



## **Analytical report: Preparing the armed forces for disruptive technological changes**

Authors: Mihai Palimariciuc and Natanael Rother  
with Claire Dhéret

This report has been prepared in the context of the European Policy Centre (EPC) project “[The future of work – Towards a progressive agenda for all](#)” and has received the kind support of the European Organisation of Military Associations and Trade Unions (EUROMIL). It is, to a large extent, based on the discussion held in the EPC workshop “[Technological changes in EU security & defence: What are the implications for the military workforce?](#)”, organised on 19 March 2019, and the interviews that were carried out with the workshop’s experts/speakers. When possible, this report provides statistical evidence to the statements made by the workshop’s speakers and participants.



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## Introduction

New technologies are massively transforming the world of work, thus requiring profound changes in how certain tasks are performed and affecting the prospects of many of the workers in the labour market. More than any other sector, the security and defence sector is particularly concerned by such changes due to its reliance on both human labour and sophisticated technologies.

This report, which is part of the research carried out by the European Policy Centre (EPC) in the context of its project entitled “The future of work – Towards a progressive agenda for all”, looks at the implications new technologies apply on the defence and security sector, while focusing its analysis on the impact on the European armed forces. By doing so, it aims to contribute to the existing body of research, while attempting to provide an answer to the following questions: (1) What is the skill composition of the armed forces in the European Union (EU)?; (2) Which disruptive technologies are most likely to have an impact on the European armed forces?; (3) How is the defence sector preparing itself for the integration of emerging technologies?; (4) Are there any existing best practice examples of armed forces training for the jobs of tomorrow?<sup>1</sup>

To answer these questions, the authors of this report have studied most of the recent literature which highlights ongoing trends in the defence and security sector, taken stock of existing evidence and data, and conducted interviews with experts in the field. In this respect, it is important to underline the difficulty researchers are confronted within the area of defence and security. More than any other sector, there is a scarcity of available data at the European level. This is due in particular to two factors: the heterogeneity of the sector across EU member states, which explains the difficulty in providing an acute comparative analysis between member states; and the high sensitivity of the sector, thus making EU countries reluctant to share data and information. That being said, this study mainly uses data provided by the EU’s Labour Force Survey (LFS) and European Defence Agency (EDA). While the former does mainly provide aggregate data, the latter only contains information for 27 EU countries (EDA27).<sup>2</sup>

This report contains two main chapters. The first section provides an analysis of the European armed forces of today in terms of its composition, investment and skills. The second part highlights the major technological trends that the security and defence sector is confronted with and presents some ongoing national and European initiatives, which aim to better prepare the defence workforce for technological changes. Lastly, the authors conclude with a few policy proposals that would not only mitigate the disruptive effect of new technologies but also unlock the potential they could offer to the armed forces.

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<sup>1</sup> See *European Policy Centre*, “[Social Europe and Well-Being > The future of work – Towards a progressive agenda for all](#)” (last accessed 02 September 2019).

<sup>2</sup> The EDA27 refers to every EU member state except for Denmark.

## 1. Human capital in the armed forces

There currently are 1.25 million people working in the armed forces across the EU. This section provides an overview of the composition of the armed forces, as well as the sector's investment into human capital.

### 1.1 Composition of the armed forces across the EU

Existing data helps to better understand three important characteristics of the armed forces in the EU: its composition in terms of military versus civilian personnel, education and enrolment in specialised programmes for defence and armed force, and distribution of skills. These three aspects are analysed below.

#### 1.1.1 Military and civilian personnel

Armed forces are usually composed of military and civilian personnel.<sup>3</sup> The former made up 80% of the total armed forces in the EDA27 in 2017, while the remainder consisted of civilian personnel. The distribution of military and civilian personnel has been rather stable in the last decade, although there has been a modest increase in the proportion of military personnel in more recent years (see Figure 1). There are a few factors worth mentioning here:

- Although the proportion of military personnel increased between 2008 and 2017 in 16 countries,<sup>4</sup> some of these changes were minor and driven by a stronger reduction of civilian rather than an increase in military personnel. The only exceptions are Lithuania and Estonia, where both categories were on the rise.
- Some countries saw significant structural changes in their armed forces due to some modifications in the way the armed force is calculated. For instance, conscripts are no longer included in the number of total Finnish military personnel since 2011. Another example is Germany and the major reform of its unified forces *Bundeswehr* between 2011 and 2012, which limited the number of military bases and soldiers.<sup>5</sup>

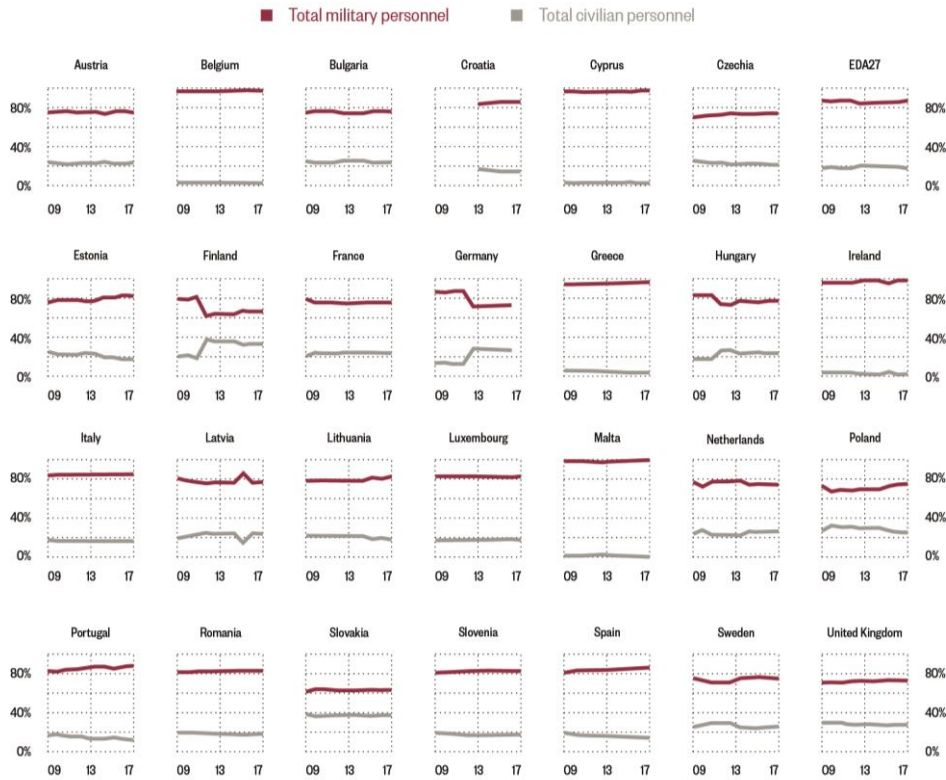
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<sup>3</sup> As defined by the European Defence Agency, military personnel includes all personnel in uniform, who can operate under military command and be deployed outside of their national territory. Civilian personnel are employed by all military establishments and armed forces.

<sup>4</sup> Croatia (from 2013 onwards), Cyprus, Czechia, Estonia, Greece, Republic of Ireland, Italy, Lithuania, Malta, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, and the UK.

<sup>5</sup> Methodological notes from the data provided by the European Defence Agency

FIGURE 1: SHARES OF TOTAL WORKFORCE OF THE ARMED FORCES OF EDA27 (% , 2008-2017)



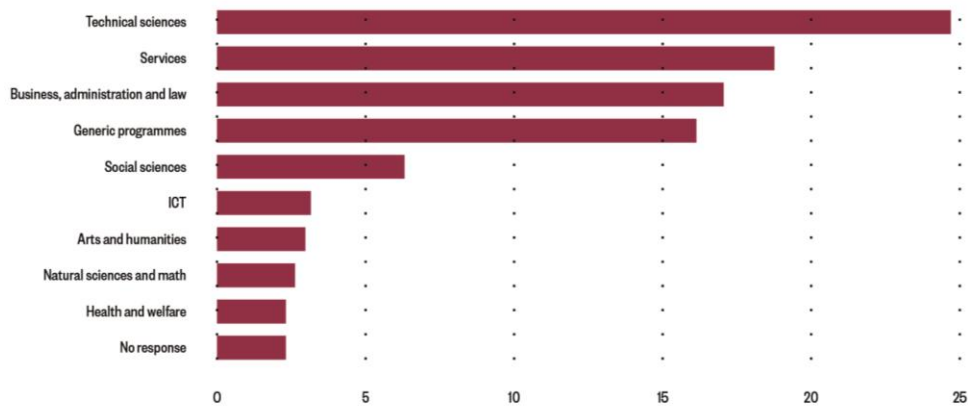
Source: Authors, based on European Defence Agency<sup>6</sup>

### 1.1.2 Education and training

The most prominent field of study within European armed forces is ‘technical sciences’, with around 24% of the total workforce having studied it in 2017. The two other most popular fields of study are ‘services’ and ‘business, administration and law’. Interestingly, less than 3% of the armed forces have studied information and communication technology (see Figure 2).

