STUDY

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European armaments standardisation

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ABSTRACT

The standardisation of armaments has been a long-standing focus of EU efforts to enhance the Union's military effectiveness, to improve capability development and to support the competitiveness of the European defence industry. Armaments standardisation is a process that can lead to cost savings for defence spending by injecting added-value in defence production processes and the avoidance of capability and equipment duplication. Standardisation is a method of improving interoperability within and between European armed forces and a process that can enhance the operational effectiveness of Europe's militaries. Both the EU and NATO have taken measures over many years and decades to enhance armaments standardisation in Europe. Yet the nature of the contemporary global defence market is that many more technologies and components integrated into military systems are sourced and/or produced in the civilian sector. The line drawn between defence equipment and capabilities on the one hand, and civilian products and technologies on the other, is increasingly blurred. In this context, and in relation to recent developments on EU defence cooperation, this study analyses the standardisation approaches taken by the EU in relation to maritime information sharing and remotely piloted aircraft systems. It makes recommendations on how EU approaches to armaments standardisation can be expanded and enhanced.

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Abbreviations

AD	Armaments Directorate
AFNOR	French National Organisation for Standardisation
AP	Allied Publication
ATS	Air Traffic Services
BAAINBw	Federal Office of Bundeswehr Equipment, Information Technology and In-Service Support
BLoS	Beyond Line of Sight
C2	Command and Control
C3	Communications, Command and Control
C3B	Consultation, Command and Control Board
CBRNE	Chemical, Biological, Radiological, Nuclear and Explosives
CCD COE	NATO Cooperative Cyber Defence Centre of Excellence
CEN	European Committee for Standardisation
CENELEC	European Committee for Electrotechnical Standardisation
CF SEDSS	Consultation Forum for Sustainable Energy in the Defence and Security Sector
CISE	Common Information Sharing Environment
CNAD	Conference of National Armaments Directors
CS	Committee for Standardisation
CSDP	Common Security and Defence Policy
CYBRID	Cyber Defence Exercise
DAA	Detect and Avoid
DCI	Defence Capabilities Initiative
DeSIRE	Demonstration of Satellites Enabling the Insertion of RPAS in Europe
DG	Directorate General
DID	Defence Investment Division
DIN	German Institute for Standardisation
DoD	Department of Defense
DSCG	Defence Standardisation Cooperation Group
EASA	European Aviation Safety Agency
ECCSA	European Centre for Cybersecurity in Aviation
ECSO	European Cyber Security Organisation
EDA	European Defence Agency
EDAP	European Defence Action Plan
EdF	European Defence Fund

EDEN	European Defence Energy Network
EDIDP	European Defence Industrial Development Programme
EDRP	European Defence Research Programme
EDSIS	European Defence Standards Information System
EDSTAR	European Defence Standards Reference System
EDTIB	European Defence Technological and Industrial Base
EEAS	European External Action Service
EFCA	European Fisheries Control Agency
EFTA	European Free Trade Area
EMAR	European Military Airworthiness Requirements
EMSA	European Maritime Safety Agency
EOF	Energy Operational Function
ERA	Enhanced RPAS Automation
ERSG	European RPAS Steering Group
ESA	European Space Agency
ESDC	European Security and Defence College
ESO	European Standardisation Organisation
ESRIF	European Security Research and Innovation Forum
ETSI	European Telecommunications Standards Institute
EU	European Union
EUGS	European Union Global Strategy
EUMC	European Union Military Committee
EUMS	European Union Military Staff
EUMSS	European Union Maritime Security Strategy
EUNAVFOR	European Union Naval Force
EUROCAE	European Organisation for Civil Aviation Equipment
EUROCONTROL	European Organisation for the Safety of Air Navigation
EuroSWARM	Unmanned Heterogeneous Swarm of Sensor Platforms
FRONTEX	European Border and Coast Guard Agency
GOSSRA	Generic Open Soldier Systems Reference Architecture
HARMSPRO	Harbour and Maritime Surveillance and Protection
HRVP	High Representative for the Union's Foreign and Security Policy and Vice-President of the European Commission
ICT	Information and Communication Technology
IoT	Internet of Things

