EUROPEAN DEFENCE AGENCY

Exploring Europe's capability requirements for 2035 and beyond

Insights from the 2018 update of the long-term strand of the Capability Development Plan

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Foreword

PREPARING FOR TOMORROW AND BEYOND

2018 marks the tenth anniversary of the Capability Development Plan (CDP) – a comprehensive planning tool that aims to assist European defence planners to identify defence priorities and collaboration opportunities. A lot has changed since 2008, including the security and defence environment in and outside of Europe, trends in the character of war, the development of new technologies and evolving European defence budgets.

With the adoption of the Global Strategy for the EU's Foreign and Security Policy (EUGS), the EU took a new and more assertive stance in European and international security and defence. Taking this into account, Member States' armed forces increasingly need to ensure that they have the capabilities necessary to respond to the challenges posed by state and non-state actors in a rapid and flexible manner based on effective interoperability and mutual cooperation. At the same time, it is important that the European Defence Technological and Industrial Base (EDTIB) is able to supply them with the necessary future cutting-edge technologies in a timely manner.

The mission of the European Defence Agency (EDA) is to support its Member States in the development of their capabilities. Rapid technological changes and the speed at which adversaries take them up requires adjustments on the planning and development side. We must stand ready to enter the future with the capabilities of the future.

The long-term capability strand (Strand B) of the CDP identifies key future strategic environment factors, related future capability requirement areas and technology groups that European militaries need to focus on to support the development of defence and security capabilities in 2035+, thus helping EDA Member States to focus their defence research and development (R&D) and procurement plans and programmes. While the aim of the long-term capability strand is not to predict the future, it does aim to provide Member States' armed forces with a spectrum of possible factors and capabilities for consideration.

This short publication provides a summary of key findings of this analysis, offering an insight into the CDP process and some of the strategic challenges facing European societies, militaries and industry up to 2035+.

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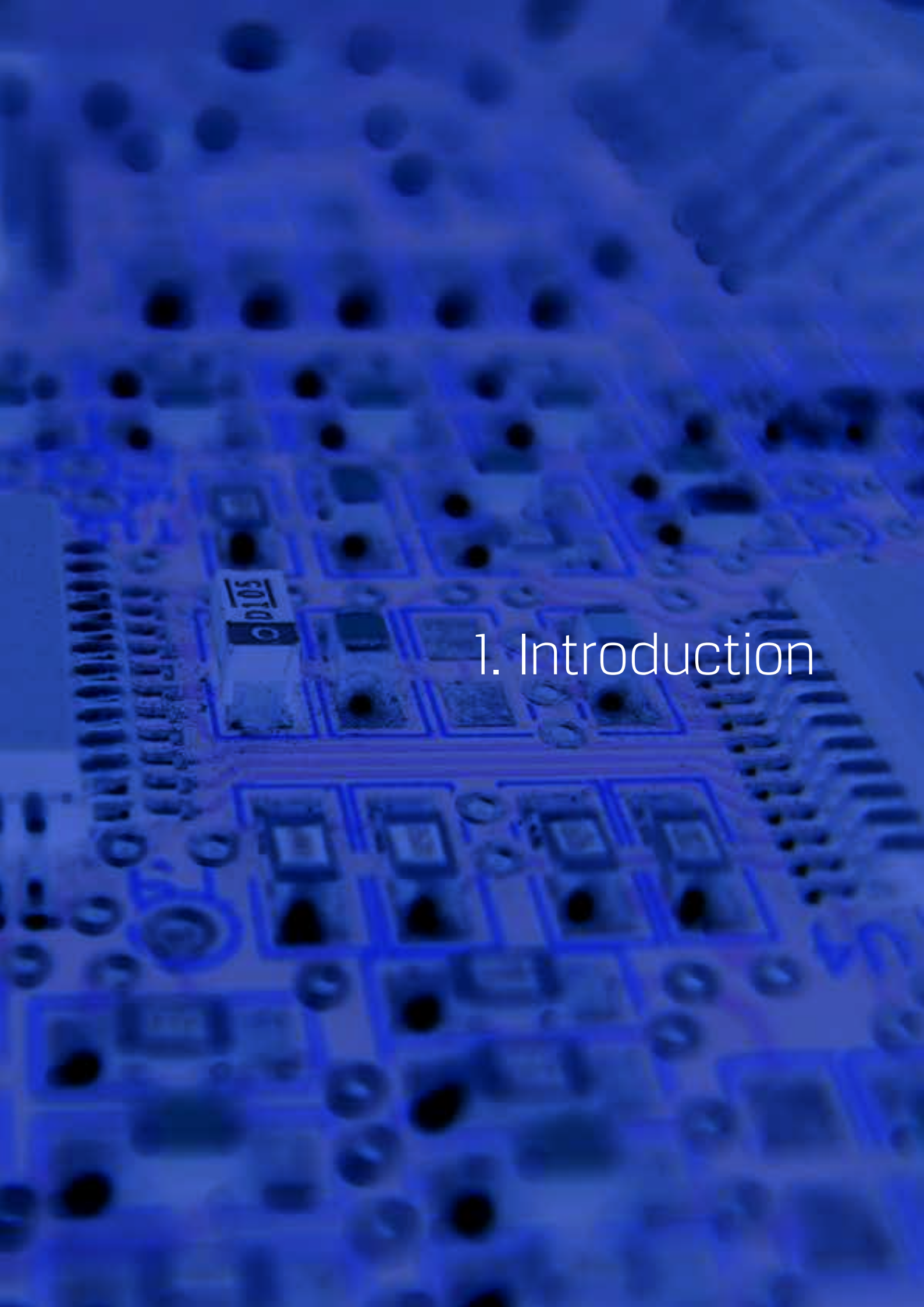


1. Introduction

1.1 THE BACKGROUND OF THE CAPABILITY DEVELOPMENT PLAN

The European Defence Agency (EDA) has been working closely with its participating Member States (pMS) to produce the Capability Development Plan (CDP) since 2008. The CDP is a comprehensive and strategic planning tool that provides an overview of future strategic military capability needs of Member States' armed forces. Its aim is to address security and defence challenges in the short, medium and long term, while providing recommendations to Member States' militaries on the capabilities they may need to react to potential security developments. This in turn provides important inputs and support to the national defence planning processes of EDA pMS.

In this way, the CDP offers a guide to national defence organisations as they build the capabilities needed to protect Europe's security, values and interests, now and in the future. This is a complex and challenging task – one that requires an understanding of the wide range of possible threats, countermeasures and operational scenarios in a complex world and uncertain future. The CDP is therefore not static, but rather a living document that is periodically updated by EDA in cooperation with its pMS and other key stakeholders such as the EU Military Committee (EUMC). This reflects the need of Member States' armed forces to remain agile, adaptable and proactive by anticipating new and emerging threats in a fast-changing world.

By continuing to evolve in light of geopolitical, social and technological developments, the CDP:

- supports conceptual development
- supports coherent integration of new and emerging technologies into military capabilities
- supports the development of appropriate strategies to turn concepts into military effects[1]
- acts as a framework to assess the fundamental character of current and future operations
- informs national defence plans and programmes
- serves as a tool to elicit opportunities for European armed forces to collaborate
- provides a capability-based approach to force and capability planning

Development of the latest iteration of the CDP has involved multiple strands of activity to examine the impact of relevant strategic, operational and technological developments. These have included reflection on lessons learnt from current and past operations, and a forward look at possible short-, medium- and long-term futures. In addition, though the CDP is driven by military not industry needs, CDP development also included assessments of the research and technology (R&T) and industrial landscapes in Europe and globally. These assessments help to understand how the capability requirements identified in the CDP might be translated into innovation and technical solutions – ensuring Member States' forces are assured freedom of action and operational advantage in an affordable, future-proof and sustainable manner through the support of industry and the R&T community.

Table 1.1 Overview of CDP strands

SHORT-TERM STRANDS		MEDIUM-TERM STRAND	LONG-TERM STRAND
General shortfalls and risks identified to achieve military objectives and requirements established in the EU Level of Ambition.[2]	Lessons learned from operations, making the process coherent with concrete needs emerging from in-theatre experience	Identification of existing and planned capability development activities. Identification of collaborative opportunities.	Assessment of future capability requirements Assessment of future technology trends R&T and industry and market assessments provide an overview of research activities and current state of the European Defence Technological and Industrial Base (EDTIB)

Source: EDA (pers. comm.).

1. EDA (2017a).
2. The Council conclusions on implementing the EU Global Strategy in the area of Security and Defence, dated 16 November 2016, define a set of capability targets (including the Headline Goal 2010) that specify what military capabilities the EU as a defence actor would need.

1.2 THIS DOCUMENT IS BASED ON A STUDY CARRIED OUT BY RAND EUROPE SUPPORTING EDA'S UPDATE OF STRAND B OF THE CDP

To help deliver the latest iteration of the CDP, EDA commissioned RAND Europe, with support from the Hague Centre for Strategic Studies (HCSS), to conduct a study to update and revise the long-term strand (Strand B) considering possible future capability requirements out to 2035+. Though the threats faced in this time horizon may be highly uncertain, the complex, resource-intensive and time-consuming task of developing new military capabilities means that decisions made today and in the near term will have a direct influence on the armed forces of the 2030s and beyond.

To understand these future long-term requirements, the RAND–HCSS team undertook the following activities:

- Identification of new and emerging technologies and strategic and societal developments that might influence capability requirements out to 2035+.
- Development of possible long-term scenarios for future conflicts and operations.
- Assessment of future military capability requirements across all military tasks, including through a tabletop exercise (TTX) involving capability planners, R&T experts and other representatives from EDA's pMS, EDA, EUMC, European Commission and NATO.
- Analysis of relevant R&T and industrial considerations, including barriers to future delivery by European industry of solutions to the identified capability requirements, and areas of dependency on non-EU third countries for raw materials, components or technology.

