of 'internet sovereignty'. In terms of security policy, the regime continuity issue comes into play in that the Russian government, through its insecurity, sees itself as being in a fundamental conflict with the West, in a zero-sum game both inside and outside the Russian borders.[70]

67. The World Bank, 'GDP Ranking, PPP Based' (accessed 13.02.21): https://datacatalog.worldbank.org/dataset/gdp-ranking-ppp-based.
68. Value Chain Integration: World Bank Group, *Russia Economic Report*, no. 44 (December 2020): https://openknowledge.worldbank.org/bitstream/handle/10986/34950/Russia-Economic-Report-Russias-Economy-Loses-Momentum-Amidst-COVID-19-Resurgence-Awaits-Relief-from-Vaccine.pdf.
69. Fredrik Westerlund et al., *Rysk militär förmåga i ett tioårsperspektiv – 2019* [Russian military capability in a ten-year perspective], Totalförsvarets forskningsinstitut (FOI), 2020: https://www.foi.se/rapportsammanfattning?reportNo=FOI-R--4752--SE.
70. Henrik Breitenbauch, Kristian Søby Kristensen and Jonas Groesmeyer, 'Afskrækkelse i cyberspace – muligheder og udfordringer' [Deterrence in Cyberspace: Opportunities and Challenges]. CMS background paper. Center for Military Studies, 2020; Keir Giles, *Moscow Rules: What Drives Russia to Confront the West* (Washington, DC: Brookings Institution and Chatham House, 2019); Mark Kofman, 'Drivers of Russian State Strategy and Military Operations', Stanford Freeman Spogli Institute for International Studies, Memo No. 6, September 2020: memo_6_-_kofman.pdf (amazonaws.com).

Strategically, Russia sees the post-Soviet space as its sphere of influence and wants to re-create and secure the country's influence there. At the same time, Russia wants to regain international status and recognition as a great power.[71] Finally, at the same time, Russia is pursuing opportunities to spread division and insecurity in the peripheral areas between NATO and the EU and Russia, including in the Balkans, as well as in the NATO and EU countries themselves, where possible. Here, Russia is drawing on a long-standing tradition of subversive political warfare.[72] In the nuclear realm, Russia wants to maintain its superpower status, which rests on nuclear parity with the United States. The Russian government is therefore very critical of missile defence, for example, which in theory could undermine Russian 'second strike capability' and therefore also its strategic stability. The development of new missile types must also be seen as an attempt at countering the future development of the U.S. missile defence, thereby preserving parity. At the same time, it is important that the Russian government's desire for great power status is primarily confirmed through its position as a nuclear superpower, and that this is demonstrated practically through, for example, arms control agreements negotiated bilaterally with the United States.

The latest major study published by the Swedish National Defence Research Institute (FOI) on Russia's military forces estimates that, by 2029, the Russian military forces will primarily – in the absence of significantly larger investments – be able to consolidate the ability created in the previous decade to lead a regional war.[73] Moreover, Russian interventions and military involvement in Syria, Africa, and more globally, driven by the desire for great power status, are also putting pressure on the existing armed forces structure, thus limiting further development opportunities.

71. John Arquilla et al., *Russian Strategic Intentions: A Strategic Multilayer Assessment (SMA) White Paper*, TRADOC/Department of Defense (May 2019); Kofman, 'Drivers of Russian State Strategy'.
72. Mark Galeotti, *Russian Political War: Moving beyond the Hybrid* (Abingdon, Oxon: Routledge, 2019); Arquilla et al., *Russian Strategic Intentions*; Daniel Goure, 'Russian Strategic Intent', in *Russian Strategic Intentions: A Strategic Multilayer Assessment (SMA) White Paper* edited by John Arquilla et al., TRADOC/Department of Defense. May 2019: 32-36; Breitenbauch and Byrjalsen 'Subversion, Statecraft and Liberal Democracy'; Henrik Breitenbauch, Niels Byrjalsen et al., 'Orden og afskrækkelse'.
73. Westerlund et al., *Rysk militär förmåga*.