<sup>6</sup> See European Defence Agency, “[Info Hub > Defence Data Portal](#)” (last accessed 5 May 2019).

FIGURE 2: COMPOSITION OF EUROPEAN ARMED FORCES BASED ON FIELDS OF STUDY (% , 2017)



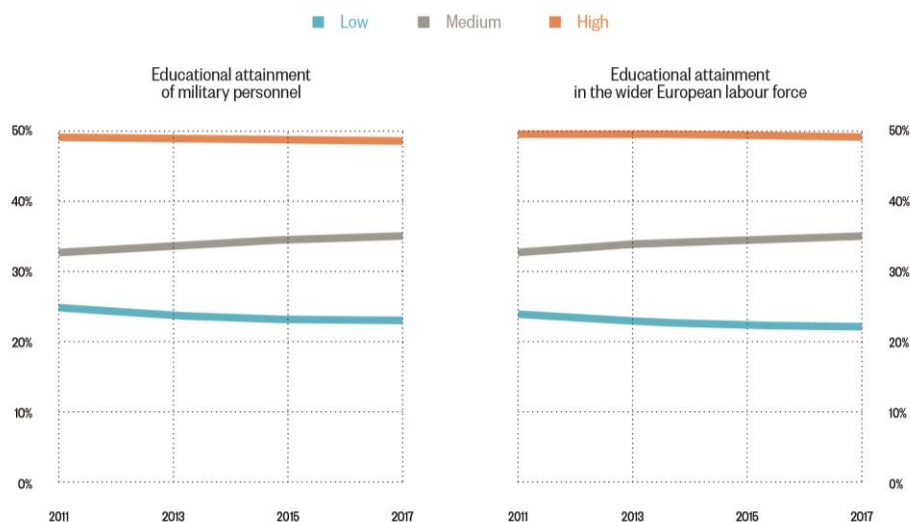
Source: Authors, based on European Centre for the Development of Vocational Training data<sup>7</sup>

Data provided by the LFS indicates that in 2017, most people working in the armed forces (15 years of age and older) were medium-skilled (48%), while high-skilled workers represented 34%, with the remaining 18% being low-skilled. The skill composition of military workers closely resembles that of the wider European labour force (see Figure 3). For more information on the skill composition in the EDA27 countries, refer to Appendix 1.<sup>8</sup>

<sup>7</sup> European Centre for the Development of Vocational Training data, extracted from *Skills Panorama*, “[Public sector & defence](#)” (last accessed 05 March 2019).

<sup>8</sup> This paper uses educational attainment as a measure for skills. This indicator assumes that additional education always results in a higher degree of skills. This is only one of the many ways skills can be measured. The authors decided to use this indicator due to the availability of the data and the desire to compare the defence labour force with that of the wider EU economy. See *Skills Panorama*, “[How \(can\) we measure skills?](#)” (last accessed 05 May 2019).

**FIGURE 3: EDUCATIONAL ATTAINMENT COMPARISON BETWEEN EUROPEAN MILITARY PERSONNEL AND WIDER EUROPEAN LABOUR FORCE (% , 2011-2017)**



*Source: Authors, based on European Union Labour Force Survey<sup>9</sup>*

Overall, trends regarding the educational level of military personnel vary significantly across the EU. Broadly speaking, three major trends are worth noting:

- In the vast majority of EU member states, military personnel are medium-skilled.
- The proportion of low-skilled workers is decreasing in almost all countries. However, there are a few Eastern European countries (e.g. Estonia, Hungary, Slovakia) which registered a slight growth (between 1 to 2%) in the number of low-skilled workers.
- In all countries, with the exception of Luxembourg, the share of high-skilled workers is either growing or remaining constant.

In addition, data on the current enrolment of students in military and defence programmes can help estimate the future size and composition of the armed forces, although it should be acknowledged that graduates from other fields of study may also join the military sector. Furthermore, students who enrol in the military and defence programmes may also leave the sector at some point. That being said, recruitment through enrolment remains a good proxy for the armed forces of the future.

Overall, there are 11,800 EU military and defence students enrolled at a bachelor level programme, 7,700 students at a master level (or equivalent), and just over 500 partaking in a short-cycle tertiary education programme.

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<sup>9</sup> See Eurostat, "[Access to microdata > European Union Labour Force Survey](#)" (last accessed 05 May 2019).

Figure 4 depicts the proportion of students for each level of the tertiary education system across EU member countries.<sup>10</sup> The absolute number of enrollees is listed on the left. It is worth noting that the distribution is very uneven across the member states: most students (over half) reside in Poland and Romania, while other countries count only hundreds of students.

**FIGURE 4: NUMBER OF TERTIARY EDUCATION STUDENTS IN THE MILITARY SECTOR (2016)**



Source: Authors, based on Eurostat<sup>11</sup>

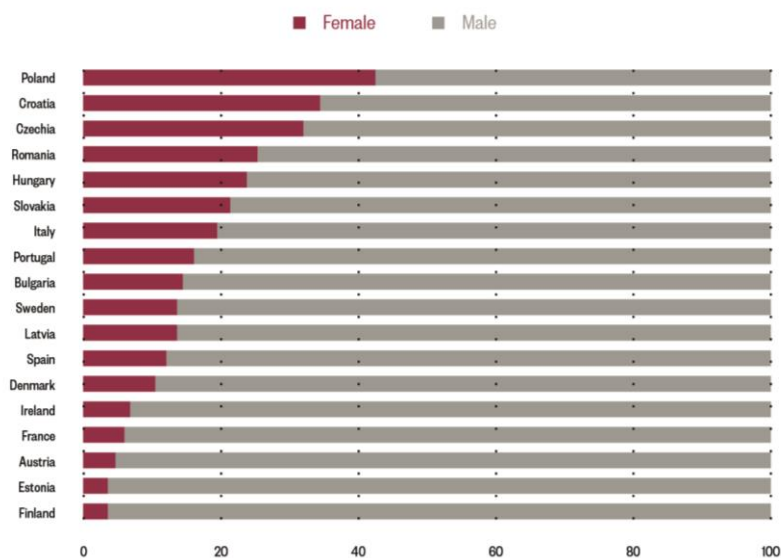
Furthermore, one should note that there is a clear gender dimension. As seen in Figure 5, males make up the vast majority of students enrolled in military-related studies throughout all European countries – with the exception of Poland, where 42% of students enrolled in this field are women. On the opposite side of the spectrum, of the 919 students in Finland, only 33 are women (4%). It is also worth mentioning the geographical heterogeneity. While female military students make up only a small proportion of the total in Western European countries, Eastern Europe does a better job at closing the gender gap.

<sup>10</sup> N.B. Figure 4 only includes countries which have military students enrolled in the tertiary education system.

<sup>11</sup> See Eurostat, “[Products Datasets > Tertiary students \(ISCED 5-6\) by field of education and sex](#)” (last accessed 05 May 2019). In the original dataset, data on Italian military students enrolled in tertiary education was incomplete. The numbers provided only represent the number of military students enrolled in bachelor’s and master’s degrees. Since data on doctoral students is missing, the overall number for students enrolled in military and defence programmes might in reality be higher for Italy.



FIGURE 5: GENDER BREAKDOWN OF MILITARY TERTIARY EDUCATION STUDENTS (% , 2016)