IMS	International Military Staff
ISO	International Organisation for Standardisation
LED	Light Emitting Diode
MAG	Main Armaments Groups
MALE	European Medium Altitude Endurance
MARSUR	Maritime Surveillance Network
MAWA	Military Airworthiness Authorities
MBT	Main Battle Tank
MC	Military Committee
MCSB	Military Committee Standardisation Board
MIDCAS	Mid-air Collision Avoidance System
MIL-SPEC	Military Standard
MIS	Maritime Information Sharing
MP	Multinational Publication
MRO	Maintenance, Repair and Overhaul
MSG	Materiel Standardisation Group
MSHT	Material Standardisation Harmonisation Team
MULTILAYER	Multi-Layer Crisis Management Exercise
NAC	North Atlantic Council
NATMC	NATO Air Traffic Management Committee
NATO	North Atlantic Treaty Organisation
NATOMC	NATO Air Traffic Management Committee
NATOTerm	Terminology Database
NDPP	NATO Defence Planning Process
NGO	Non-Governmental Organisation
NHQC3S	NATO Headquarters Consultation, Command and Control Staff
NIAG	NATO Industrial Advisory Group
NIP	National Implementation Plan
NISP	NATO Interoperability Standards and Profiles
NSB	National Standardisation Board
NSDD	NATO Standardisation Documents Database
NSO	NATO Standardisation Office
NZEBs	Nero Zero Energy Buildings
OCCAR	Organisation for Joint Armament Cooperation
PACE	Parallel and Coordinated Exercise

PADR	Preparatory Action on Defence Research
PESCO	Permanent Structured Cooperation
R&D	Research and Development
RPAS	Remotely Piloted Aircraft Systems
RTC	Restricted Type Certificate
SES	Single European Sky
SESAR JU	Single European Sky Air Traffic Management Research Joint Undertaking
SFDPS	Stakeholder Forum for Defence Procurement Standardisation
SME	Small and Medium-Sized Enterprise
SO	Standardisation Organisation
SPIDER	Inside Building Awareness and Navigation for Urban Warfare
SSG	Standardisation Staff Group
SSN	Safe SeaNet
STANREC	Standardisation Recommendation
STANAG	Standardisation Agreement
TEN-T	Trans-European Transport Network
TRAWA	Standardisation of Remotely Piloted Aircraft System Detect and Avoid
UAV	Unmanned Aerial Vehicle
US	United States
WEAG	Western European Armament Group

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Executive Summary

The standardisation of armaments has been a long-standing focus of EU efforts to enhance the Union's military effectiveness, to improve capability development and to support the competitiveness of the European defence industry. **Armaments standardisation is a process that can lead to cost savings for defence spending by injecting added-value in defence production processes and the avoidance of capability and equipment duplication**. Standardisation is a method of improving interoperability within and between European armed forces and a process that can enhance the operational effectiveness of Europe's militaries. Both the EU and NATO have taken measures over many decades to enhance armaments standardisation in Europe. Yet the nature of the contemporary global defence market means that many more technologies and components integrated into military systems are sourced and/or produced in the civilian sector. Historically, 'spin-off' from military research and development into the civil sector has led to the development of technologies such as microwave ovens and GPS, but increasingly 'spin in' means that civil research and development is benefitting the defence industry in areas such as microprocessors and sensors. Thus, **the line drawn between defence equipment and capabilities, and civilian products and technologies, is increasingly blurred**.

Armaments standardisation is a challenging area of defence cooperation. While the benefits of armaments standardisation are well known, a number of factors conspire to complicate standardisation efforts. While there is an increased use of civil standards, ministries of defence and military planners still tend to support indigenous industries and to define only national military requirements. This means that various national industrial considerations and military requirements across Europe are not always aligned. Whereas in the civil sector firms largely define the standards to be utilised, in the defence sector it is governments and the military that do so. In this regard, standardisation may imply a degree of economic openness with the consequence that national industries are exposed to market forces. It may also imply security considerations related to security of supply of components and equipment. **For some components and technologies there is a genuine concern in ministries of defence and militaries that security of supply may be compromised**. In this respect, effective standardisation rests on the whole defence supply chain including firms that put together components and technologies to produce systems such as frigates, aircraft and tanks (the 'systems integrators') and firms that produce components and technologies ('tier firms' and 'SMEs'). Industry buy-in at all levels is required if there is to be a genuine European Defence Technological and Industrial Base.