This short publication provides an unclassified summary of some of the key findings of this analysis, offering an insight into the CDP process and some of the strategic challenges facing European societies, militaries and industry out to 2035+.

1.3 STUDIES ON FUTURE CAPABILITY NEEDS ARE IMPACTED BY THE UNCERTAINTY OF THE FUTURE

Given the inherent deep uncertainty of how the world might evolve out to 2035+, the analysis presented in the following chapters was conducted within certain bounds and based on particular assumptions. Therefore, a number of important caveats apply:

- This document represents a short high-level summary of the much more extensive and granular analysis conducted to revise the long-term Strand B of the CDP. As such, it is not intended to be comprehensive or to reflect the more sensitive inputs to the CDP process.
- The analysis proposes future capability requirements based on the results of the TTX held at EDA in Brussels in June 2017 with the participation of EDA pMS. As such, the capability requirements included in the following chapters are limited only to the outputs of the TTX – as generated by the pMS and other participants – and do not consider additional sources.
- The analysis of R&T considerations similarly focuses on technology groups identified in the TTX (instead of the broader scoping of new and emerging technologies conducted in the first phase of the study). In addition, certain high-profile technologies that are already the subject of extensive, more detailed analysis as part of other ongoing EDA projects were excluded to avoid duplication of effort and maximise the focus of limited study resources on a subset of enabling technologies with potential application across the broadest range of possible future military tasks.

Moreover, general caution should be exercised for all work on long-term future trends as inevitably these trends are identified from today's point of view and may not take into account the inherent uncertainty of the future. Ethical and legal considerations are important when deliberating the use of new technologies. However, this report does not consider the ethical and legal aspects of future capability requirements or new technologies and assumes that the described capability requirements should be implemented within the legal and ethical requirements of the time.

3. Major technologies that are thus not included in detail in the discussion of R&T trends are: cyber technologies, kinetic weapons, manned vehicles, pharmaceuticals, propulsion technologies and radars.


Data Breac
Cyber Attack

2. The future strategic environment in 2035+

Long-term capability planning is a multidisciplinary process – one which faces complex challenges and an uncertain future. Despite this high degree of uncertainty, defence planners and decision makers must take into account the possible trends that will shape the future strategic environment out to 2035+ when considering the military capabilities needed in the future.

Without trying to predict the future, this chapter illustrates some of the key global trends that may cause violence, instability and insecurity, and to which European defence organisations must therefore adapt if they are to retain operational advantage in any future conflict.

Table 2.1 Summary of key selected strategic environment factors

FACTOR	SELECTED KEY ASPECTS
Social factors 	Increased age disparities, including an ageing global population but growth of youth populations and youth unemployment in certain regions. Population decline in Europe, but slight growth in the rest of the world. Polarisation of society. Urbanisation, including growth of megacities. Empowerment of individuals. Reduced trust in government. International and internal migration. Population concentration in coastal areas.
Technological factors 	Acceleration in the development and use of new technologies. Democratisation of technology by emerging powers and non-state actors. Civilian and 'dual-use' industries as drivers of innovation, with benefits to military. More tools to address social, economic, environmental and military challenges. New vulnerabilities, particularly around cybersecurity. More capabilities for adversaries. Impact of technology on social, cultural, political, ethical and legal norms.
Economic factors 	Continuous economic globalisation, if not without opposition or discontent. Decline of cohesion and economic power of the West. Rise of emerging economies. Increased inequalities. Increased costs of the welfare society. Impact of new technology on employment, skills and economic opportunity.
Environmental factors 	Increased range and scale of impacts from climate change. Pollution effects. Increased vulnerabilities to pandemic diseases. Increased risk of floods and desertification. Stresses on resources, such as food, water and energy. Competition for agricultural land and raw materials. Exploitation of space and pressure on other global commons.
Actors 	Decreased role of the state as the main security provider. Outsourced military functions. Cities increasingly players in their own right. Increased importance of Non Governmental Organisations (NGOs), multinational companies, private security and military companies, media, individuals and international organisations. Continued need to work through alliances, partnerships and networks.
Conflict characteristics 	Universal and timeless nature of war. Unpredictable and constantly changing character of war and conflict. Blurring of lines between conventional, unconventional and asymmetric warfare. Blurring of lines between war and peace. Increase in wars by proxy. All physical and virtual domains likely to be utilised, with actors switching across domains to gain advantages. Conflict in densely populated or restricted terrains, such as urban environments.

Source: RAND Europe analysis.[4]

4. Kepe, M., et al. (2017a)

2.1 GLOBAL AND LOCAL SOCIETY FACES MOUNTING PRESSURE FROM DEMOGRAPHIC CHANGE, RISING INEQUALITY, URBANISATION AND THE EROSION OF TRADITIONAL CIVIC STRUCTURES

A number of societal factors may increase society's vulnerability to unrest and could aggravate tensions leading to non-armed and armed conflicts. Society may become increasingly polarised along political, social, religious, gender, population, racial, urban–rural, age and other divisions, exacerbating the pressures on welfare systems caused by the continuous population decline in Europe and increased urbanisation. Furthermore, increased empowerment of individuals may result in a decline of trust in government and defence and security forces.

Globally, age disparity and population growth trends are expected to continue, requiring more social opportunities for young populations across the world. International and internal migration will continue to be high and even increase as people will be trying to seek better social opportunities, escape conflicts and flee the effects of climate change. While the global population is expected to continue to grow, albeit at a slower rate, the population increase is likely to be unequal across the world, with Europe being the only area[5] with continuous population decline. While in 2015, 24 per cent of Europe's population were aged 60 or older, by 2050 this is projected to reach 34 per cent. Likewise, the ageing global population is likely to lead to a number of social and economic effects, intensified by advances in medicine and healthcare that will create the conditions for living longer[6].

Urbanisation is expected to increase, with 70 per cent of the world's population projected to live in cities by 2045[7]. While this trend may encourage economic and social developments, it may also place a burden on existing social structures, infrastructure and environments and contribute to the spread of communicable diseases, leading to higher vulnerability to epidemics and pandemics. These factors may cause tensions among urban populations. Lastly, with the world's population expected to be increasingly concentrated in coastal areas, urban population centres may become more exposed to climate change effects such as rising sea levels and hurricanes, as well as environmental disasters such as oil spills. Without appropriate management, rapidly increasing urbanisation may lead to weak management of crises and areas of deprivation that could become breeding grounds for crime and unrest.

National and ethnic belonging will continue to be a key part of an individual's identity, particularly in countries that are ethnically homogenous and nationalistic. Civil values and sense of civic duty may decline in developed countries as part of a greater focus on the individual and its interests and an increasingly consumeristic attitude to the citizen–state relationship[8]. While religion is likely to continue to be an important factor in most people's self-identification, with some even returning to religion as a haven in a changing and challenging world, both religious secularisation and neo-orthodoxy are likely to endure. Moreover, some people may increasingly associate themselves with virtual communities in the online world.

Furthermore, with gender equality expected to continue to improve in developed countries, military forces increasing their pool of recruitment and the armed conflict frontline becoming less clear, women are expected to become increasingly active participants in frontline combat and military leadership roles.

2.2 INNOVATION AND THE DEMOCRATISATION OF DISRUPTIVE TECHNOLOGIES WILL TRANSFORM FUTURE SOCIETY, CREATING NEW RISKS TO MANAGE AND NEW OPPORTUNITIES TO EXPLOIT

Technology is a key driver for exponential change in the world. Future technological developments are likely to be 'game-changing' for society; for example, increased computing power, the widespread use of artificial intelligence (AI) and further developments in autonomous systems and human–machine interfaces may change individual, intra-national and international interactions in many domains. Moreover,

5. The UN world area division is used here: Africa, Asia, Europe, Latin America and the Caribbean, Northern America, Oceania.
6. UK Ministry of Defence (2014).
7. UK Ministry of Defence (2014).
8. Ministry of National Defence of Lithuania (2013).

new manufacturing techniques and materials are likely to change the way civilian, defence and security products are supplied and used by the customer.

While technological advances may help to address key military capabilities, they may also create new security vulnerabilities and cause ethical, moral and legal concerns. Continuous technological developments may also create a misleading perception among populations and decision makers that technologies can provide a solution to all problems, which could lead to an overreliance on them. Communication technologies may also alter high-level strategic political and military decision making by making them increasingly influenced by individual opinions. Moreover, due to the global growth of technology, technologies such as cyber-based tools, non-lethal weapons, bio-engineered weapons and weapons of mass destruction may become more affordable and increasingly become part of adversary's arsenals.

2.3 FAR FROM ELIMINATING CONFLICT, GLOBALISATION AND THE INCREASING INTERDEPENDENCE OF WORLD ECONOMIES WILL CREATE NEW THREATS, RISKS AND STRAINS ON RESOURCES

While it is difficult to forecast its scope and pace, economic globalisation is expected to continue in the future. The unequal distribution of the benefits of globalisation, with countries with high-tech industries being likely to benefit more than others, may lead to less cohesive and more polarised societies, and some states and non-state actors that do not benefit from economic globalisation may become disillusioned and more likely to harbour terrorist and organised crime groups. Globalisation may also influence the extent to which nations have control over their economies, with future markets and economies becoming increasingly interdependent. This could lead to severe spill over effects for regional and global markets in times of economic and political crises. Similarly, the increasingly interlinked industrial supply chains worldwide may have critical impacts on national self-sufficiency in certain critical equipment and resources[9].