Source: Authors, based on Eurostat<sup>12</sup>

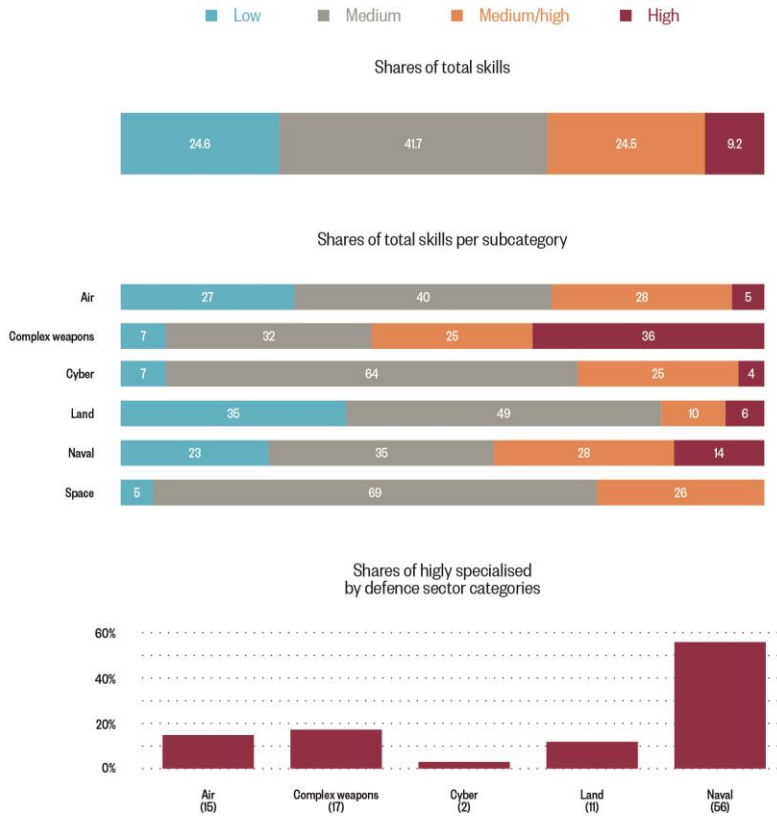
### 1.1.3 Armed forces' skills

In addition to the enrolment of students in security and defence programmes, it is interesting to study the extent to which the skills owned by the armed forces are specific to the sector. In this respect, research<sup>13</sup> done on the whole defence sector (which therefore goes beyond the armed forces) indicates that of the more than thousand documented skills, a quarter has a low level of specialisation to defence, 42% fall under the medium category, and another quarter has a medium to high level of specialisation. Interestingly, the same research indicates that 9% of the skills owned by the European armed forces fall into the category of medium-to-high level of specialisation. The category of complex weapons has the greatest proportion of highly-specialised skills (36%), despite representing a small subcategory in the defence sector. Furthermore, more than half of all skills that are considered to be unique to the defence sector can be found in the naval sector.

<sup>12</sup> See Eurostat, "[Products Datasets > Tertiary students \(ISCED 5-6\) by field of education and sex](#)" (last accessed 05 May 2019)

<sup>13</sup> Retter, Lucia; Louise Taggart and Jon Freeman (2015), "[Key Skills and Competences for Defence](#)", Brussels: European Defence Agency.

FIGURE 6: DISTRIBUTION OF SKILLS IN THE DEFENCE INDUSTRY (% , 2015)



Source: Authors; based on Retter, Taggart and Freeman (2015)<sup>14</sup>

In our attempt to map the mismatch between the supply and demand of skills in the armed forces, we relied on existing research and interviews with key experts. There was a consensus among those interviewed concerning the magnitude of the problem and the need for urgent measures. These interviews revealed worries in regards to a widening gap between the demand and supply of not only technical but also cognitive and social skills.

<sup>14</sup> See Retter, Lucia; Louise Taggart and Jon Freeman (2015), “Key Skills and Competences for Defence”, Brussels: European Defence Agency. This report provided a list of competences for different tasks in the defence sector, covering the following six domains: air, land, naval, complex weapons, cyber and space. For each of these domains, specific tasks were defined and the respective competences were listed. The skills analysis is based on this research and provides an overview of their findings. By way of a preview, they categorised skills into four groups, according to the degree of specialisation: low, medium, medium/high and high. Low skills are those commonly available, used in defence and are fully transferable to other sectors. Medium skills are widely used by defence and, to an extent, the civil sector. Medium/high skills are specific to defence, requiring an extensive background in defence engineering. High skills are unique to defence.

The gap between supplied and demanded skills can be identified through two different methodologies. First, by looking at different fields of work (e.g. air defence), specific tasks relevant to segments of the armed forces can be identified. Second, a ‘cross-sectional’ approach can highlight skills that are needed in the armed forces across different fields of work and for specific technological areas. As this report seeks to give an overview of all the components of the armed forces, the second approach was adopted.<sup>15</sup>

The Table highlights what social/cognitive and technical skills have been identified in the skills gap assessment of previous research studies.<sup>16</sup> It is important to note that currently, as well as in the immediate future, technical skills make up the majority of the skills deficit. However, in the not-so-distant future, studies suggest a growing gap between the demand and supply of social and cognitive skills, such as management and leadership. This projection is illustrative of the dual impact new technologies will have on the labour market. Although technological innovation increases the demand for technical know-how, technologies also change how people work and interact with machines, which in turn increases the demand for social and cognitive skills.

**TABLE: CROSS-CUTTING SKILLS FOR NEW AND EMERGING AREAS OF TECHNOLOGY**

<b>Social/cognitive skills</b>	<ul style="list-style-type: none"> <li>- Teamwork</li> <li>- Leadership</li> <li>- Critical thinking</li> <li>- Cultural awareness</li> <li>- Resilience</li> <li>- Data management</li> <li>- Cyber hygiene and awareness</li> </ul>
<b>Technical skills</b>	<ul style="list-style-type: none"> <li>- Advanced manufacturing</li> <li>- Deep learning and algorithm design</li> <li>- Robotics and unmanned systems</li> <li>- Artificial intelligence</li> <li>- Augmented/virtual reality and human machine-integration interfaces</li> <li>- Quantum technologies</li> <li>- Advanced energy generation, storage, and distribution</li> <li>- Nanotechnologies</li> </ul>

## 1.2 Spending and investing in human capital

In 2017, the EDA27 member countries had a total defence expenditure of €214.1 billion. Compared to 2006, this constitutes an 11% increase in nominal prices. On average, Central

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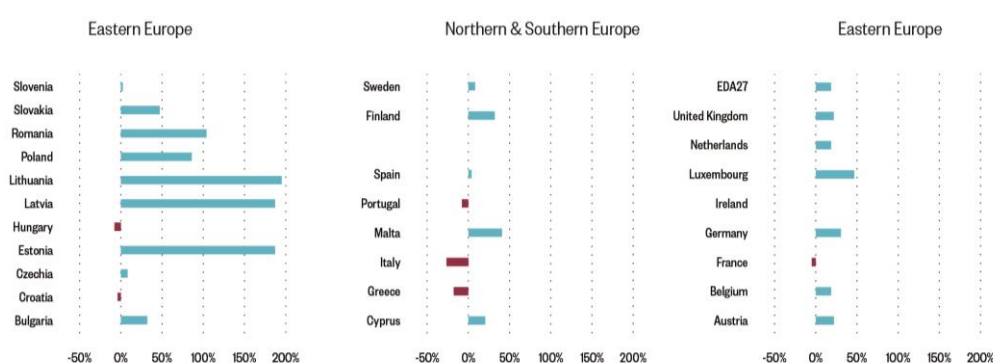
<sup>15</sup> See Galai, Katerina; Lucia Retter; Julia Muravska; Marta Kepe; Alice Lynch; Anna Knack; Jacopo Bellasio; Antonia Ward; Sofia Meranto; Davide Maistro; Liga Baltina; Terence Hogarth (2019), [Vision on defence related skills for Europe today and tomorrow](#), Brussels: European Commission.

<sup>16</sup> *Ibid.*

Europe has experienced the most growth (55% on average), whereas the smallest increase was in Western Europe (6.6% on average). Changes were moderate in Northern Europe (14% on average) and Southeast Europe (25% on average).

Trends also differ within regions. The largest increase in total defence expenditures occurred in the Baltic States, such as Lithuania (157%) and Estonia (154%). Meanwhile, seven countries reduced their expenditures.<sup>17</sup> The largest reductions can be seen in Italy (by 23%) and Greece (by 22%) (see Figure 7).

**FIGURE 7: DEFENCE EXPENDITURE GROWTH IN EDA-27 COUNTRIES (% , 2005-2017)**



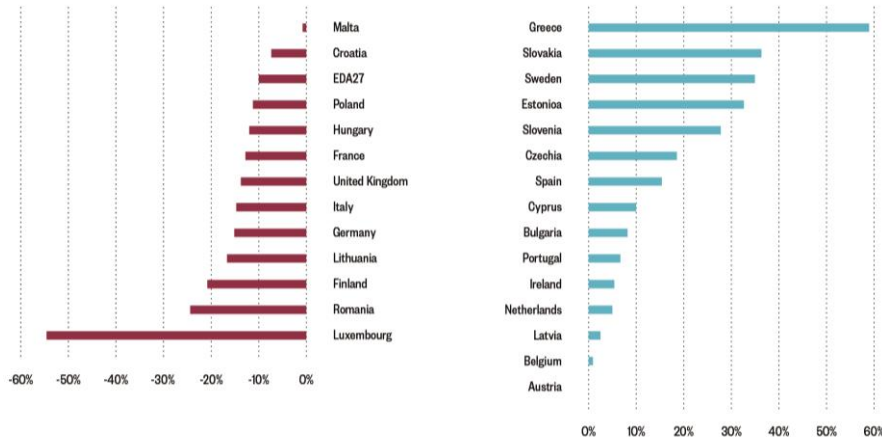
Source: Authors, based on European Defence Agency<sup>18</sup>

As regards the share of personnel expenses on total expenditures, it has decreased steadily among the EDA27. Whereas personnel expenses accounted for around 54% of total expenditures in 2006, they only represented 49% in 2017. 13 countries showed increasing trends, 11 showed decreasing trends, and the share remained constant in 3 countries. Of course, trends in total defence expenditures and the share spent on personnel do not always develop in the same way. Some countries that have reduced their overall defence expenses now spend a higher proportion of their total expenses on personnel without witnessing an increase in absolute terms. For more details on this, see Figure 8, which highlights the countries that saw an increase in personnel expenditure in blue, and the countries which saw decreasing trends in red.