4.7. Russia's general and military technology policy

In the Russian case, it is difficult to separate general technology policy from military technology policy, because the defence industry is a significant part of the manufacturing sector, R&D, and export of goods.[74] The 2015 National Security Strategy identified the defence industry both as a source of military means to maintain Russian sovereignty and as an epicentre of technological development and innovation.[75] The defence industry is closely linked to the state and has relatively limited integration and synergy with the civilian economy. The link to the political-economic elites in the Russian state points to ineffective forms of governance and suggests future challenges in achieving announced goals.[76] At the same time, the Russian economy is experiencing a general lag in IT development compared to the West and China.[77]

A significant part of the general Russian technology policy is therefore about investing in digital technologies through the national technology initiative and other frameworks.[78] In 2019, the Russian government budgeted more than €4 billion for AI investment, the objective being to become a world leader in a technology type with both great economic and military potential. The way in which the initiative is implemented – through private sector investment in frameworks and start-up environments – simultaneously seeks to circumvent and address existing weaknesses in the Russian defence industry and how it is embedded in

74. Andrey Frolov, '[Russia's] Defence Technologies and Industrial Base', in *Defence Industries in Russia and China: Players and Strategies*, edited by Richard A. Bitzinger et al. *EU-ISS Report*, No. 38 (December 2017), 9-18.
75. Andrey Frolov, 'Defence Technologies and Industrial Base', 9-18, cf. Instituto Español de Estudios Estratégicos (IEEE). *Russian National Security Strategy*. December 2015: http://www.ieee.es/Galerias/fichero/OtrasPublicaciones/Internacional/2016/Russian-National-Security-Strategy-31Dec2015.pdf.
76. Vladislav Inozemtsev, *Russia's Defense Sector: An Economic Perspective*, Swedish Institute of International Affairs, Brief no. 3 (2019). Inozemtsev notes: 'The restoration of the Russian [defence industrial complex] is just one of the means for sustaining the "captured state" Mr. Putin wants to manage...".
77. World Bank Group, *Russia Economic Report*.
78. Samuel Bendett, 'Russia's AI Quest Is State-Driven – Even More than China's. Can It Work?', *Defense One* (25 November 2019): https://www.defenseone.com/ideas/2019/11/russias-ai-quest-state-driven-even-more-chinas-can-it-work/161519/.

the state.[79] Russia also benefits from close links between the military authorities and civilian research communities in Russian universities.

An example of the Russian development of military technology with great potential implications is the investment in robot and drone technology aimed at achieving tactical swarming effects and the use of AI-assisted lethal force. According to Samuel Bendett of the Center for Naval Analyses, the Russian military forces are developing weapons that can lean on AI to identify and combat targets.[80]

Russian military reforms since 2008 have focused on modernizing the country's command, control, and communications systems in the broadest sense (C4ISR) with a view to establishing a more mature precision regime. Nevertheless, there are numerous industry-related challenges facing Russia's strategic development. Despite relatively clear political objectives, the defence industry has had difficulty delivering, partly due to inadequate management on the part of the Ministry of Defence.[81]

In addition to the modernization of conventional forces, Russia's military technology approach can be divided in two. It is, firstly, a strategy to counter the U.S. third compensation strategy with the first nuclear compensation strategy. This has primarily involved the continued development of strategic and tactical nuclear weapons as well as their means of delivery in the form of new missile systems.

Secondly, it is a broader R&D investment policy, based on a military investment fund (a Russian version of the U.S. DARPA), which complements general technology investments. The fund, established in 2012, focuses on:

> *... high-risk, high-pay-off technologies in areas that include hypersonic vehicles, artificial intelligence, additive technologies, unmanned underwater vehicles, cognitive technologies, directed energy weapons, and others. While Russian technologies are at the early stages in some areas,*

79. Bendett, 'Russia's AI Quest Is State-Driven'.
80. Kelsey D. Atherton, 'Russian System Uses Infantry to Spot for Robots', *C4ISR.net* (3 April 2019): https://www.c4isrnet.com/unmanned/2019/03/04/russias-new-robot-is-a-combat-platform-with-drone-scouts/.
81. Roger McDermott, 'Tracing Russia's Path to Network-Centric Military Capability', Jamestown Foundation (4 December 2020): https://jamestown.org/program/tracing-russias-path-to-network-centric-military-capability/.

> *in key areas such as directed energy weapons, rail gun, hypersonic vehicles, and unmanned underwater vehicles, programs are progressing into advanced stages, backed by considerable financing for many years prior to the [founding]. The key challenge for Russia, however, is sustained resource allocation to translate these 'disruptive' innovations into actual military capabilities.*[82]

In that sense, Russia has chosen to enter the military technology competition based on a variant of the American compensation strategy. By investing in nuclear weapons and means of delivery (new missile technologies), Russia seeks both to maintain nuclear parity (and thus its status as a nuclear superpower), and at the same time to utilize a flexible doctrinal approach to nuclear weapons to compensate for other relative (conventional) weaknesses. In addition, Russia is actively participating in both the general and military technology competition with a number of focused initiatives.