Furthermore, maintaining a welfare society in the developed world will become increasingly expensive due to the ageing population, with this potentially affecting future defence funding. Yet, even if defence spending is increased in the face of increasing regional or international tensions, this may not lead to more high-end technologies or larger forces due to the increasing real-time costs of such technologies and manpower capabilities.

2.4 CLIMATE CHANGE, POLLUTION AND RESOURCE SCARCITY WILL PLACE GROWING PRESSURE ON BOTH GLOBAL SOCIETY AND VULNERABLE LOCAL COMMUNITIES, DRIVING POTENTIAL CONFLICT

Factors such as climate change, pollution and diseases are expected to have a significant impact on the future environment and may aggravate existing tensions, while access to resources will increasingly be a cause for conflict. In combination with population growth, environmental factors may create significant stresses on the demand for and availability of resources such as food, water and energy. Growing populations in most of the world will increase the demand on the agricultural industry to produce food, while the availability of arable land will be influenced by rising sea levels, flooding and desertification that will decrease and/or change the location of agricultural areas. Likewise, fisheries and aquaculture may be affected by alterations in water exchange, droughts, floods and changes in temperature and sea levels. Furthermore, water availability is expected to be increasingly unequal, with competition for water likely to cause tensions between countries and regions with the same water sources.

Climate change together with the increased mobility of the world population may lead to the spread of pandemics and epidemics, resulting in significant burdens on the public healthcare systems. For example, the onset of warmer weather may lead to viruses normally found in warmer climates spreading to countries where they are not indigenous, with this having the potential to overwhelm public healthcare systems. Furthermore, most of the world's population is expected to concentrate in coastal areas, exposing urbanised population centres to climate change effects such as rising sea levels, hurricanes and tsunamis, as well as other environmental disasters such as oil spills. The above factors imply the

9. Canada National Defence Headquarters (2014).

possibility that European armed forces may increasingly be called upon to participate in humanitarian assistance and disaster relief operations in response to environmental crises, or to become engaged in conflict in such areas.

The availability of raw materials will be influenced by the above trends, and will also impact manufacturing trends. Energy requirements worldwide are expected to grow. Despite the growth of renewable and nuclear energy production, hydrocarbons will remain the main energy source worldwide. The increasing interconnectedness of energy and transport networks may cause cumulative vulnerabilities in 'transport choke-points', such as the Panama Canal, the Straits of Hormuz and the Malacca Straits. However, these could be alleviated by the potential opening of Arctic Sea routes due to global warming. Consequently, these factors will have an impact on access to and prices of raw materials and components used in military equipment manufacturing in Europe, potentially affecting the ability of the EDTIB to supply European countries with the capabilities needed in the requested timeframe.

2.5 NEW SOCIAL NORMS, TECHNOLOGIES AND WAYS OF WARFARE WILL CHALLENGE THE ETHICAL AND LEGAL STRUCTURES OF THE RULES-BASED INTERNATIONAL SYSTEM

As most conflicts in the future are likely to be unconventional, the existing principles of international law governing the use of military force will be challenged. Existing international laws will also be challenged by the following:

- Changes in the international world order, the lack of an overarching global leader and potential lack of an overall international interpretation of international laws.
- The increasing occurrence of non-kinetic conflicts challenging the application of laws designed for kinetic warfare.
- The blurring of lines between combatants and non-combatants.
- The question of how to apply international law to technological advances, such as human enhancement, AI and autonomous technologies.
- Potential warfare in new domains, such as space.

Furthermore, there is no guarantee that all countries will abide by the Law of Armed Conflict (LOAC), International Humanitarian Law and International Human Rights Law or interpret international regulations in a comparable way. It is possible that some actors may seek ways of separating themselves from international norms and regulations and try to protect their power and influence. Therefore, differences in the interpretation of laws will have an increasing impact on military operations and future warfare. Furthermore, an increasing use of autonomous systems instead of soldiers may cause a shift in the understanding of the military profession and the related ideas of honour and courage.

2.6 INTERCONNECTIVITY AND THE EROSION OF STATE MONOPOLIES ON POWER WILL NECESSITATE PARTNERSHIPS WITH GLOBAL, REGIONAL AND NON-STATE ACTORS TO PROMOTE SECURITY

While the overall role and influence of the state may diminish due to the increasing power and influence of the individual and of non-governmental and commercial organisations, state actors are still expected to continue to be major players in international and regional security and defence. Guaranteeing the territorial defence and sovereignty of a country will continue to be the main responsibility of a state and its armed forces. Depending on the national arrangements, armed forces are likely to become more involved in supporting the resilience of a country's civilian security sector and society as a whole. Some countries in Europe and elsewhere may choose to gradually outsource military functions to private security and military companies (PSMCs) due to economic and demographic reasons and the increased cost of specialised systems. This may, however, pose legal challenges and issues related to the chain of command, further decrease the role of the state as a provider of security and erode public control over armed forces.

The future operating environment is likely to be increasingly crowded with various non-adversarial and adversarial state and non-state actors. The importance and influence of NGOs and other entities, including multinational companies, PSMCs,

10. Finland Ministry of Defence (2016).
11. US Joint Chiefs of Staff (2016).

international media, armed non-state actors, influential individuals and international organisations, could grow in the future. Their increasing importance will be due to technological advancements and possible disillusionment with the abilities of states to address welfare, security and other concerns of the population. Non-state actors may also gain influence through leveraging their financial resources and recognisability among the public. However, they are unlikely to achieve legal and decision-making powers that equal those of the state. The future military opponent in the case of a state–state war may comprise national armed forces, contracted private companies and non-state proxies with differing levels of armaments and available technologies. The use of technologies and actors could be impacted by international norms and regulations in place in 2035+.

While the two main types of state actors may be revisionist powers and failing/failed states, it will be increasingly difficult to distinguish between the different types of actors. Cities will become players in their own right in terms of security and defence. More specifically, failed and failing cities may increasingly become a phenomenon in both the developed and the developing world. Such cities, where local governance is weak, may become a security challenge for the whole country.

Adversarial non-state actors will continue to have a significant role in conflicts and may include groups of different actors ranging from ideologically motivated terrorist organisations and rebel groups to multinational corporations, PSMCs and criminal organisations with varied capabilities. These actors may also act as state proxies through projecting their political influence, which could add confusion to the crowded environment.

2.7 THOUGH THE NATURE OF WAR REMAINS UNIVERSAL, THE CHARACTER OF WARFARE CONTINUES TO EVOLVE AND POSE NEW CHALLENGES TO AIR, LAND, SEA, SPACE AND CYBER FORCES

The overall character of war is unpredictable and continuously evolving; new technologies will most probably not be able to eliminate the fog of war. Future conflicts are likely to be characterised by a disintegration of the border between conventional and unconventional or asymmetric warfare and between the states of war and peace. While the possibility of interstate conflicts will continue to exist, conflicts may include elements of hybrid warfare, proxy wars, use of cyber capabilities and use of strategic attacks to disrupt critical infrastructure, particularly in areas that highly value data integrity, such as financial services. At the same time, war will retain its fundamental nature as a violent and purposeful activity.

Future conflicts will take place in all physical (land, air, sea and space) and virtual (cyberspace) domains. A conflict will not be limited to only one domain at any one time. On the contrary, actors are likely to shift between domains, trying to leverage those that give them the most advantage or where they have superior capabilities.

Due to increasing urbanisation, conflicts on densely populated terrain will increase. As a high percentage of these populated areas are expected to be located in coastal areas, this may also imply a requirement for amphibious capacities. The maritime domain is likely to maintain its strategic importance due to the globalisation of trade, its use in criminal networks, the aggregation of population in coastal areas and the impacts of climate change, which could lead to rising sea levels. The air domain is also likely to retain its importance, especially with an increasing use of unmanned aircraft. Cyberspace and space may increasingly become a domain of military activities or targets due to the strategic role of these domains.

3. Future military capability requirements

This chapter presents a perspective on future military capability requirements for European countries based on EDA's work on the update of the long-term strand of the CDP. A number of key military capabilities that might be needed by Member States' forces to safeguard Europe's freedom and security and respond to potential future crises were identified.

3.1 OUTLINE OF MILITARY TASKS OF MEMBER STATES' ARMED FORCES

EDA prescribes a set of core military capability areas: Command, Inform, Engage, Protect, Deploy and Sustain. All these areas are inherently interconnected and allow Member States' forces to ensure their defence and security in a changing strategic environment.

Figure 3.1 EDA's generic military task list (GMTL)

Table 3.1 Future implications for military requirements per GMTL

GMTL	FUTURE IMPLICATIONS
COMMAND	Need to ensure real-time situational awareness and common operational picture, as well as rapid decision making and information sharing within the military mission and with national and international government, civilian and commercial actors on the ground.
INFORM	Need to ensure rapid collection and integration of multiple types of information from many different sources, as well as rapid analysis (incl. big data analysis, prioritisation and identification of significant patterns) and delivery to decision makers.
ENGAGE	Need to integrate a distributed network of different sensors and effectors to generate a flexible range of kinetic and non-kinetic effects, depending on which are most appropriate to achieve the desired operational outcomes in a given situation.
PROTECT	Need to ensure effective and efficient resilience not only of military forces but also civilian populations, infrastructure and systems against potential disruption or attack, including against kinetic threats and non-kinetic, e.g. cyber and electronic warfare.
DEPLOY	Need to deploy forces to areas of operation (or conduct casualty evacuation [CASEVAC]) at long range and at short notice, potentially in the face of sophisticated anti-access area denial (A2/AD) threats.
SUSTAIN	Need to support mobile and rapidly deployable forces through resilient, automated,

3.2 CROSS-CUTTING FUTURE CAPABILITY REQUIREMENTS

The latest revision of the long-term strand of the CDP suggests a number of key high-level requirements that will have a significant impact across all the generic military tasks of Member States' armed forces, as shown in Figure 3.2.