<sup>17</sup> Specifically Croatia, France, Greece, Italy, Republic of Ireland, Portugal, Spain and Slovenia.

<sup>18</sup> See European Defence Agency, "[Info Hub > Defence Data Portal](#)" (last accessed 5 May 2019). Defence expenditure growth is calculated with a comparison between 2005 and 2017. However, for some countries, due to limited data, the growth rate is calculated between 2006 and 2017 (e.g. Romania, Bulgaria), or 2013 and 2017 (e.g. Croatia).

**FIGURE 8: GROWTH RATES OF PERSONNEL EXPENDITURE AS A PROPORTION OF TOTAL MILITARY EXPENDITURE (% , 2005-2017)**



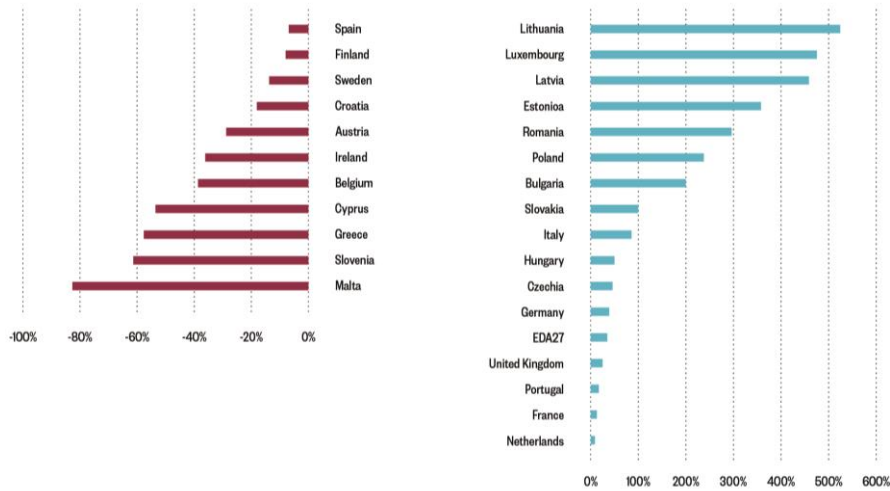
Source: Authors, based on European Defence Agency<sup>19</sup>

Total defence investments in the EDA27 amounted to €44 billion in 2017, 80% of which was spent on procuring defence equipment, while the rest was spent on research and development (R&D). Although investment is increasing in average across the EDA27, the situation varies from one country to another. Investment in defence has increased in 14 countries and decreased in 12,<sup>20</sup> with 4 countries spending more than 90% of all of its R&D expenses (see Figure 9).

<sup>19</sup> See *European Defence Agency*, “[Info Hub > Defence Data Portal](#)” (last accessed 5 May 2019). The data shows the growth of personnel expenditure as a proportion of total military expenditure from 2006 to 2017. However, due to limited data, the growth rate for Cyprus is representative for 2007 onwards and the data for Croatia describes the growth rate from 2013 onwards.

<sup>20</sup> N.B. Due to data restrictions, trends over time are not measured for all countries.

FIGURE 9: MILITARY INVESTMENT GROWTH (% , 2005-2017)

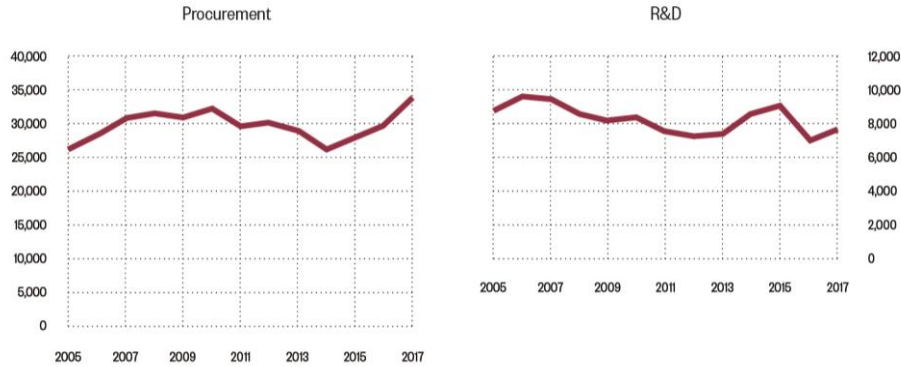


Source: Authors, based on European Defence Agency<sup>21</sup>

The investment structure of the defence sector has also changed over time. The share of R&D has slightly decreased, while investment in equipment procurement is on the rise. Between 2014 and 2017, such overall investment increased by nearly 40%, thus reducing the share of R&D expenditures to 17.8% in 2017 (see Figure 10).

<sup>21</sup> See *European Defence Agency*, "[Info Hub > Defence Data Portal](#)" (last accessed 5 May 2019). Data on investment growth describes the relation between investment in 2005 and 2017. However, due to limited data, growth in Romania and Bulgaria is calculated using data from 2006 to 2017, 2008 to 2017 for Belgium and 2013 to 2017 for Croatia.

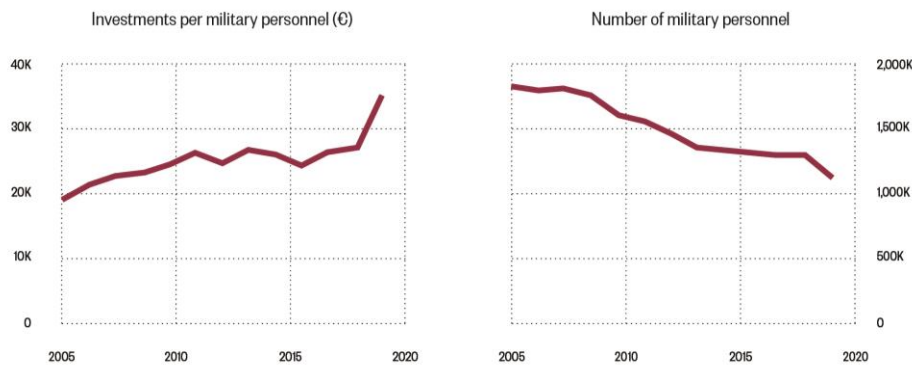
**FIGURE 10: EDA MILITARY INVESTMENT TRENDS (€MILL., 2005-2017)**



Source: Authors, based on European Defence Agency<sup>22</sup>

As regards spending on human capital, it is worth noting that while the total number of personnel in the armed forces decreased from 1.86 million in 2005 to 1.25 million in 2017, military investment per personnel increased. This trend might be linked to the broader shift occurring in the military labour market. Technological changes have reduced the demand for military personnel while increasing the need for highly-skilled workers.

**FIGURE 11: INVESTMENT PER MILITARY PERSONNEL AND TOTAL NUMBER OF MILITARY PERSONNEL IN EDA27 (2005-2017)**



Source: Authors, based on European Defence Agency<sup>23</sup>

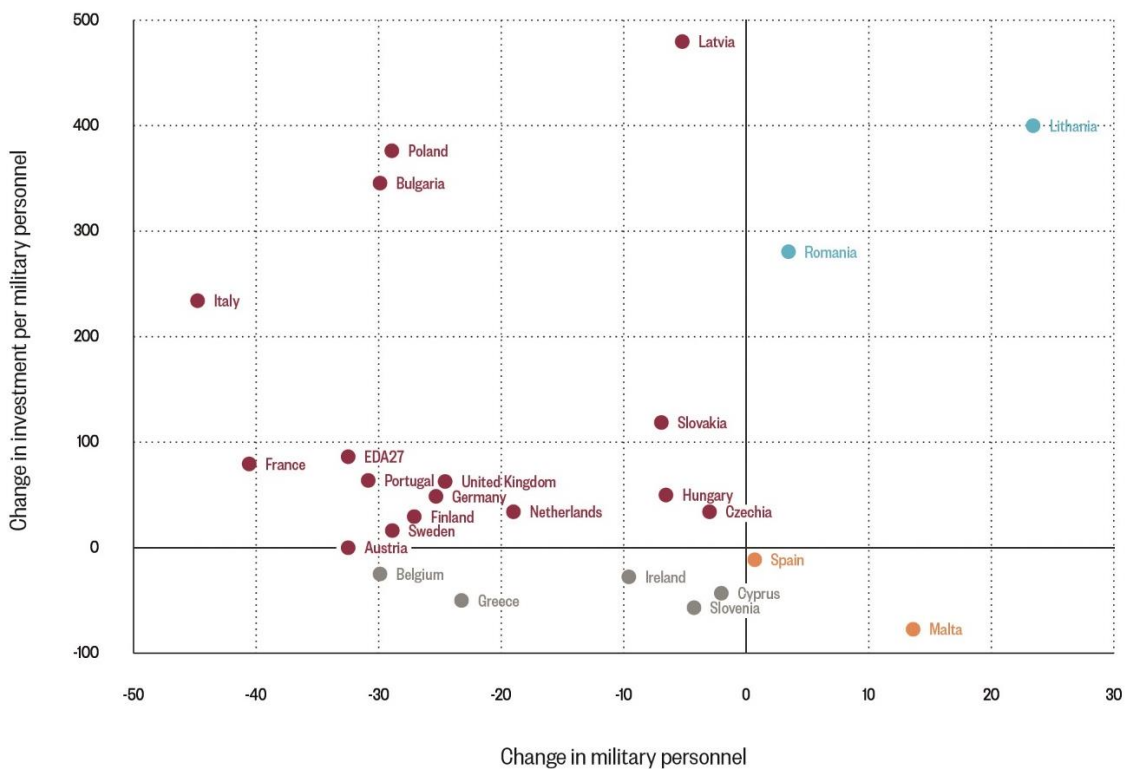
This trend of rising investment in the workforce and declining numbers of military personnel is occurring in 16 out of 27 countries. 2 other countries show rising investment in military personnel and an increased number of military personnel, while in 5 countries, both investment in military personnel and the number of military personnel is decreasing. Lastly, 2 countries saw