In this context, and in relation to recent developments on EU defence cooperation, this study assesses **how effective EU approaches to armaments standardisation have been and how EU action might be improved and possibly expanded**. To this end, this study looks at the state of the art of armaments standardisation in Europe and it highlights the opportunities and challenges associated with defence-related standardisation. The study also outlines the EU's and NATO's respective armament standardisation strategies and it underlines the commonalities and differences of each approach. Here, the analysis also touches upon the growing importance of EU Agencies such as the European Aviation Safety Agency. The study then turns to two case studies on maritime information sharing and remotely piloted aircraft systems to highlight in more detail how the EU approaches the development and application of hybrid standards. These two particular case studies have been selected on the basis that the European Commission identifies these two technology domains as priority areas for the EU's standardisation efforts in its Communications of the 24 July 2013 (see COM(2013) 542 final) and 24 June 2014 (see COM/2014/0387). The study also **outlines other domains that could benefit from EU attention such as military mobility, cyber defence and energy management for defence**.

This study highlights the complex nature of standardisation and it explains how standardisation can broadly be defined as a process leading to the continuous, repeated and efficient use of technical

guidelines, processes and rules. Standardisation in a European context has tended to be of a voluntary nature with the need for consensus between a range of stakeholders from industry, governments, international organisations and civil society. A challenge in promoting the adoption and use of standards is that there is little in the way of an enforcement mechanism to mandate use of standards by industry, governments and armed forces. **The defence sector is like no other and armed forces have a set of particular requirements in relation to the development of standards**. In particular, issues such as security of information and security of supply are of paramount importance in the defence sector. Furthermore, defence and civil needs often diverge especially during the stages of technology and systems maturity.

With a view to addressing the challenges and issues surrounding armaments standardisation in the EU, this study makes recommendations in relation to: 1) the format of **inter-institutional cooperation** at the EU level; 2) the opportunities to be seized from the **European Defence Fund** if it is correctly configured; 3) the potential to provide greater oversight and commitment to standardisation through **Permanent Structured Cooperation**; 4) the application of existing **EU legislation** on defence; and 5) the way in which **information on hybrid standards** is shared among stakeholders such as governments, militaries, industry and European Standardisation Organisations.

1 Introduction

1.1 Background

The standardisation of armaments has been a long-standing focus of European Union (EU) efforts to enhance the Union's military effectiveness, improve capability development and support the competitiveness of the European defence industry. **Armaments standardisation is a process that can lead to cost savings for defence spending** by injecting added-value in defence production processes and the avoidance of capability and equipment duplication. Standardisation is a method of improving interoperability within and between European armed forces, which is a process that can enhance the operational effectiveness of Europe's militaries. Both the EU and the North Atlantic Treaty Organisation (NATO) have taken measures over many decades to enhance armaments standardisation in Europe. For example, in the late 2000s the European Defence Agency (EDA) developed and carried forward from the European Commission two online databases to facilitate information exchange on defence-related standards: the European Defence Standards Information System (EDSIS) and the European Defence Standards Reference System (EDSTAR). Furthermore, in 2009 the EU adopted a directive on defence procurement (2009/81/EC) and a directive on defence transfers (2009/43/EC) that respectively called for greater use of armaments standards in defence-related contracts and an open European defence equipment market.

Armaments standardisation has also gained the attention of the highest political level, with the European Council calling in 2013 for the EDA and the European Commission to develop 'hybrid standards' for defence in coordination with three European Standardisation Organisations (ESOs): European Committee for Standardisation (CEN), European Committee for Electrotechnical Standardisation (CENELEC) and the European Telecommunications Standardisation Institute (ETSI). This objective was already identified in a 2013 European Commission Communication on how to achieve a more competitive and efficient defence and security sector in the EU. This Communication affirmed that developing hybrid standards would benefit the European defence market and, on this basis, the European Commission announced that it would seek to develop such standards for airworthiness, data sharing, encryption and communication technologies. Accordingly, in 2014 the Commission published a further Communication on a 'New Deal for European Defence' and it elaborated a roadmap for greater standardisation and certification for maritime information sharing (MIS) and Remotely Piloted Aircraft Systems (RPAS).

In its 22 November 2016 Resolution on the 'European Defence Union', the European Parliament called for a reflection process on armaments standardisation with a view to eventually developing EU-level legislation. It made this call based on recognition 'that interoperability is key if Member State's forces are to be more compatible and integrated' (European Parliament, 2016). This acknowledged the EU Global Strategy's (EUGS) observation that '[d]eeper defence cooperation engenders interoperability, effectiveness, efficiency and trust (EU Global Strategy, 2016: p. 20). The European Parliament's Resolution also reiterated the Council of the EU's 14 November 2016 Conclusions on implementing the EU Global Strategy in the area of security and defence (see 14149/16), which stated that **standardisation and certification for EU defence are critical enablers for cooperation** (Council of the EU, 2016a: p. 10).