Figure 3.2 Summary of seven overall future military capability requirement trends

Source: Kepe et al. (2018).

These trends are further described below.

3.2.1 Efficient information sharing with joint multinational forces and other actors on the ground is an underlying requirement in all GMTLs

Member States' future forces will need the ability to effectively share unclassified and classified information among different levels and units within national and multinational deployments and with non-military actors. This will help to ensure rapid data-to-decision (D-2-D) timelines while operating in potentially contested and complex future operating environments with multiple participating friendly military and non-military actors. This requirement also coincides with the need to ensure that Member States' forces have a good awareness of the information environment in which they are operating, ensuring that they are able to understand and respond quickly to any changes in the security environment. Meeting this requirement will help Member States' forces to engage with key audiences in an effective manner to create, strengthen and preserve favourable conditions for the overall mission goals.

Examples of measures that could help address this requirement:

- Using interoperable communication systems.
- Using data-sharing systems.
- Developing training for forces on communication with non-military actors.
- Developing and using common technical standards for military and commercial satellite communications.

3.2.2 There is a need to ensure effective and rapid decision making at all levels, supported by enhanced situational awareness in complex, congested battlefields

Rapid decision making, including the ability to provide rapid and verified unclassified and classified information to military decision makers, a short D-2-D timeline and real-time situational awareness, is a significant underlying factor for Member States' forces to be able to respond to increasingly complex air, land, sea, space and cyber operating environments and help achieve rapid decisions at all levels on the best possible actions. Good situational awareness of all levels of the deployed forces is crucial for Member States' militaries to gain and maintain advantages over the adversaries of 2035 and beyond. This will require an acknowledgement of the increasing importance of understanding the information environment and the sentiment of the people of the host nation, and the ability to discern between the multiple players in the region of deployment. As well as supporting kinetic or non-kinetic offensive and defensive operations, a good understanding of these elements and their physical, informational and cognitive elements will also help with strategic communications (STRATCOM) messaging and ensure that the most effective vehicles of communication are used by European forces.

Examples of measures that could help address this requirement:

- Enhancing the surveillance capabilities of individual soldiers.
- Developing ground-, air-, sea- and space-based intelligence, surveillance, target acquisition, and reconnaissance (ISTAR) capabilities that capture data for use by AI systems to allow for faster and more targeted analysis of large amounts of different ISTAR inputs originating from different sources.
- Improving human cognitive capabilities.
- Maximising areas of communications and electronic search, intercept and identification coverage to aid threat recognition.
- Developing reliable systems for detecting, tracking and targeting the air, sea, land, space and cyber activities of adversaries.

3.2.3 Civil–military cooperation will be necessary to ensure the fulfilment of mission mandates and leverage partners' networks, resources and capabilities

Civil–military cooperation helps foster deeper and common understanding between the armed forces and civilian actors, ensuring that the actions of Member States' military forces are culturally appropriate for the host region and relevant for the situation. Understanding the actions of civilian actors on the ground, such as NGOs, humanitarian actors and private companies, and how they may influence the activities of Member States' forces and shape the increasingly complex and contested operational environment, will also help in carrying out the military mandate in an efficient manner. Within this complex environment, the ability to identify and coordinate cooperation with civilian organisations to complement a mission's resources should be particularly emphasised. At the same time, the growing reliance on civilian actors for certain supporting functions, e.g. logistics, will require increased cooperation on securing civilian networks and operations against physical or cyberattack, so as to counter vulnerabilities in the private sector or other organisations supporting frontline military operations.

Examples of measures that could help address this requirement:

- Developing reliable and resilient communications networks.
- Developing a good cultural understanding.
- Developing unified command, control, communications, computers, and intelligence (C4I) systems for crisis management.
- Holding regular exercises to train cooperation with various civilian actors.
- Increasing cooperation on securing civilian networks and operations against physical or cyberattacks.

3.2.4 Mobility is key to allow Member States' forces to engage in more flexible, agile deployments and operate in complex, contested and hazardous environments

Mobility is a key force multiplier and has been increased substantially over the last centuries. Improving strategic-, operational- and tactical-level mobility will continue to be vital for Member States' forces, be it via improvements of current technologies or through the use of unmanned and/or autonomous vehicles and robotics. Considering the expected decline in the differences between times of peace and conflict, and the disappearance of frontline soldiers, Member States' forces and their conventional and special operations forces (SOF) need to be mobile and flexible. This will give them the ability to adapt and respond quickly to a range of operational scenarios and deploy themselves to areas with little or no host nation support.

Examples of measures that could help address this requirement:

- Reducing the logistics burden to improve the self-sustainability of forces
- Using lightweight modular and easily transportable materials and equipment
- Using smaller, more independent deployments.

3.2.5 Cyberspace will become an ever-more integrated part of the physical battlefield, information activities and influence operations

Member States' forces need the ability to conduct defensive and offensive cyber operations at the strategic, operational and tactical level, including the ability to disrupt and defeat the adversary forces by reducing their will or capacity to fight. These capabilities may also include the ability to disrupt and take control of the adversary's manned and unmanned systems as remotely piloted and autonomous vehicles become more prevalent on the future battlefield. In order to make better use of their defensive and offensive cyber capabilities, Member States' forces need to seamlessly integrate cyber into their concepts, doctrine, operational planning and training, thus building the capability to ensure flexibility of effects. This includes integrating cyber operations not only with kinetic operations, but also with other forms of information warfare, e.g. influence, STRATCOM and psychological operations (PSYOPS) activities.

Examples of measures that could help address this requirement:

- Developing higher cyber situational awareness.
- Developing automated cyber vulnerability and intrusion detection and defence.
- Developing the ability to carry out responsive defence actions that combine both the physical and cyberspace protection of military and civilian networks and systems.

3.2.6 Deploying a flexible range of non-lethal and non-kinetic effects will allow forces to minimise collateral damage while disrupting the adversary's capabilities

Member States' forces need the ability to employ a flexible range of effects on demand, including access to non-lethal weapons systems, such as microwave and sonic-based weapons. These may be targeted against individuals or groups to create a non-lethal area-of-effect for purposes such as incapacitation, crowd control or area denial. Furthermore, the development and use of electronic warfare and jamming capabilities across all domains may minimise collateral damage while disrupting the use of the electromagnetic spectrum.

Examples of measures that could help address this requirement:

- Developing an improved understanding of how to conduct battle damage assessment of non-lethal strikes.

3.2.7 Enhancing individual soldiers will empower them with improved information gathering, mobility and resilience to operate in complex, contested environments

There is a need for enhanced levels of resilience among individual service personnel, which in future may be achieved through human enhancement technologies (either biological or cybernetic). While the use of these technologies will be limited by the ethical and legal constraints of the day, they could increase the ability of individuals to gather and process information, resist the effects of pathogens and chemical, biological, radiological and nuclear (CBRN) threats, and benefit from improved cognition, strength, speed and other capabilities. This capability may be necessary not only due to an increased spread of diseases through greater population movements and potential climate change effects, but also because of the possibility that technological proliferation may lead to unfriendly actors possessing CBRN weapons. Such technologies may also help address the potential need for European countries to mitigate the decrease in the recruitment pool for military forces due to the expected population decline in Europe, thus requiring the existing personnel to serve longer or have more intensive deployments.

Examples of measures that could help address this requirement:

- Improving the strength, endurance, mobility and resistance of individual soldiers
- Improving resistance to CBRN and other toxin threats.

4. Technology, research and industrial enablers for future military capabilities

While the fundamental nature of war is timeless and unchanging, innovation in military technologies has repeatedly transformed the character of warfare – affecting what, why, how, when and where conflicts are fought. Keeping pace with technological progress is therefore essential for European defence; however, this is a growing challenge in the 21st century, as innovation continues to occur ever-more quickly. For example, cutting-edge military capabilities can take decades to research, develop, prototype, manufacture, test, field and integrate, but might be obsolete by the time they are put to use. At the same time, disruptive new threats can emerge with little or no warning.

To address this imbalance, Member States'militaries and EDA must plan ahead to anticipate future capability needs and adapt to the fast pace of change in the technology and industrial environments. Member States' forces in 2035+ will not only need to keep a watchful eye on the horizon of scientific and industrial progress, but also provide the political, regulatory and organisational enablers that support a vibrant innovation ecosystem for defence. Only in this way can Member States' militaries position themselves to identify, understand and absorb innovative new ideas and technologies more quickly than potential adversaries.