<sup>22</sup> See European Defence Agency, “[Info Hub > Defence Data Portal](#)” (last accessed 5 May 2019).

<sup>23</sup> *Ibid.*

increased numbers of military personnel despite fewer investments per staff.<sup>24</sup> In Figure 12, the blue states registered both an increase in investment and the number of personnel, red states registered an increase in investment but a decrease in personnel, orange countries registered an increase in personnel and decrease in investment, and grey countries registered a decrease in both investment and personnel.

**FIGURE 12: INVESTMENT PER MILITARY PERSONNEL AND NUMBER OF MILITARY PERSONNEL OVER TIME (% , 2005 - 2017)**



Source: Authors, based on European Defence Agency<sup>25</sup>

<sup>24</sup> Changes in military personnel are calculated based on the actual number of personnel. Due to a lack of data, Croatia is not included in the analysis. Where specific data was not available for certain years, the closest years possible have been used (Belgium: 2008; Bulgaria: 2006; Germany: 2016; Romania: 2006). Luxembourg and Estonia were excluded as outliers.

<sup>25</sup> See *European Defence Agency*, "[Info Hub > Defence Data Portal](#)" (last accessed 5 May 2019). Luxembourg was excluded as an outlier. For some countries, the figure describes the latest available data (see notes to other Figures).



## 2. Addressing technological changes in the defence and security sector

This chapter provides an overview of current technological changes, their impact on the defence and security sector, as well as a selection of good practices in preparing the workforce for the jobs of tomorrow. More specifically, this section details three strategies which can be employed to tackle the skills gap in the defence sector: critical actions in the labour market, advanced education, and public funding and international collaborations.

### 2.1 Technological changes and their impact

The first part of this report documented the existing skills gap in the security and defence sector. However, in order to form a comprehensive understanding of the future evolution of this skills gap, it is necessary to analyse the technologies which are likely to have the greatest impact on the sector and the kind of skills these technologies require.

Due to the sheer amount of technological innovation happening in the sector, this report aimed to build a taxonomy of innovation shaping the security and defence sector. Based on existing literature, the taxonomy classifies the most relevant and ongoing technological trends in order to better identify new opportunities and areas of action for the armed forces and defence sector as a whole. These trends are presented below.



*Connectivity* is an overarching category that covers several technologies, including the Internet of things (IoT), blockchain technology and virtual reality. At the most basic level, the IoT interconnects non-smart machines by enabling them to send and receive data. The implications of connecting technologies are significant. By increasing connectivity, the IoT augments physical objects by providing shared information on a global scale and supports machine decision-

making.<sup>26</sup> In the defence sector, by combining surveillance data, the IoT can improve situational awareness and the safety of ground troops.

Moreover, the abundance of information can enhance military logistics chains.<sup>27</sup> Blockchain technology consists of a type of data structure which enables the tracking of transactions in a distributed network of computers.<sup>28</sup> For the defence sector, it provides more autonomy and security of information as it creates a horizontal distribution of information across the armed forces and countries.

Virtual reality and augmented reality are technologies which reproduce simulated environments. While the first one creates a virtual world, the second uses sensors to display virtual elements in the real world. These technologies have important applications in training ground troops as well as reducing the distance and information asymmetry between troops and decision-makers.

Taken together, technological innovations that enhance connectivity offer an opportunity to reduce the need for logistical coordination and thereby reduce costs. In tandem, this increases the accuracy of decision-making and the safety of people on the ground.

The *Understanding* category includes big data analytics and quantum computing. In the past, big data was primarily used to understand and predict consumer behaviour by revealing previously unnoticeable trends and patterns through traditional measuring methods. Now, it is also being used to gain a more comprehensive picture of security risks and potential terrorist attacks. Apart from security, big data analysis allows experts to detect logistics inefficiencies and correct them.<sup>29</sup> Furthermore, quantum computers<sup>30</sup> have a wider range of uses in the defence sector, from cybersecurity and encryption to augmenting the previously mentioned technologies. While a normal computer can operate using two symbols, quantum computers can use multiple symbols at the same time. Because of this, quantum computing is exponentially faster than normal computing and can go through many datasets in very little time.

Understanding risks and opportunities is vital in the military environment. Recent developments in technology and data analysis have the potential to increase the predictability of decision-

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<sup>26</sup> Atzori, Luigi; Antonio Iera and Giacomo Morabito (2017), "[Understanding the Internet of Things: definition, potentials, and societal role of a fast evolving paradigm](#)", *Ad Hoc Networks*, Volume 56, pp.122-140.

<sup>27</sup> Montiel-Sánchez, Ignacio (2017), "[Artificial Intelligence \(AI\) & Cognitive Computing in defence](#)", *European Defence Matters*, Volume 14, p.14.

<sup>28</sup> Sultan, Karim; Umar Ruhi and Rubina Lakhani (2018), "[Conceptualizing Blockchains: Characteristics & Applications](#)", Lisbon: International Association for the Development of the Information Society's 11<sup>th</sup> International Conference on Information Systems.

<sup>29</sup> See [European Defence Matters \(2017\), Volume 14](#).

<sup>30</sup> See IBM, "[What is quantum computing?](#)" (last accessed 04 March 2019).

making and the overall security of operations. Accordingly, these new technologies will require an increase in civilian personnel, who can detect patterns and provide real-time analysis to military staff who take decisions on the ground.

*Manufacturing* refers to the new manufacturing technologies which could also bring about some major breakthroughs in the armed forces' equipment and its operation. For instance, 3D printing could reduce the costs associated with the production of tools and parts, enhance their design and streamline the time it takes to reach the end-user. In turn, this can defray the transportation and storage-related costs of spare parts, further reducing the logistic footprint of an operation. Robots could also be used to replace humans in performing dangerous tasks, augment human capability through sensors or help with manual tasks. Lastly, advanced materials containing special structures that provide practical use (e.g. heat insulation, camouflage, integrated sensors to measure the heartbeat of soldiers) have the potential to increase the operational effectiveness of military missions and increase the safety of military personnel.

Finally, *Artificial Intelligence* refers to the cross-cutting technology AI, which includes deep learning. Derived from neural networks, most of the technological leap in the sector from 2009 onwards can be attributed to this technology. It uses data analysis to predict and discover hidden information and patterns in the ocean of data generated by existing networks and sensors. Another aspect that is relevant to building an AI-enabled cyber defence is the implications of quantum computing or high-processing computers. Enhancements in data processing may increase the efficiency of algorithms. There is reason to believe that AI may push this technology to another level known as 'intelligent autonomous algorithms'. This stands to reason given that computers have demonstrated stronger skills in playing chess and poker than humans, which can be considered games of strategy rather than ones that require simply memorising patterns

The benefits that AI could bring to the military sector are so vast that its potential is difficult to measure. To unlock the potential of these technologies, armed forces must increase their efforts of acquiring programming skills and data analysis competencies. Although these technologies promise to increase safety, active military personnel must learn not to over-rely on them, as there is a danger of down-skilling. Because of this, decision-makers, besides needing more technological knowledge, must also sharpen their management skills and their understanding of the ethical implications of AI.