The Russian military innovation system is basically better equipped for conceptual innovation than is the Chinese, but it is lacking with respect to practical implementation to the extent seen in the United States.[83] Mass – including investment capacity – and organizational adaptability are at the same time important factors when comparing Russia's future development opportunities with the somewhat larger, more modern economies of the United States and China. Nevertheless, over the next five to ten years, Russian military technology will likely continue to pose a greater concrete challenge to Danish and European security than will the Chinese.

4.8. Other state and non-state actors

Global technological development and the boom in computing power, sensor capabilities, and weapons technology in general are inflating the price of military capabilities, at the same time as technologies are

82. Emphasis added. Raska, 'Strategic Competition'; Kashin and Raska, *Countering the U.S. Third Offset Strategy*.
83. Raska, 'Strategic Competition', 74.

spreading. This has global security and defence policy consequences. The spread of technology means that both great powers (e.g., China, Russia) and intermediate states, (e.g., Iran, Nigeria, Brazil, Indonesia) acquire or build capacities that, until recently, were reserved for a narrow Western club of American allies. Drones, cruise missiles, and advanced air defence systems are three examples of military technologies that are spreading and helping to balance out the military superiority of the West.

Even countries that actively define themselves as challengers to the rule-based world order, such as Iran and North Korea, make a very limited contribution to the overall technology competition. However, their significant role in global security policy is still linked to technology issues. On the one hand, the two countries are examples of, respectively, the hitherto unsuccessful and successful proliferation of nuclear weapons. On the other hand, they are both key examples of countries actively contributing to the diffusion of technologies and capabilities in the field of means of delivery. Where the nuclear issue justifiably receives great international attention (that North Korea has or is close to having established some form of mutual deterrence with the United States is of great importance and emphasizes Iran's objective interest in acquiring a nuclear weapons capability), then the second issue is also very significant globally. The proliferation of general missile and sensor technologies reduces the relative value of the Western military lead (and therefore also to some degree the political manoeuvrability), just as it affects bilateral and regional power balances more generally worldwide. For example, the Iranian missile programme is the core rationale for NATO's joint investments in missile defence technology.

Although international terrorist organizations are likely to continue to pose a significant security threat, both globally and to Western countries, they are only slightly relevant to technology competition in general and militarily. However, general technology development plays a significant role in the operational capabilities of non-state actors. The proliferation of *civilian 'commercial off the shelf'* (COTS) technologies, such as drones, has already been adapted by organizations such as IS.[84]

84. Torben Toftgaard Engen and Jon Kjellund, 'Nye militære trends i den syriske borgerkrig' [New Military Trends in the Syrian Civil War], CMS Report, Centre for Military Studies, 2018: https://cms.polsci.ku.dk/publikationer/nye-militaere-trends-i-den-syriske-borger-

Just as they have thus far used commercially available software for communication, operations planning, and practice, violent non-state actors will presumably continue to benefit, in an asymmetrical manner, from market-based access to AI and other digital services, including relatively secure communication.

krig/download/CMS_Rapport_2018__2_-_Nye_milit_re_tendenser_i_den_syriske_borgerkrig.pdf.

5

Implications for the West and Denmark

The technology competition between the great powers will be a significant factor in global security policy in the decades to come. Regardless of the possibilities to handle this contest diplomatically,[85] the great powers will all partake in it. Russia plays a significant role in European security and will continue to do so throughout the period. But the US-China relationship has become the most important bilateral relationship in international politics – and the military technology competition is one of the most important dimensions in their relationship. How this relationship develops will have major implications for the rest of the world.

The technology competition includes the relationship between state and market and the ability to coordinate and mobilize cooperation with a view to supporting and exploiting innovation, also for military purposes. The innovation models of the respective states and their general and military technology policies therefore become long-term security policy pieces on the chessboard. It is not given which model is the most effective.

Quantity has its own quality, which renders the Chinese economic growth a significant factor, just as authoritarian systems with a higher degree of political control potentially have better opportunity to prioritize resources strategically. However, differences in maturity levels in the

85. Kevin Rudd, 'Short of War: How to Keep U.S.-Chinese Confrontation from Ending in Calamity', *Foreign Affairs*, March/April 2021; Kurt Campbell and Jake Sullivan, 'Competition without Catastrophe: How America Can Both Challenge and Coexist with China', *Foreign Affairs*, September/October 2019.