4.1 CHANGING PACE AND FOCUS OF TECHNOLOGICAL INNOVATION FOR DEFENCE

4.1.1 Member States' forces can no longer take technological superiority for granted, as innovation will play a vital role in transforming the future of warfare in 2035+

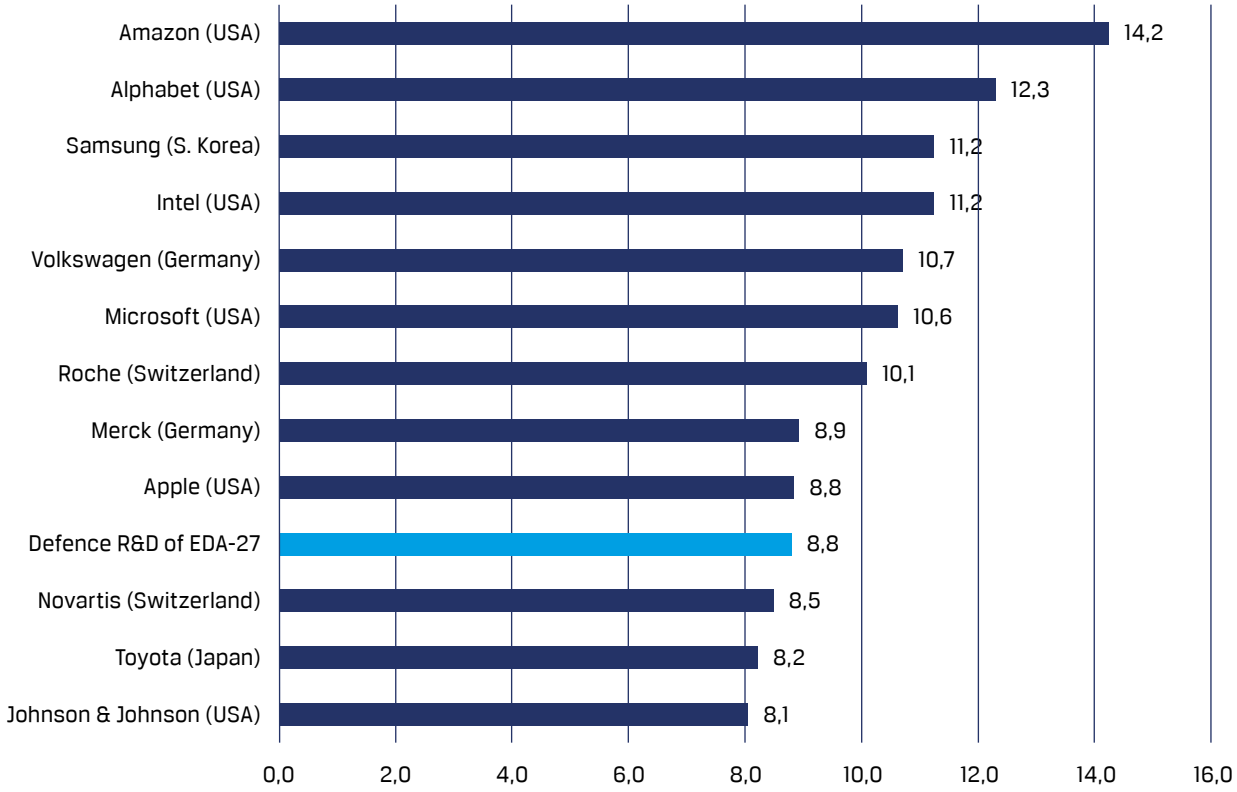
Understanding the fast-changing technology landscape is an essential input to the CDP for a number of reasons. Technology affects many aspects of conflicts and is therefore a critical component of defence planning. New technologies have often shaped military strategies and tactics and inspired the development of defence innovations. For centuries, Western militaries could 'offset' a quantitative disadvantage against an opponent's larger forces by having the qualitative edge in terms of technology, interoperability and training.

In an increasingly connected, complex and information-rich global society, innovation not only shapes the ways and means by which wars are waged, but also influences the ends for which people fight, as well as how they conceptualise the shifting boundaries between 'war' and 'peace'. In turn, this conditions the role and responsibilities of defence institutions in preventing, preparing for, engaging in and moving away from conflict in defence of European citizens, interests and values.

4.1.2 Member States' forces will have to adapt to changing dynamics in the pace, nature and location of technological innovation – raising new threats and challenges

In the past, it was the military that drove the cutting edge of technological innovation, often with beneficial 'spill overs' into wider civilian life – jet travel, satellite navigation and the Internet being just a few examples. That relationship is now being reversed. The growth of research and development (R&D) in the commercial sector and the interconnected global innovation and production networks increasingly mean that the dynamics in defence innovation work the other way around – with technologies often first developed in a civilian context and then adapted for military application. The combined defence R&D expenditure of the 27 pMS of EDA is now significantly smaller than the annual research spending of leading commercial companies – many of them based outside of Europe, including in the USA or Asia (see Figure 4.1).

Figure 4.1 Comparison of defence R&D of EDA-27 with top commercial research spenders (€bn)



Source: EDA Defence Data (2016), Statista (2017)

Similarly, the democratisation of many key emerging technologies means that Member States' forces are seeing their technological edge over both state and non-state adversaries eroded. Major non-European nations are developing low-observable 'stealth' fighters, advanced tanks and long-range artillery, ambitious space programmes, AI and new cyber and electronic warfare systems. These fast-developing capabilities are being combined with new concepts and doctrines that cut across all operational domains and do not obey traditional Western ways of thinking, including a blurring of the boundaries between war and peace. At the same time, non-state actors are using 'dual-use' commercial off-the-shelf (COTS) technology to improvise low-cost and adaptable alternatives to expensive military equipment. These could include deploying fleets of cheap, disposable unmanned air vehicles (UAVs), launching cyberattacks on military and civilian targets and even jamming satellite communication signals in space.

Member States' militaries increasingly rely on close cooperation with commercial suppliers, NGOs and others to help collect intelligence, provide technical or cultural expertise, support troops on deployment, maintain equipment, provide essential infrastructure and services and deliver aid or humanitarian relief. They also seek to escape the long lead times, high costs and obsolescence issues associated with a traditional 'platform-centric' approach – such as acquiring a new ship, aircraft or vehicle every 15–20 years or more – and avoid building 'exquisite' platforms that may be too over-engineered for efficient use against low-end threats and too costly or time-consuming to replace if damaged or destroyed on operations.

Instead, Member States' forces anticipate a growing focus in the future on modular design, open architectures, incorporation of commercial technologies and a 'system of systems' approach that mixes a range of high-end and more affordable systems, sensors and effectors. This, it is hoped, may provide Member States' militaries with greater flexibility, value for money and resilience. These characteristics can help them to adapt to sudden mission changes or rapid evolution in technology or threat environments.

4.1.3 Changing dynamics of innovation and technological proliferation mean Europe must promote a more agile, proactive approach to outsmart its adversaries

As the focus of innovation shifts away from European and US dominance to include emerging global powers and multinational firms, the need to understand and anticipate changes in the technology environment more quickly than potential competitors only increases. Moving towards 2035+, these developments make it ever-more important that EDA understands a broad spectrum of potential future technology trends if it is to help European defence planners develop innovative military applications to respond to existing and new forms of threat to peace, stability and democratic values. The importance of this task is reflected in a range of ongoing EDA activities, including the Horizon Scanning and Technology Watch Tool or CapTech[12] Strategic Research Agendas (SRAs), as well as in initiatives from the European Commission, such as the Key Enabling Technologies (KETs) and Future Emerging Technologies (FETs) programmes.

4.2 ENABLING TECHNOLOGIES FOR FUTURE EUROPEAN MILITARY CAPABILITIES

4.2.1 While the most disruptive innovations may be impossible to predict, a range of new technologies emerging today will shape future European forces to 2035+

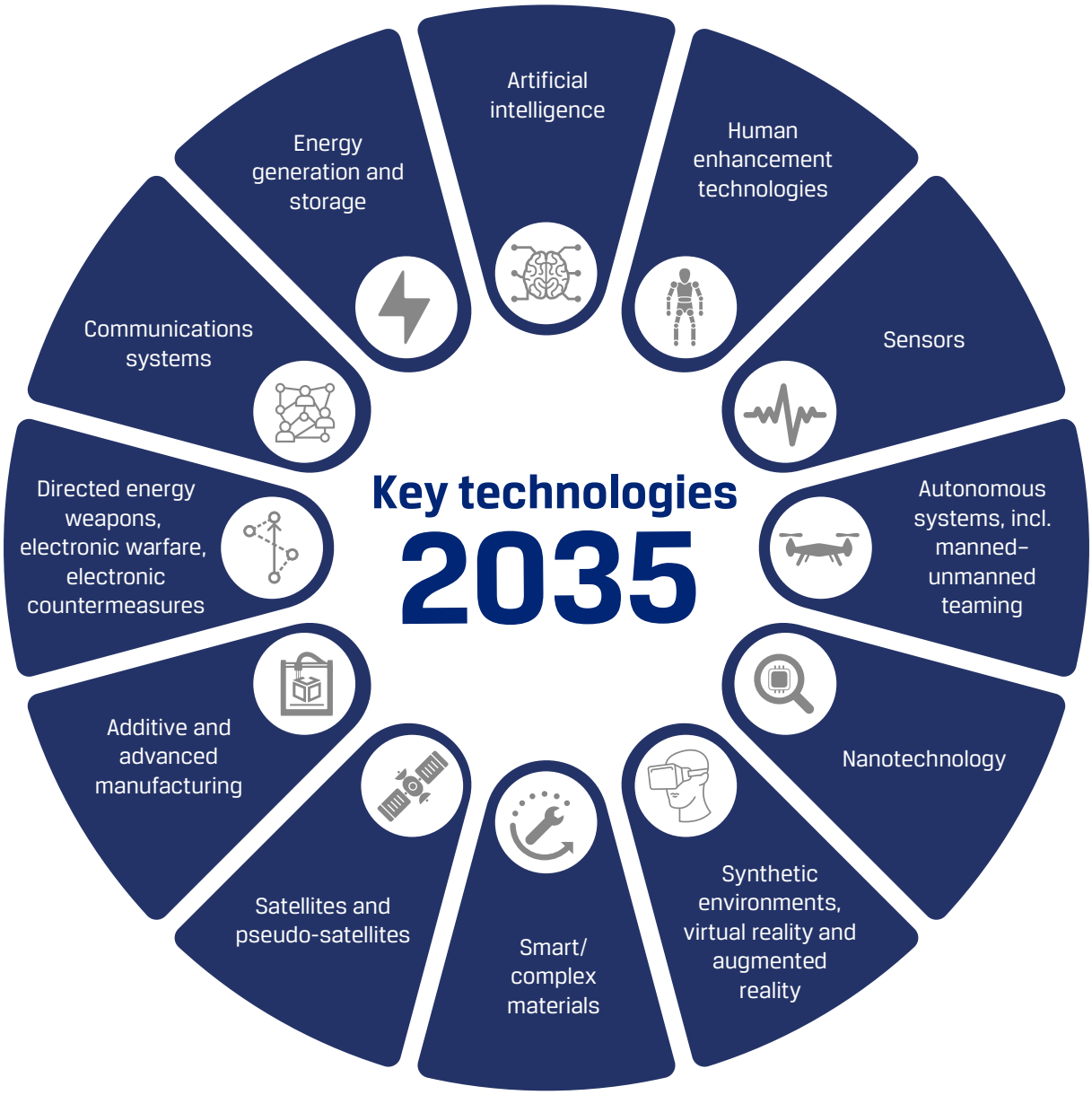
The unpredictable nature of technological development means that the most novel and disruptive breakthroughs – sometimes referred to as 'Black Swans' – can be almost impossible to predict, occurring with little or no warning but potentially large impact[13]. It is likely to be the case that science and technology will evolve in unexpected ways out to 2035+, beyond the lens of today's perspective to anticipate fully or understand. Overall, the future remains uncertain.