## 2.2 Relevant initiatives

European armed forces suffer from labour shortages, not least due to the negative perception of the sector and the fierce competition they face from the private sector in recruiting talents. A series of actions have already been undertaken by the sector to address the issue. The section

below presents some of them while also highlighting some best practices based on case studies from ten countries.<sup>31</sup>

### 2.2.1 Education and training activities

There are two paths for prospective and existing employees to enrich their skill sets.<sup>32</sup> First, there are the general education and training programmes offered through vocational or university education (e.g. early career internships). Second is the specialised training or up-skilling programmes (e.g. developing sector-specific skills through specialised programmes, vocational schools and apprenticeships). These paths may involve collaborative activities between industry, government bodies and education sectors.

A 2019 European Commission study gave a comprehensive analysis of over 371 initiatives that sought to develop the supply of defence-related skills across 16 EU member states. A majority of 219 was managed by educational institutions, 100 were managed by industry, 21 were managed by governments and 31 were managed by other stakeholders.<sup>33</sup> Figure 13 provides an overview of the distribution of the various programmes delivered in the 16 countries, by type of education/training providers. Over 40% of the programmes are delivered by educational institutions, 28% are managed by the industry, around 10% by the government and the rest is managed by third parties and consortiums. It is worth noting that this distribution highly varies from one member state to another. For instance, the industry is not involved in countries such as Latvia, Belgium or Estonia, whereas the government is absent in countries like Germany, Finland, Poland, Lithuania, Austria, Belgium and Estonia. A list containing greater detail of the actual programmes per country appears in Appendix 5.

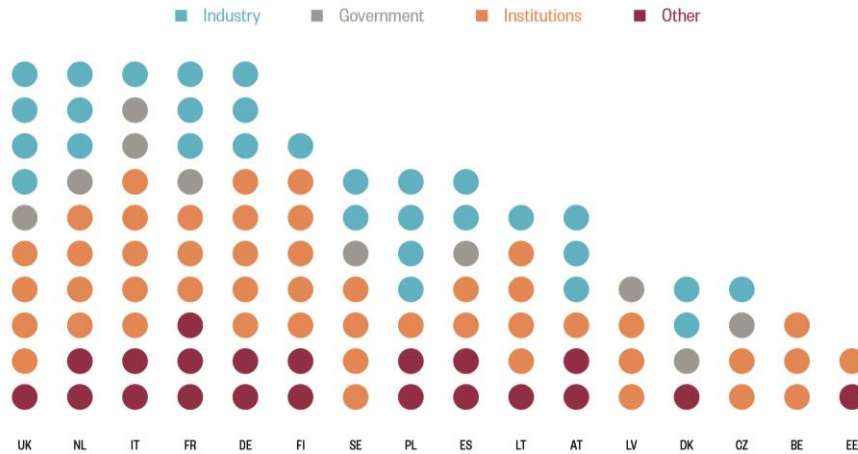
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<sup>31</sup> See *European Commission*, "[Internal Market, Industry, Entrepreneurship and SMEs > Sectors > Defence Industries > Skills in the defence sector](#)" (last accessed 13 April 2019). The following countries were included: Germany, Denmark, Spain, Finland, France, Italy, the Netherlands, Poland, Sweden and the UK.

<sup>32</sup> See Galai, Katerina; Lucia Retter; Julia Muravska; Marta Kepe; Alice Lynch; Anna Knack; Jacopo Bellasio; Antonia Ward; Sofia Meranto; Davide Maistro; Liga Baltina; Terence Hogarth (2019), [Vision on defence related skills for Europe today and tomorrow](#), Brussels: European Commission, *op.cit.*, 56.

<sup>33</sup> *Ibid.*, p.56.

FIGURE 13: SCOPE OF PROGRAMMES WHICH ATTEMPT TO FOSTER DEFENCE-RELATED SKILLS (2019)



Source: Authors, based on Galai et al. (2019)<sup>34</sup>

Experts taking part in the EPC workshop spoke to the value of networks of universities/defence academies and R&D clusters in this regard. Stakeholders have also developed hands-on programmes for entry-level personnel in this sector, through scholarships or paid internships. Armed forces and the defence industry have also targeted students by raising awareness about available programmes.

Speakers at the EPC workshop indicated that governments work closely with academia and the industry to ensure the content of educational programmes aligns with the defence sector’s needs. In at least one case, a military university developed programmes tailored to civilian students as well. This might be an example of knowledge transfer between the private and the public sector. Online courses have also been put in place to reduce the enrolment barrier and reach a relatively wider audience.

### 2.2.2 Opportunities for career advancement

According to our expert interviews, rewarding high-achieving and -potential employees with career advancement and additional responsibility, as well as fostering a proficient digital environment, are good practises for the defence sector to employ. As per example, to attract the best talents, the US military offers both monetary and non-monetary incentives (e.g. family resources, opportunities for education and career advancement).<sup>35</sup> An example is the Sailor

<sup>34</sup> See Galai, Katerina; Lucia Retter; Julia Muravska; Marta Kepe; Alice Lynch; Anna Knack; Jacopo Bellasio; Antonia Ward; Sofia Meranto; Davide Maistro; Liga Baltina; Terence Hogarth (2019), [Vision on defence related skills for Europe today and tomorrow](#), Brussels: European Commission

<sup>35</sup> Ferdinando, Lisa, [“Military Leaders Highlight Efforts, Challenges in Recruiting, Retention”](#), U.S. Department of Defense, 13 April 2018.

2025 programme which aims to change how training is conducted, emphasising access to training by mobile delivery platforms; or to increase the number of career advancements based on skills and competencies to 15%.<sup>36</sup>

Various attempts have also been made by EU countries' governments, or even armed forces themselves, to make the defence sector more attractive to current and future personnel. For instance, by emphasising R&D, the sector can cultivate a wide variety of defence-related skills. This can be done through strong collaboration among universities, government and private companies. These stakeholders have also developed hands-on programmes for entry-level personnel in this sector through scholarships or paid internships. Finally, awareness-raising programmes targeting students have been identified as an effective means to recruit talent.<sup>37</sup>

Primarily, there are two ways to support collaboration among individuals and across sectors. First, with respect to education, industry, academia and governments support multidisciplinary and dual-use programmes which teach skills to the public and private sectors. Second, collaborations between stakeholders have been strengthened by the government and industry associations (e.g. foreign equipment suppliers).

### 2.2.3 Public funding and international collaborations

International collaborations are essential to help EU member countries allocate taxpayers' money more efficiently, to yield more value for their investments.<sup>38</sup> There have been several attempts to foster defence skills on an EU-wide scale; some of the projects are briefly described below.<sup>39</sup>

#### Education

- [European Security and Defence College](#) provides strategic-level education in European security and defence policy, featuring courses designed by the governments of member countries.
- [European Union Agency for Law Enforcement Training](#) provides support for the development of defence skills through online learning and police exchange programmes.
- [Europe's New Training Initiative for Civilian Crisis Management](#) provides guidelines and training for civilian experts working in crisis management and acts as a certifying authority for such training courses.
- [European Consortium for Advanced Training in Aerospace](#) offers a condensed course on aerospace business integration, covering a wide range of topics across the aerospace industry. The courses are developed by leading companies and academic institutions.

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<sup>36</sup> Wilkinson, Don (2018), "[Onboard with Sailor 2025](#)", *Surface Warfare Magazine*, Volume 58.

<sup>37</sup> Retter, Taggart and Freeman (2015), *op.cit.*

<sup>38</sup> European Commission (2017), [Towards a European Defence Union: Permanent Structured Cooperation and the European Defence Fund](#), Brussels.

<sup>39</sup> Retter, Taggart and Freeman (2015), *op.cit.*

### Exchange programmes

- [European Initiative for the Exchange of Military Young Officers](#) is an exchange programme for military officers that uses the European Credit Transfer and Accumulation System (ECTS), a tool which quantifies the number of credits needed to complete a university year, and converts credits taken at one higher education institution into a qualification at another.<sup>40</sup>
- *European Naval Academies* provides exchange opportunities for naval officers.
- The [International Military Academic Forum](#) is an exchange programme for young officers, inspired by the Erasmus Programme.

### Funding

- [European Defence Fund](#) is an EU-financed programme promoting cooperation and cost-savings among member countries, to jointly research, develop and acquire defence technology and equipment.<sup>41</sup>
- [Permanent Structured Cooperation](#) is an instrument provided in the Lisbon Treaty, which enables willing member countries to pursue cooperative partnerships in defence and security.<sup>42</sup>
- [EDA](#) sponsors training activities, including Air-to-Air Refuelling, the European Air Transport Fleet, the European Armaments Cooperation course, the European Advanced Airlift Tactics Training Course, and helicopter training programmes.

### Others

- *European Union Police Services Training*<sup>43</sup> aims to contribute to the strengthening of civilian capabilities in order to support stabilisation efforts in countries emerging from a political crisis.
- *Inter-European Air Forces Academy* is a forum for experts to foster the exchange of information on air force-related issues.

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<sup>40</sup> European Commission, "[Education & Training > European Credit Transfer and Accumulation System \(ECTS\)](#)" (last accessed 17 May 2019).