Chinese, Russian, and American innovation environments nevertheless indicate that Western societies have several advantages in the technology competition, which is particularly centred around the American military innovation system.[86] This competition is about relative acceleration: How good are the respective systems at adapting to innovation? Therefore, the question is especially whether China will be able to exploit 'second mover' effects to overtake the West in the race for new technologies in the coming decades.

5.1. Can the West meet the challenge?

At stake for the United States and the West in the military technology competition is to maintain the lead within the precision regime. Here, an important aspect is the ability of the West to systematically develop new technologies that can further improve the precision regime or create radically new opportunities – all faster than the 'challenger' countries.

A significant difference from the Cold War era is that innovation and technology development are much less controlled directly or indirectly by state actors and instead taking place in multinational corporations. Western control over the technologies that have driven the development of military revolutions was historically characterized by the fact that the technologies were developed directly or indirectly by the state – often for specific military purposes. However, the current development of disruptive digital and biological technologies is primarily driven by the private sector, which is changing the conditions for defence policy and planning. As technology-related R&D is increasingly left to private actors, military organizations come to depend increasingly on collaboration with the private sector. In itself, this entails a loss of state-military control, and it demands the development of new forms of public-private cooperation. But it also undermines control over technology development and distribution. There is increased risk of hostile states and non-state actors developing their own military technologies based on

86. 'Overall, the United States continues its military innovation lead in terms of future-oriented technological patterns, conceptual paths, however, with relatively slow organizational adoption and adaptation'. Raska, 'Strategic Competition', 76; Gilli and Gilli, 'Why China Has Not Caught Up Yet'.

Western technology, which could potentially render the battlefield more dangerous for Western forces.

China's response to this challenge is 'civil-military fusion', which enlists large Chinese corporations in general and military technology development. This approach raises new questions about the Western state-market relations model, especially regarding the IT sector. Overall, the West is well equipped for renewed and changed technological competition, although there are significant challenges pertaining to China's strategy regarding military superiority. Open societies have a stability advantage via their more legitimate political systems. They generally have high levels of human capital, well-functioning public and private sectors and a high-quality innovation infrastructure, which together provide a good starting point for dealing with a long-term need for investment in the development of new civilian and military technologies. Basically, it is advantageous for the West that military technological revolutions are also about organizational adaptability.[87] Military technological revolutions depend on technological transformation, military systems development, operational innovation, and organizational adaptation – which are generally strengths that characterize Western societies.[88]

Nevertheless, the technology agenda also represents a fundamental internal disagreement in the Euro-Atlantic community. Its potential as a political and economic *driver* of joint initiatives within *both* NATO and the EU demonstrates its simultaneous potential to both unite and divide the West. The European interest in the general technology competition (e.g., the ambition regarding technological and digital sovereignty) and, to a lesser extent, the military technology competition – the European countries have at least an interest in a European defence industry base – does not entirely coincide with that of the United States. But collaboration can exist without confusion. How the major Western countries organize themselves in terms of technology competition – both in re-

87. Horowitz, *Diffusion of Military Power*.
88. Andrew Krepinevich, *The Military-Technical Revolution: A Preliminary Assessment* (Washington DC: Center for Strategic and Budgetary Assessments, 2002 [1992]). Moreover, the international political order, the level of competition among the strongest states, and their strategies for pursuing and exploiting the potential of new military technologies are crucial to military technological revolutions. The military technology revolution is thus a broad-based, complex phenomenon that goes beyond technological innovation.

lation to each other and in relation to challengers China and Russia – are important factors in the question of whether the West and the open societies will be able to act in concert in the great power competition; not least in relation to military technology, where it will be particularly necessary.

Western countries have previously been plagued by uncertainty in a similar situation. In the darkest years of the 1970s, French political thinker Raymond Aron wrote a defence of 'decadent Europe' – and he was right: the stagflation of the 1970s was replaced in the 1980s by new growth and marked new industrial revolutions in the form of, among other things, digitization, the effects of which are still seen today.[89] This optimistic doctrine is relevant to the West here in the beginning of a new, long-running race: the free institutions and general adaptability of open societies give the West an advantage over both civilian and military innovation.