At the same time, it is possible to identify new and emerging technologies that are beginning to come into focus today and anticipate their future impact on the mission, shape and capabilities of Member States' forces. The revision of the long-term strand of the CDP out to 2035+ identifies a wide range of different new technologies, or novel applications of existing principles, that will influence the future capability requirements of militaries in Europe. Based on horizon scanning, it is possible to cluster the most promising, relevant and impactful of these novel technologies to identify those likely to have the most significant effects on societal development and defence and security out to 2035+.

The 12 priority technology groups identified for the CDP to 2035+ are shown in Figure 4.2.

12. CapTech or Capability technology areas are networking fora for government, industry, small and medium enterprises and academia experts that are moderated by EDA.
13. Taleb (2007).

Figure 4.2 Key technologies that may enable future military capabilities in 2035+



Source: RAND Europe (2018).

As outlined in Table 4.1, each of the 12 key enabling technologies (see Figure 4-2) is expected to influence European military capabilities across the full range of military tasks.

Importantly, many of the most innovative defence applications out to 2035+ may come from the integration of two or more enabling technologies to generate a novel combined capability. This is reflected in EDA's Technology Building Blocks (TBBs) concept and the approach of the OSRA framework [14]. Examples could include the combination of new materials, battery technologies, additive manufacturing techniques and communication and sensor chips to produce embedded surveillance systems able to connect with other parts of the environment (e.g. the Internet of Things), or the mixture of augmented reality, autonomous systems and AI to create seamless human–machine interfaces allowing soldiers to direct unmanned assets on the battlefield with simple voice, gesture or other commands.

Exploring these potential overlaps and synergies between multiple technology groups will therefore remain an important task for European ministries of defence (MODs) and EDA out to 2035+ as they seek to develop innovative technological solutions to address emerging capability needs.

Table 4.1 Examples of possible applications of key enabling technologies to military tasks

TECHNOLOGY GROUP	SELECTED EXAMPLES
1. HUMAN ENHANCEMENT (BIOLOGICAL, CYBERNETIC, OTHER) 	• Use of exoskeletons to increase the physical strength, protection and mobility of deployed combat and logistics personnel. • Cybernetic augmentation, genetic alteration and/or nanotechnologies to enhance human cognition. • Pharmaceuticals and other means for improving the resilience of individual soldiers to CBRN threats and other injuries in the field.
2. SENSORS 	• Integration of sensors and effectors with the individual soldier to generate radical improvement in situational awareness, ISTAR and communication capabilities, and to provide remote health monitoring. • Monitoring intrusion and maintaining resilience of headquarters through damage and intrusion monitoring sensors, acoustic sensor systems and facial and physiological recognition sensors. • Access to data generated through networks of sensors embedded in the environment (e.g. Internet of Things) to detect adversary activities.
3. AI 	• AI decision-making support tools to support command and control at all levels, including use of predictive algorithms to anticipate threats/trends through analysis of big data. • Use of AI to perform intelligence gathering and processing to provide a Common Operational Picture and provide situational awareness. • Application of AI to support activities such as STRATCOM, logistics planning, airspace management and analysis of lessons learned.
4. SYNTHETIC ENVIRONMENTS, VIRTUAL REALITY AND AUGMENTED REALITY 	• Support to decision making through use of high-fidelity simulated environments to identify possible courses of action. • Virtual reality and augmented reality for such applications as training, logistics planning and direct movements. • Integration of virtual reality/augmented reality with improved human–machine interfaces to enable more seamless manned–unmanned teaming.

14. EDA (2017b); OSRA stands for 'Overarching Strategic Research Agenda'. OSRA was set up to harmonise the Strategic Research Agendas of the individual CapTechs.

5. SMART/COMPLEX MATERIALS 	• Low-observable materials for covert reconnaissance and strike missions. • Self-repairing, self-destructive and programmable smart materials to facilitate the assembly, security and resilience of infrastructure. • Improved lightweight armour for individual soldiers and manned and unmanned systems across all domains, including counter improvised explosive devices (C-IED).
6. SATELLITES AND PSEUDO-SATELLITES 	• Access to a resilient network of military, civilian and commercial satellites or other communications nodes (incl. High-Altitude Endurance (HALE) UAV, pseudo-satellites) for global reach. • Use of space-based or HALE assets for ISTAR purposes. • Improved physical hardening, mobility and cybersecurity for space-based assets, including use of clusters of micro- and nanosats, and new launch technologies to ensure European access to space.
7. AUTONOMOUS SYSTEMS, INCL. MANNED–UNMANNED TEAMING 	• Swarming unmanned systems in air, land or maritime domains to overwhelm adversary defences, including teaming with manned assets. • Remotely operated or autonomous medical systems to treat injured personnel in the field and/or provide CASEVAC under fire. • Unmanned logistics/delivery systems and engineering vehicles to reduce the force protection demands of manned supply convoys.
8. COMMUNICATION SYSTEMS 	• High-speed secure communications for transferring increasingly huge datasets and enabling automated analysis in real time. • Access to a diverse range of high- and low-tech communications to ensure flexibility and meet advanced capability needs while providing fall-back options. • Use of HALE UAVs and other systems to create deployable nodes for communication networks, including in face of denied access to space.
9. ADDITIVE AND ADVANCED MANUFACTURING 	• Portable additive manufacturing and printing of components and supplies to enable forces to self-sustain with limited logistic support. • Application of 3D printing and other advanced manufacturing techniques to enable new lightweight designs for aircraft, armour, etc. • On-demand manufacturing of bespoke prostheses, pharmaceuticals and other medical equipment (e.g. blood) to support medical ops.
10. NANOTECHNOLOGY 	• Nanotechnologies to provide connected information exchange networks and improved human perfowrmance or cognition. • Nanobots that improve human resistance to damage, pathogens and toxins to enhance SOF capability. • Specialist nanobots that help tend, maintain and repair deployed systems, including in space.
11. DIRECTED ENERGY WEAPONS, ELECTRONIC WARFARE, ELECTRONIC COUNTERMEASURES 	• Directed energy weapons (DEW) to counter adversary swarms of UAVs and mass fires, providing improved magazine depth and flexibility of effects. • Electronic warfare (EW) systems and electromagnetic spectrum management to achieve tactical and operational effects against both civilian and high-grade military electronic systems. • Electronic countermeasures (ECM) to improve resilience of friendly systems to adversary EW, along with reversionary modes and redundant systems.
12. ENERGY GENERATION AND STORAGE 	• Renewable energy generation to decrease the logistics footprint of deployed forces in-theatre. • Improved energy storage and energy generation, integrated with unmanned surveillance systems to maximise deployment time. • Novel and improved efficiency propulsion to increase endurance and reduce fuel costs and deployment times (e.g. hypersonic).

15. Kepe et al. (2018).

4.3 RESEARCH BASE AND DEFENCE-INDUSTRIAL ISSUES

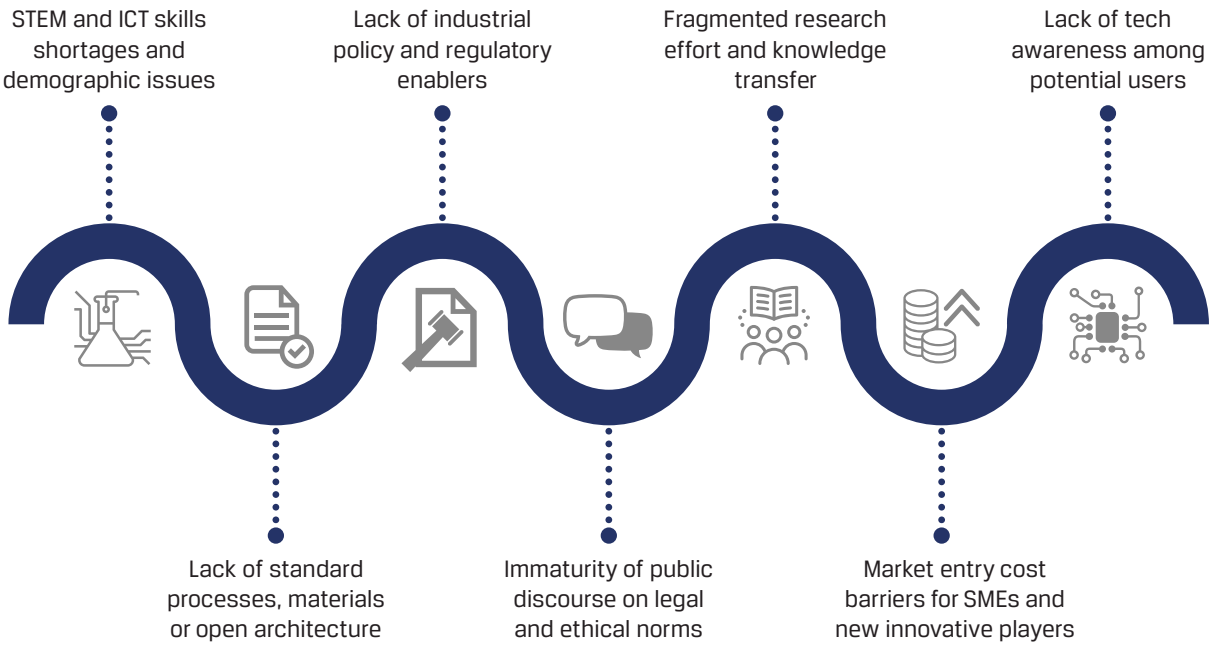
4.3.1 European capability planners should recognise where they can shape the evolution of defence technology and industry and where they must adapt to it