<sup>41</sup> See European Commission, "[Internal Market, Industry, Entrepreneurship and SMEs > Sectors > Defence Industries > European defence fund](#)" (last accessed 17 May 2019).

<sup>42</sup> *Ibid.*

<sup>43</sup> See Retter, Taggart and Freeman (2015), *op.cit.*, [Annex C](#).

## Conclusions and strategic proposals

The armed forces and the defence sector are now facing a challenging and demanding time in general. New technologies call for a new workforce structure and demand new skill sets. A clear strategy on how to expand the knowhow of armed forces personnel is essential to ensure security and political stability. Based on the expert interviews carried out by the EPC and the information collected at the workshop, three major conclusions leading to several recommendations can be highlighted.



### **Increase data availability**

As shown earlier, there is a lack of data on European armed forces and their workers' skills sets, from digital skills to technical expertise. Even though more data than expected was found, the current level of aggregation does not allow for a detailed analysis nor a tailor-made action plan.

- *Recommendation 1:* To better equip the armed forces with the appropriate skills, it is first and foremost essential to have a decent understanding of the skills composition of the workforce and identify the gaps and mismatch between supply and demand. Some of the existing surveys conducted on an international level contain additional data on the composition of the military workforce but are not made publicly accessible. To enable researchers to carry-out new studies on the topic and provide additional evidence, it is key to make relevant data available. Collecting more comprehensive data for the military workforce should become a key mission for Eurostat and public authorities.
- *Recommendation 2:* The military sector suffers from a lack of attractiveness, and talents often opt for the private sector. However, there is very little knowledge of how military employees perceive their jobs and how they would like their working conditions to be improved. To reverse this, a large scale survey should be carried out by trade unions (e.g. EUROMIL) to fill in this knowledge gap and also provide additional information about initiatives and best practices undertaken by the sector to attract and retain talents.



### **Foster collaboration**

There are many promising initiatives, programmes and research plans at both the national and international levels which support the public defence sector in its technological adaptation. However, as for technological innovation, the private sector is often way ahead.

- *Recommendation 3:* The cooperation between the private sector and armed forces needs to be strengthened in every member state. It is vital that ongoing training



programmes remain tied to the fieldwork of the armed forces. To do so, the military sector should organise high-tech camps where the private sector is invited to present technological solutions to challenges faced by the armed forces.

- *Recommendation 4:* European armed forces must have access to the best training on new technologies (e.g. AI), and the EU must become a world champion in this field. To do so, it is imperative to establish a European university specialising in AI and offering programmes to armed forces.
- *Recommendation 5:* International cooperation between army officers is still too limited, not least due to public authorities' willingness to preserve a high level of confidentiality in the sector. However, the development of exchange programmes between European armed forces would bear significant benefits. This would enable them to compare how their programs and initiatives meet their demand, learn from each other and also organise training programmes of a larger scale, thus reducing costs.



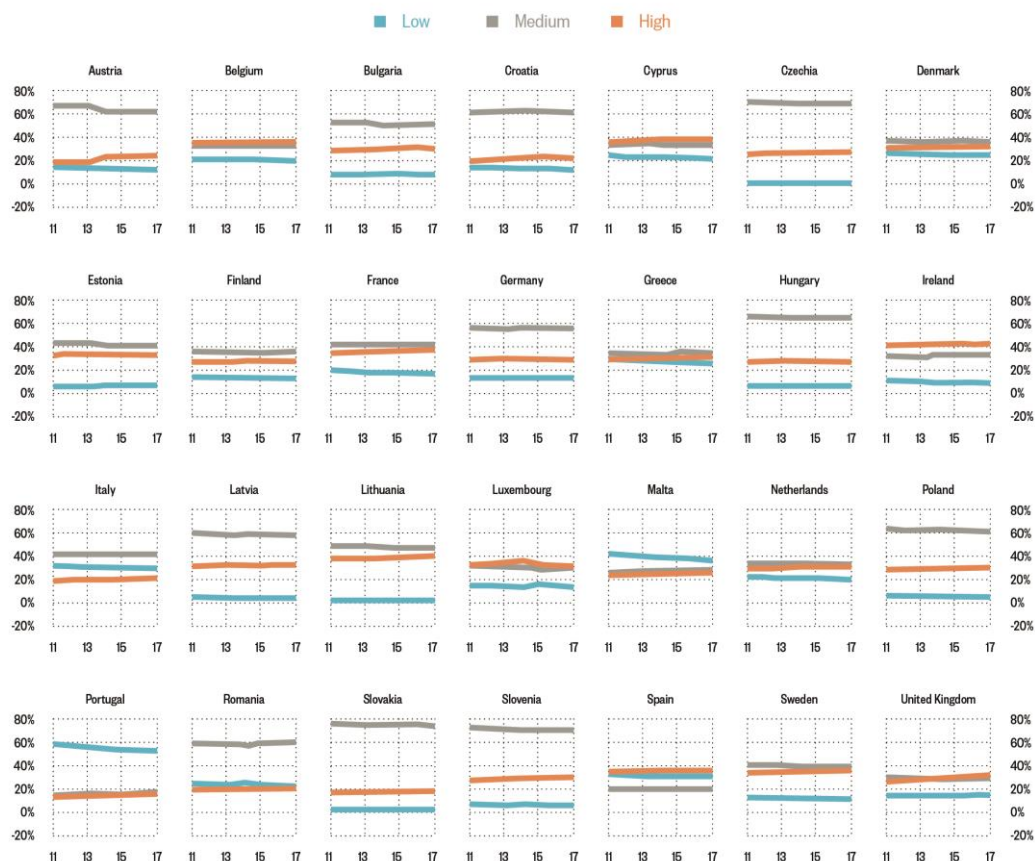
#### **Prepare for the unknown**

Digitalisation will continue to change the defence and security sector and the working conditions of the armed forces. New jobs will emerge, and existing jobs will see significant changes, or perhaps even disappear. Although it is challenging to forecast the type and scale of future changes, we have good reason to believe that many of them will be disruptive. It calls for a general approach to invest in people's capacity to learn and adapt to new technologies and tasks.

- *Recommendation 6:* Education and training programmes for the armed forces should entail both technical and cognitive skills. In fact, it is not enough to have access to high-tech equipment – the armed forces must also understand how they function, be able to interpret the information it sends and master how they can be repaired in case of failures.