5.2. Danish implications

For Denmark, the technology competition represents an accentuation of certain parts of the factors framing defence and security policy from the outside, both in the form of new threats and problems, including both current and longer-term agendas, and in the form of new expectations and demands from allies and partners. This new technology agenda simultaneously raises challenges and provides opportunities for Denmark.

The intensified technology competition is indicative of a more dangerous world with a greater focus on deterrence, greater financial costs per military unit, and generally a more conflicting and unpredictable security policy framework for Denmark.

Using this logic, NATO co-operation will increase expectations to Danish defence policy once NATO's technology development policy becomes more concrete. But much of the work will take place in and between the major states, and, through the European Defence Fund, the EU has already provided a new European framework for the military

89. Raymond Aron, *Plaidoyer pour l'Europe décadente* [Advocacy for a Decadent Europe] (Paris: Robert Laffont, 1977).

aspects of technology competition of an order of magnitude that it is doubtful NATO will match – without a renewed, major transatlantic agreement. In relation to the 'strategic autonomy' debate, including technological sovereignty, the technology competition therefore accentuates the tensions between the major European countries (and the EU), on the one hand, and the United States on the other.[90]

This is uncomfortable for Denmark, despite the country already having balanced its operational military cooperation patterns in both directions. The Danish opt-out of EU defence cooperation constitutes a special risk, which can go from being a practical challenge to a genuine problem. The international dimension of technology competition increases the need for and value of international cooperation. Part of this can be lifted via ordinary diplomacy and military cooperation with allies and partners. This is especially important to be able to deal with the practical consequences of new technologies on an ongoing basis.

The technology competition will also pull the international framework for Danish defence and security policy in a direction that Denmark, more than many other small countries, has a good opportunity to contribute to and benefit from. With its relative prosperity and the high level of technology and education in society and business, Denmark has an excellent basis upon which to meet an increased focus on technology content in military units. With its relatively strong digital sector, Denmark has ample opportunity to conceive of new defence and security policy initiatives in the direction of cooperation on innovation and development. The new technologies are therefore also a prism for a possible rethinking of defence and security policy, so that new parts of it (additional marginal moneys in a future settlement, for example) can assume the form of more development-oriented investments, including increased collaboration with both the business community and the research world.

As the great power competition does not dominate global politics as was the case during the Cold War, and there is still cooperation in large parts of global politics (the multidimensional nature), there is consider-

90. EURACTIV "'The EU Cannot Defend Europe': NATO Chief": https://www.euractiv.com/section/defence-and-security/news/the-eu-cannot-defend-europe-nato-chief/, 8 March 2021.

able room for manoeuvre at the levels below the superpowers, as mentioned for the Europe-USA relationship. This means that Denmark has a choice to make in connection with technology competition – how and how much Denmark gets involved is also an exercise in optimization. How the great powers choose their relative positioning strategies (e.g., in the form of choices that make the opponent's counterattack more expensive or more difficult) is relevant here. For Denmark, the technology competition is covered by the basic intentions of security and alliance policy, which is to create cost-conscious contributions to the cohesion of NATO and other security policy communities, including the prioritization of means and initiatives to ensure the military relevance of the Danish defence.

5.3. Defence policy

In purely military terms, the investments being made by the major allied countries and especially the United States in technological development mean that the Danish defence is under further pressure to modernize technologically. The forthcoming Danish defence settlement may well have to balance between increased resilience and robustness, on the one hand, and digitalisation and increased technology content on the other. If the military technology visions of Denmark's allies become a reality within the next five to ten years, the Danish defence risks falling behind if insufficient investment is made in defence technology content, including digitization, in the intervening period. The principle of the current agreement to follow NATO recommendations for Danish defence planning may therefore prove inappropriate as a model for the forthcoming agreement – unless NATO's recommendations have time to change in line with the technology competition. In any case, Danish defence planning will have to be based on independent, long-term choices that balance multiple considerations in a single package: A settlement does not have to be completely in line with NATO's recommendations if other circumstances suggest deviating from them.

The growing importance of digitalization for military capabilities means that Denmark will become even more dependent on public-private technology partnerships for both development and operational use – and even choosing tactical military systems will to an even greater

degree become a strategic choice. Increased data volumes and the need to be able to access networks and updates mean that materiel choices become even more of an alliance policy choice; both lead to increased vulnerability for a relatively small state.