Future capability requirements for 2035+ reflect evolutions in the strategic and threat environments and the underpinning technologies available to both friendly and hostile actors. At the same time, European defence organisations should remain aware of the 'art of the possible', not just in technology terms, but also in relation to the capacity and capability of European defence industry to deliver solutions to address military requirements. As already discussed, innovation is increasingly occurring outside of defence laboratories or traditional defence-industrial firms. Faced with emerging new global and civilian players, European governments at national, EU and NATO levels recognise the enduring importance of promoting an efficient, capable and competitive defence-industrial base, and of better engaging with new potential partners through collaboration with international allies and 'dual-use' research. This brings wider economic benefits in terms of employment, skills, innovation and export, and ensures Europe has the strategic autonomy and security of supply to equip its armed forces with the tools they need to protect Europe's interests and values in a complex, uncertain world.

4.3.2 Skills, funding and regulatory challenges may hamper R&D development in Europe out to 2035+, if not addressed in the short and medium term

European defence planners looking to the future must remain aware of a range of important challenges to the development of European industrial capacity and capabilities in each of the 12 technology areas identified for the CDP in the long term. This means understanding how the current 'health' of the EDTIB and R&D base might impact the future delivery of technological solutions to military requirements in 2035+. Table 4.2 summarises the key issues.

Figure 4.3 Overview of key challenges for European industry



Source: RAND Europe (2018).

Table 4.2 Summary of key challenges and barriers for long-term technological development

CHALLENGE	DESCRIPTION
STEM AND ICT SKILLS SHORTAGES 	The EDTIB and R&T base face a general shortage of Science, Technology, Engineering and Mathematics (STEM) and Information Communication Technology (ICT) skills as well as more niche, technology-specific expertise. European defence industry will be competing for the same pool of skills with civilian companies as well as global competitors. Considering the synergies between various technologies, there will also be an increased demand for multidisciplinary skills and integration of multiple technologies and fields. It may be difficult to secure niche defence-specific skills in such technologies as DEW in the absence of programmes to provide opportunity for 'on the job' learning.
LACK OF STANDARDISATION OF PROCESSES AND MATERIALS 	The lack of manufacturing standards in such areas as additive manufacturing, artificial intelligence, energy storage and generation and sensors is hindering investment, development and application of these technologies. It also contributes to fragmentation of technologies as companies are establishing their own standards.
LACK OF INDUSTRIAL POLICY AND REGULATORY ENABLERS 	Development and innovation of emerging technologies are challenged by the lack of industrial policies and key enabling regulation on topics such as liability, use of open data and safety aspects related to their use. Investments in and development of other strategically sensitive technologies, such as satellites, are also affected by import and export restrictions in Europe and major manufacturers such as the United States.
IMMATURITY OF PUBLIC DISCOURSE ON LEGAL AND ETHICAL NORMS 	Ethical concerns and the lack of a mature, established normative framework also hinder the further exploitation of technologies such as AI, robotics and human enhancement, particularly in the military context where their usage may be most controversial.
FRAGMENTED RESEARCH EFFORTS AND KNOWLEDGE TRANSFER 	Fragmentation of research and investment efforts in Europe and poor knowledge transfer among research and manufacturing operators impact Europe's ability to increase its role in technology maturity and level of expertise.
MARKET ENTRY COST BARRIERS 	High market entry costs and high technology development costs impact the development of some technologies, such as satellite manufacturing and operation.
LACK OF AWARENESS OF POTENTIAL USERS 	Lack of technology awareness among potential users, and thus reduced potential market, may be a challenge to the development of emerging technologies.

4.3.3 Global dependencies may impact the future strategic autonomy of European industries and militaries dependent on access to the latest technology

Crucially, the issues affecting European industry and R&D cannot be separated from wider global developments. Both defence and civilian industry are increasingly dependent on complex international supply chains for key components (such as microchips) and critical resources (such as rare earth minerals).

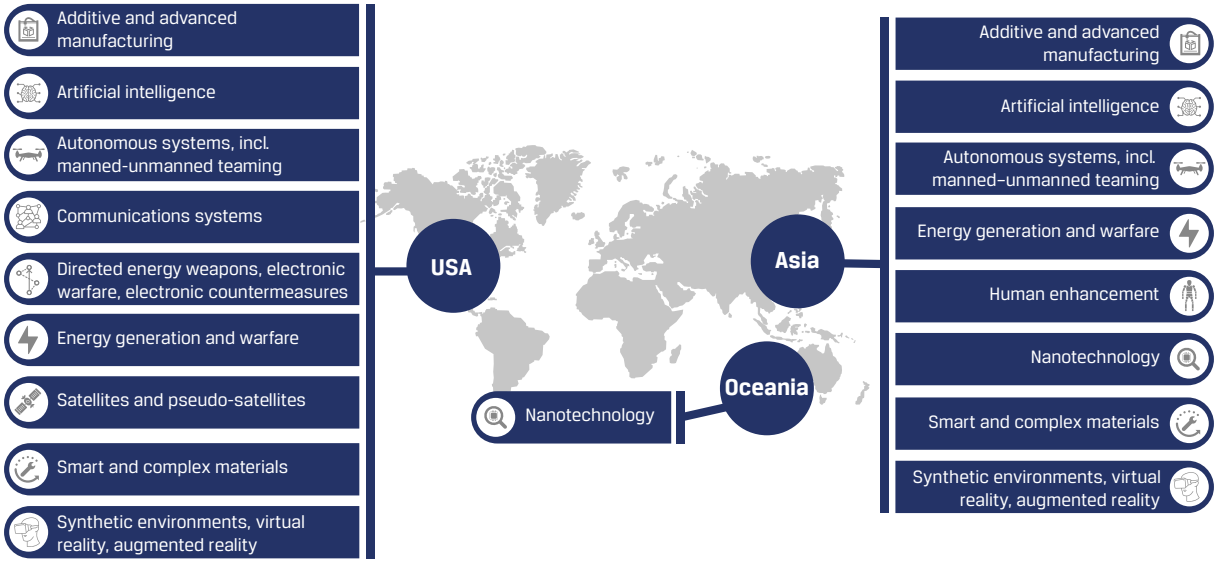
While European companies and governments are investing in new materials, alternative manufacturing techniques and waste reduction to minimise the effects of this dependency, Europe will continue to rely on third countries for certain key enablers of defence innovation and production out to 2035+. The EDTIB is 100-per-cent dependent on imports from third countries for 19 of 39 critical raw materials necessary for its production processes. Importantly, Europe depends on a relatively small selection of countries, such as the United States, Brazil, South Africa and China, leaving supply chains vulnerable to potential 'strategic shocks' from any major geopolitical or economic shifts occurring between now and 2035+.

Figure 4.4 Top ten countries for EDTIB raw material dependence

Source: European Commission (2016).

However, Europe's reliance on global suppliers is not just about materials. Innovation is no longer dominated by the United States, Europe and Japan, but is also being driven by major investments in emerging economies such as China or India. Ensuring access to the latest cutting-edge technologies, products and services will be essential if European forces are to develop the defence capabilities they need for 2035+. Figure 4.5 shows major non-European actors already playing an important role today across defence production in Europe. At the same time, European defence planners must prepare for operational scenarios where they can no longer rely on having technological advantages over adversaries, and must instead develop alternative strategies and tactics for countering sophisticated and agile adversaries. This might include increasing investment in training, interoperability, reversionary modes, adaptability and mass.

Figure 4.5 Major third-country-dependency regions per each of 12 identified technology groups



Source: RAND Europe analysis.

5. Implications for Member States' armed forces and European capability planning

The EDA CDP's longer-term (Strand B) process is aimed to support the national military capability planning processes of its pMS. While the CDP is a comprehensive planning support tool for all EDA pMS, it shares the defence planning environment with both the national defence planning processes of its pMS and the NATO Defence Planning Process (NDPP), with which EDA shares 22 member states.

Recent EU initiatives, such as the Coordinated Annual Review on Defence (CARD), Permanent Structured Cooperation (PESCO) and the European Defence Fund (EDF), will facilitate greater synchronisation with national defence planning cycles and increase capabilities of EU member states, fostering greater cooperation and efficiency in developing new enabling technologies and capabilities. The EU–NATO relationship has also progressed significantly over the last few years with most notable development in the implementation of the common set of proposals endorsed by the EU and NATO Councils 6 December 2016 and 5 December 2017 aiming for strengthened cooperation in areas such as countering hybrid threats, cyber defence, defence capabilities, exercises and maritime security, as well as on military mobility and counter-terrorism.