## Appendices

### APPENDIX 1: EDUCATIONAL ATTAINMENT BY EU COUNTRIES (% , 2011-2017)

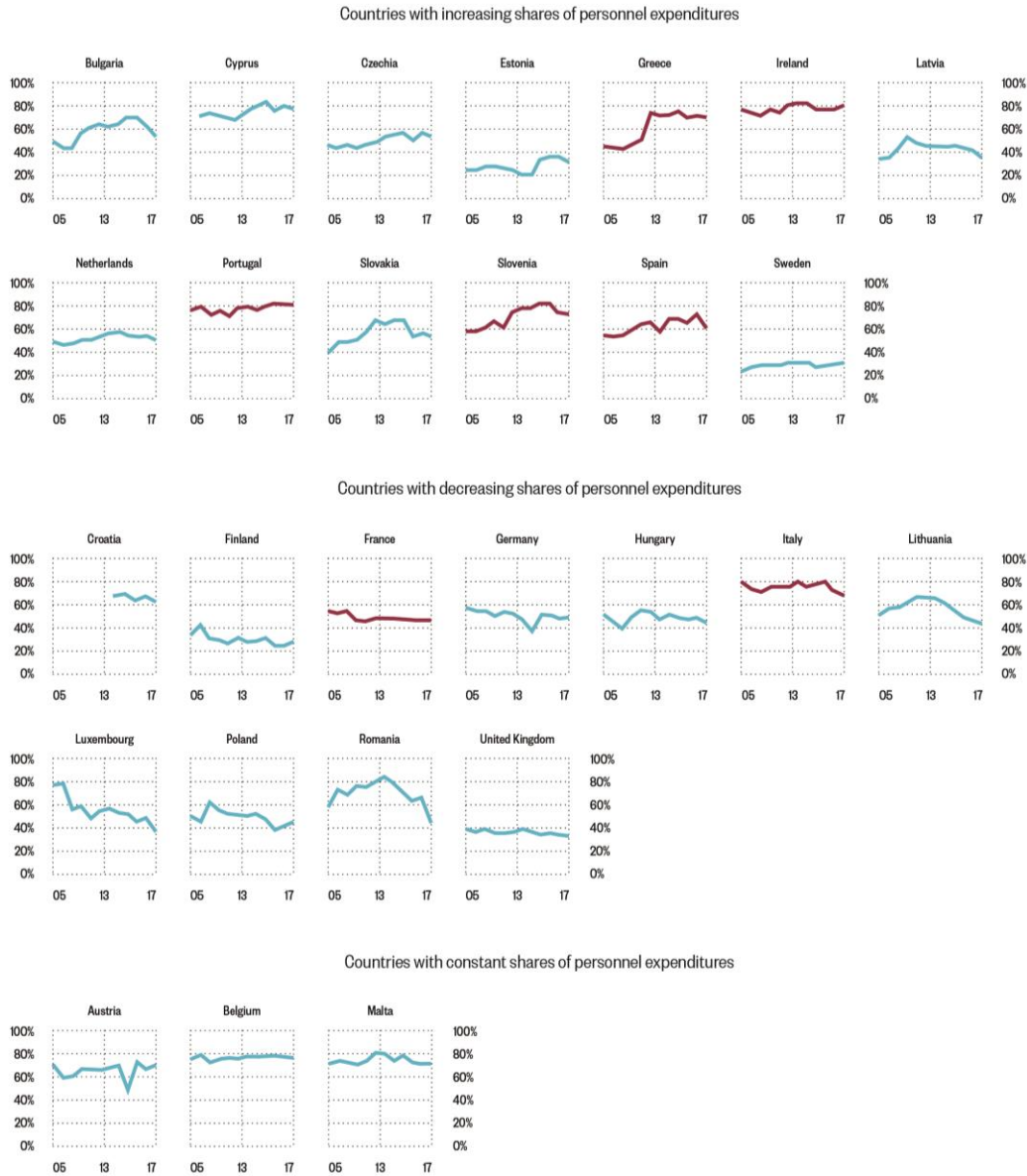


Source: Authors, based on European Union Labour Force Survey<sup>44</sup>

<sup>44</sup> See Eurostat, "[Access to microdata > European Union Labour Force Survey](#)" (last accessed 05 May 2019).

## APPENDIX 2: SHARE OF PERSONNEL EXPENDITURES ON TOTAL EXPENDITURES (2006 – 2017)

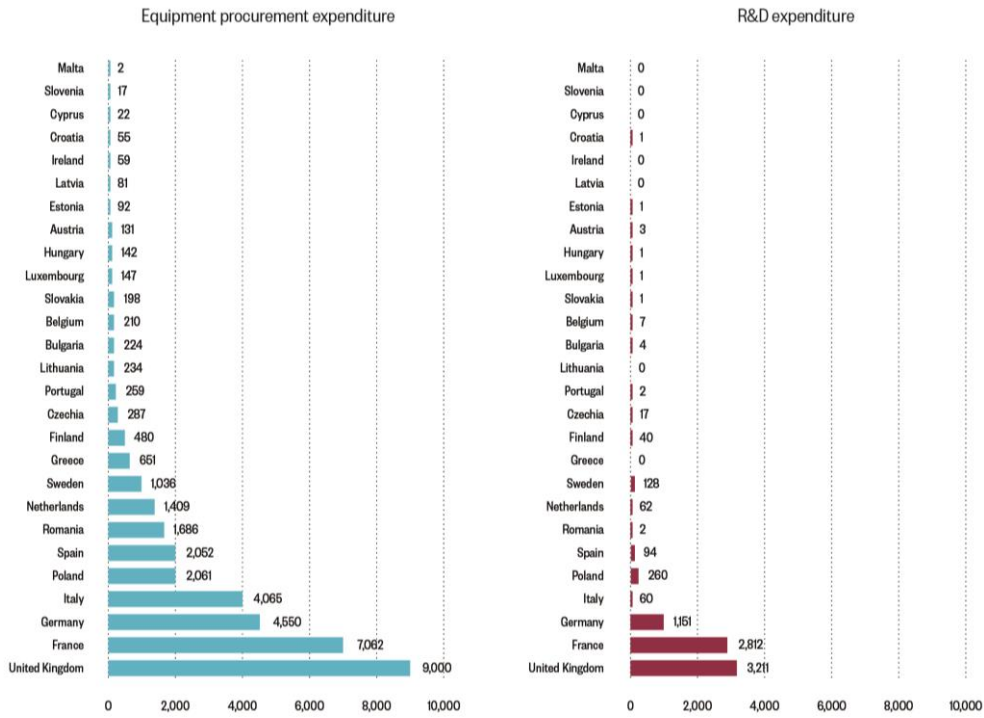
■ Overall defence spending has decreased ■ Overall defence spending has not decreased



Source: Authors, based on European Defence Agency<sup>45</sup>

<sup>45</sup> See European Defence Agency, "[Info Hub > Defence Data Portal](#)" (last accessed 5 May 2019).

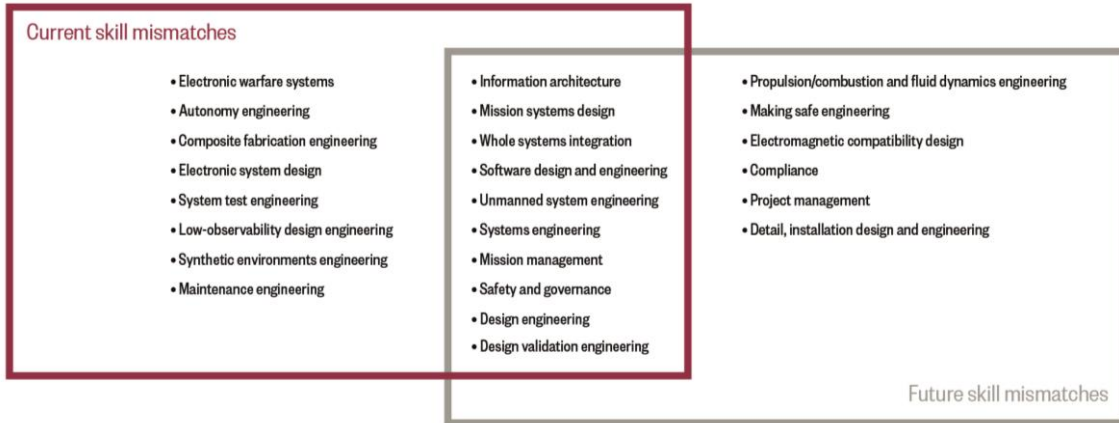
### APPENDIX 3: DEFENCE INVESTMENT IN THE EDA27 COUNTRIES (2017)



Source: Authors, based on European Defence Agency<sup>46</sup>

<sup>46</sup> See European Defence Agency, "[Info Hub > Defence Data Portal](#)" (last accessed 5 May 2019).

#### APPENDIX 4: SKILL MISMATCHES OF TODAY AND THE FUTURE



Source: Authors, based on Galai et al. (2019)<sup>47</sup>

<sup>47</sup> See Galai, Katerina; Lucia Retter; Julia Muravska; Marta Kepe; Alice Lynch; Anna Knack; Jacopo Bellasio; Antonia Ward; Sofia Meranto; Davide Maistro; Liga Baltina; Terence Hogarth (2019), [Vision on defence related skills for Europe today and tomorrow](#), Brussels: European Commission pg 100

## APPENDIX 5: EDUCATIONAL PROGRAMMES ON VARIOUS LEVELS

<i>Entity and Initiatives/Programmes</i>	AT	BE	CZ	DE	DK	EE	ES	FI	FR	IT	LT	LV	NL	PL	SE	UK
<b>Industry</b>																
Internal corporate training	X			X	X		X		X	X				X		X
Traineeship, apprenticeship and internships	X			X					X		X		X	X	X	X
School/university placement schemes			X	X			X		X				X	X	X	X
SME association programs	X							X								X
Intra-industry and intra-sector programs					X								X	X		
<b>Educational institutions</b>																
Vocational and technical college courses										X	X					
Defence academy and military staff college courses	X	X	X				X	X	X	X	X	X	X	X	X	X
Undergraduate degrees		X		X		X		X		X	X	X	X		X	
Postgraduate degrees		X		X				X	X	X	X		X		X	X
Early career education programs				X				X				X				
Mid-career education programmes									X	X			X			X
Defence-related skill classification framework				X				X								X
Secondary school education and recruitments programs			X	X			X								X	
<b>Government</b>																
EU-led skills programmes and frameworks			X				X									
National government and ministry of defence-led									X	X			X		X	X
Regional or cluster-level programmes					X					X		X				
<b>Other</b>																
Research centre development programmes				X					X							
Jointly led associations or consortia					X		X	X		X	X			X		X
Dual-degree programs	X			X		X			X				X	X		
Cross-country exchange programmes	X															
External training organisation								X	X	X			X			
Professional association schemes							X									

Source: Authors, based on Galai *et al.* (2019)<sup>48</sup>

<sup>48</sup> See Galai, Katerina; Lucia Retter; Julia Muravska; Marta Kepe; Alice Lynch; Anna Knack; Jacopo Bellasio; Antonia Ward; Sofia Meranto; Davide Maistro; Liga Baltina; Terence Hogarth (2019), [Vision on defence related skills for Europe today and tomorrow](#), Brussels: European Commission