It has become standard for large countries to develop actual strategies for disruptive technologies, just as the same policy track within NATO is on the way to further concretization. Several of these strategy papers can be characterized more as focus lists and statements of intent. Nevertheless, the strategy papers of other countries are a sign that Denmark must also establish a more solid framework to follow the development of both civilian and military technologies while at the same time also keeping an eye on the plans of allies, partners and non-Western countries and their measures to promote the technologies. This will involve a broad effort that cannot necessarily be solved with a single strategy document – partly because the consequences in principle include, on the one hand, defence and security policy together with foreign and security policy and, on the other hand, the more general Danish business, innovation and research policy.[91] The forthcoming Danish defence agreement can address the challenges of technology competition in a variety of ways.

A first option is to establish a **technological benchmark for the defence and security policy area**. Such an overall technological ambition for the field of defence can ensure political awareness of the role of technology in defence development, thereby setting a new framework for capacity development in general. The ambition must be at minimum to ensure that the Danish defence is not decoupled from close allies, not even in five to ten years.

This includes initiatives launched in connection with the national action plan, which is linked to the European Defence Fund. For example,

91. Denmark has a number of strategies for specific technologies and technological developments. In 2019, for example, the Ministry of Finance and Ministry of Industry, Business, and Financial Affairs presented a national strategy for AI, and the Danish Energy Agency presented a 5G-action plan for Denmark, but the strategies do not take into account the security and defense policy dimensions: Regeringen, 'National strategi for kunstig intelligens' [National Strategy for Artificial Intelligence], Ministry of Finance and Min-istry of Industry, Business, and Financial Affairs, March 2019: https://www.regeringen.dk/media/6537/ai-strategi_web.pdf; Regeringen, '5G-handlingsplan for Dan-mark' [5G Action Plan for Denmark], Danish Energy Agency, February 2019: https://ens.dk/sites/ens.dk/files/Tele/5g-handlingsplan_for_danmark.pdf

the Military Technology Coordination Forum under the Ministry of Defence can be used as a stepping stone to **enhanced defence planning** with the involvement of the Ministry of Defence, the Defence Command and the Materiel and Procurement Agency under the Ministry of Defence to support the assessment of military capacity needs by continuously comparing technology development and defence plans. Against this background, the need for further national and international collaboration similar to the Danish participation in the AI Partnership for Defense can be identified. Finally, the Military Technology Coordination Forum can be expanded with a public dimension so as to involve both the business community and the research world in a **military technology council**, which would create both publicity on the subject and input into early, exploratory phases of defence planning.

Another, broader option is to establish an actual **technology competition strategy** anchored in the Ministry of Defence. In addition to the Ministry of Foreign Affairs, such a competition strategy could include other innovation-relevant ministries, such as the Ministry of Finance, the Ministry of Industry, Business, and Financial Affairs and the Danish Ministry of Higher Education and Science. Such a strategy could form the framework for cooperation in the interfaces between the defence community and digital Denmark, including research and development as well as concrete projects that can also have broader socio-economic effects. (These ideas are unfolded in a separate CMS brief[92]). Further justification for such an initiative is that the existing digital strategies (5G, AI) have little or no security policy character at all.[93]

A third possibility is to identify a limited number of **Danish technology priorities** based on strategic importance, existing knowledge or R&D capacity, supply and other value chain uncertainty, as well as

92. Henrik Breitenbauch, 'Hvad nu hvis Danmark øger forsvarsbudgettet til to procent? En sondering af mulighederne for at styrke dansk innovation og forsvarsevne' [What if Denmark increases the defense budget to two percent? An exploration of the possibilities for strengthening Danish innovation and de-fense capability]. CMS Brief, Center for Military Studies, 2020.
93. Forsvarsministeriet, 'National handlingsplan til fremme af danske interesser i forhold til EU's For-svarsfond' [National Action Plan to Promote Danish Interests in Relation to the EU Defence Fund], For-svarsministeriet, December, 2019: https://fmn.dk/globalassets/fmn/dokumenter/2020/-national-handlingsplan-2020-2020.pdf; AI Partnership for Defense, 'Joint Statement', Joint Artificial Intelligence Center, 15-16 September 2020: AI_PfD_Joint_Statement_09_16_20.pdf.

commercial opportunities. At the same time, a new framework can be set for **the role of defence industry policy in defence policy** – a framework based on a broad utility rationale for national innovation policy and international network building. The policy determining technology priorities will thus enable the long-term retention of technical expertise in the Danish Ministry of Defence Acquisition and Logistics Organisation (DALO), R&D and production capacity in research and industry, which would create 'added political value' in relation to allies and partners (as also reflected in the recently published defence industry strategy).

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