Cooperation in research, development and testing of new technologies and their applications to defence are important to ensure European technological advantage over potential future adversaries through knowledge sharing, building industrial and user capacity and skills, sharing R&D, testing infrastructure and other collaborative activities. While EDA has already championed numerous collaborative programmes, such as increased access to EU funding opportunities for defence and 'dual-use' manufacturers and support for joint R&D and procurement initiatives, further programmes aimed at long-term capacity development could contribute to the security and defence of EDA pMS in the future.

The purpose of this document is not to identify and prioritise specific EDA pMS collaboration programmes. However, several overarching areas of interest can be identified that may be taken forward in an EU framework in order to develop the military capabilities that may be needed by Member States' forces in 2035+. These are:

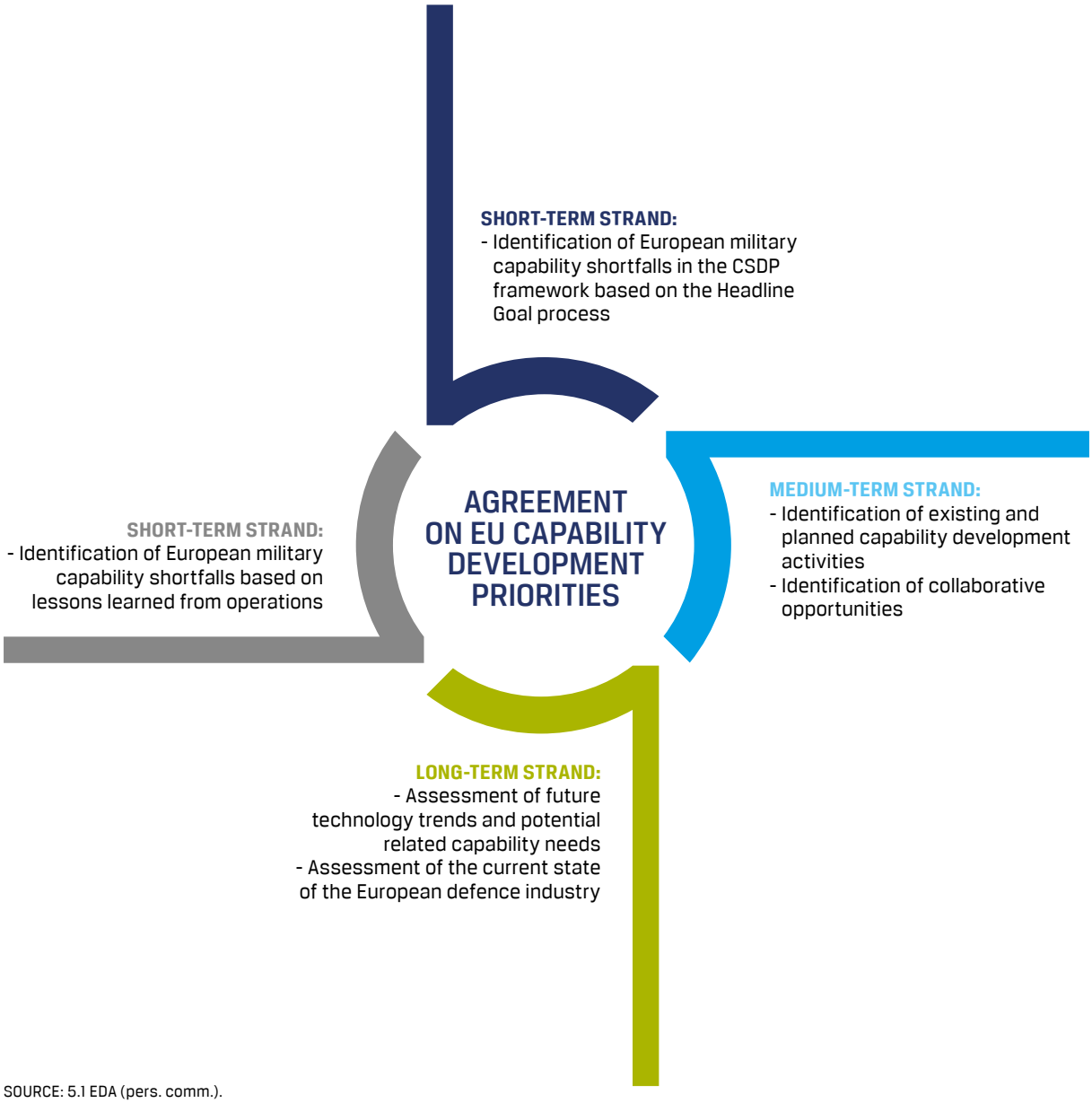
- Key future military capability requirements include efficient and secure information-sharing tools, advanced and rapid decision making, effective civil–military cooperation, high levels of force mobility, ability to carry out offensive and defensive operations in cyberspace, use of non-lethal capabilities and use of enhanced individual soldiers.

- In order to ensure these capabilities, the need for conventional weapons systems will persist and the need for cyberspace capabilities will increase. Other technologies that may enable Member States forces' ability to operate in the future strategic environment are human enhancement (biological, cybernetic, other) technologies, sensors, artificial intelligence, synthetic environments, virtual reality and augmented reality, smart/complex materials, satellites and pseudo-satellites, autonomous systems (incl. manned–unmanned teaming), communication systems, additive and advanced manufacturing, nanotechnology, DEW, EW, ECM and energy generation and storage.

- R&D investment and development programmes are in place in Europe across many of the key enabling technologies, but often with a fragmented approach between different EDA pMS. Moreover, within the 12 enabling technologies described previously much of the investment and policy initiative is coming from the civilian sector, including multinational and non-EU actors (e.g. United States, China). This means that there is scope for European collaboration initiatives and programmes for European industry to develop the technologies needed for Member States' militaries in the future.

The CDP being a comprehensive tool for EU capability planning, the update of the long-term capability requirements contributes to the overall update of the plan. The plan, therefore, merges the update of the long-term strand with those of the other strands (see Chapter 1) and encompasses several stages, as shown in Figure 5.1.

Figure 5.1 CDP prioritisation process towards EU Capability Development Priorities



SOURCE: 5.1 EDA (pers. comm.).

The CDP provides a comprehensive overview of military capabilities in Europe and is aimed to help national military planners to identify their national capability gaps as seen from an EU perspective and assist in overall national capability planning. Furthermore, the update of the CDP sets the stage for new EU capability development priorities that will guide the EU support for its member states in developing the prioritised capabilities.

REFERENCES

Canada National Defence Headquarters. 2014. *The Future Security Environment 2013–2040*. As of 27 March 2018: http://publications.gc.ca/collections/collection 2015/mdn-dnd/D4-8-2-2014-eng.pdf

EDA. 2017a. 'Capability Development Plan.' Eda.europa.eu, 16 July. As of 27 March 2018: https://www.eda.europa.eu/what-we-do/activities/activities-search/capability-development-plan

EDA. 2017b. 'Capability Technology Areas'. As of 18 November 2017: https://www.eda.europa.eu/Aboutus/how-we-work/expert-teams/capability-technology-areas

EDA. 2017. Defence Data 2006-2016. As of 27 March 2018: https://eda.europa.eu/docs/default-source/documents/eda-defence-data-2006-2016.pdf

European Commission. 2016. *Raw Materials in the European Defence Industry.* JRC Science for Policy Report. As of 27 March 2018: https://setis.ec.europa.eu/sites/default/files/reports/raw materials in the european defence industry.pdf

Finland Ministry of Defence. 2016. *Securely into the Future. Ministry of Defence Strategy 2025.*

Kepe, M., Black, J., Hall, A., Grand-Clement, S., Wilms, E., De Spiegeleire, S. 2017a. *Support to Capability Development Plan (CDP) Strand B Revision: WP3 – Tabletop exercise (TTX).* Santa Monica, Calif.: RAND Corporation. PR-3175-EDA. Commissioned by EDA contract ref. 16.CPS.OP.186.

Kepe, M., Lynch, A., Black, J., Marcic, A., Bekkers, F. 2017b. *Support to Capability Development Plan (CDP) Strand B Revision: WP4 – Study of research and technology and defence industry aspects of tabletop exercise findings.* Santa Monica, Calif.: RAND Corporation. PR-3372-EDA. Commissioned by EDA contract ref. 16.CPS.OP.186.

Kepe, M., Black, J., Ward, A., Lynch, A., Grand-Clement, S, Hall, A. 2018. *Support to Capability Development Plan (CDP) Strand B Revision: WP5 – Long-term capability assessment.* Santa Monica, Calif.: RAND Corporation. PR-3419-EDA. Commissioned by EDA contract ref. 16.CPS.OP.186.

Ministry of National Defence of Lithuania. 2013. *The World 2023. Updated and Expanded Version.* As of 19 May, 2017: https://kam.lt/en/defence policy 1053/important documents/the world 2030.html

Council of the EU. 2016. Council Conclusions on the Implementation of the Joint Declaration by the President of the European Council, the President of the European Commission and the Secretary General of the North Atlantic Treaty Organization, 15283/16, 6 December 2016

Statista2017. Ranking of the 20 companies with the highest spending on research and development in 2017 (in billion U.S. dollars). As of 30 March 2018: https://www.statista.com/statistics/265645/ranking-of-the-20-companies-with-the-highest-spending-on-research-and-development/

Taleb, N. 2007. *The Black Swan: The impact of the highly improbable.* UK: Penguin.

UK Ministry of Defence. 2014. Global Strategic Trends – Out to 2045. As of 27 March 2018: https://www.gov.uk/government/publications/global-strategic-trends-out-to-2045

US Joint Chiefs of Staff. 2016. Joint Operating Environment 2035. The Joint Force in a Contested and Disordered World. 14 July. As of 27 March 2018: https://fas.org/man/eprint/joe2035.pdf

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