As far as NATO efforts are concerned, since 2014 the alliance has mainly – but not exclusively – relied on the NATO Standardisation Office (NSO) for its own armaments standardisation efforts. The NSO functions as a database and a networking mechanism between stakeholders such as military representatives, government officials, standardisation experts, industry, etc. The NSO is an independent body that assists NATO's Military Committee (MC) in the area of standardisation. It should be recognised that NATO has a longer heritage than the EU in developing defence-related standards – the first NATO standardisation body was established in 1951. Through the adoption of Standardisation Agreements (STANAGs) and Recommendations (STANRECs), NATO has helped develop thousands of defence-related standards. **It is a stated aim of the EU**

to ensure complementarity between EU and NATO efforts on standardisation, especially in the context of the two EU-NATO Joint Declarations (signed in 2016 and 2018) and the 74 action points agreed by both organisations. One of the joint work areas specifically relates to EU-NATO efforts to improve standardisation and interoperability.

Despite past endeavours, however, armaments standardisation at the EU-level has taken on even more salience following the development of initiatives such as the European Defence Fund (EdF) and Permanent Structured Cooperation (PESCO). Such initiatives have the potential to induce industrial and governmental cooperation on standardisation. These initiatives also occur in a context where the European Commission has recently overhauled the European Standardisation System (ESS) to meet the challenges of rapidly evolving needs. **Standardisation is ever more relevant, especially in a context of increasing defence spending in Europe** – from 2015 to 2017, the EU-28 increased defence spending by 6.1 % of USD 14 billion (Fiott and Bund, 2018: p. 129). Furthermore, for the first time in history the EU will directly (co)finance defence research and capability development under the EdF, but only on condition that EU financial support is used to reduce duplication, enhance interoperability and foster greater standardisation. For example, under the proposed European Defence Industrial Development Programme (EDIDP) (worth EUR 500 million for the 2019-2020 period), the adoption of common technical specifications and/or standards would be legally required before financing can be released. Under the Preparatory Action on Defence Research (PADR), the EU has an opportunity to ensure that defence-related standards form part of fundamental defence research efforts. PESCO is also important because it symbolises a binding commitment on the part of EU Member States to greater EU cooperation on operations and capabilities. Of the 20 binding PESCO commitments agreed to in 2017, the need to develop harmonised requirements for capability projects features prominently.

1.2 Armaments standardisation

Although armaments standardisation is crucial for EU security and defence, **the process of commonly developing and agreeing to standards in the defence sector is challenging**. Primarily, questions arise over the commonly agreed definition of what armaments standardisation means. Standardisation can relate to a discussion about the interoperability of weapons systems within and between European armed forces, but it may equally apply to the intricate and technologically advanced components that make up weapons systems. It may even apply to industrial processes, maintenance, repair and overhaul (MRO), logistics and training. Whereas the term 'arms' relates to specific weapons systems and equipment, **the term 'armaments' is more comprehensive in that it encompasses the technical and administrative features of standardisation**. This study employs this wider terminology in order to better analyse the industrial and hybrid features of defence-related standardisation. In doing so, the study clearly differentiates between the standardisation of weapons systems and the standardisation of components and technologies, and it focuses on the dual-use aspects of standardisation.

A related challenge is how to define the term hybrid standards. Hybridity in relation to armaments standardisation basically refers to the dual-use nature of components, technologies and processes that are used in producing weapons systems. **It has long been a feature of the defence industry to source key components and technologies from the civil sector (known as 'spin in')**. One of the chief drivers of this phenomenon is cost and efficiency. By relying on the civil sector it is possible for defence firms to avoid investing in (and replicating) costly research and development (R&D) in certain areas that are not directly financed by governments (i.e. for components where there is a higher degree of hybridity). Relatedly, whereas the main characteristics of weapons systems have not changed much over the preceding decades, performance and efficiency can be mainly found in the technologies that are integrated into systems. It would be far too costly for defence firms to initiate and sustain R&D programmes for each performance-enhancing technology that could be developed for their weapons systems. While governments remain the

key sources of investment for defence R&D, increasingly civilian R&D provides the basis for technologies and components that are eventually integrated into weapons systems. In this respect, while defence R&D is still important there is a recognised need to rely more on civil components and technologies in order to keep R&D costs low, especially where performance requirements dictate that civil standards are applicable for military requirements.

Therefore, hybrid standards represent the crossover from civil to defence sectors. On this basis, institutions such as the European Commission have long advocated for the greater use of civil standards in the defence sector as they concern components and technologies. In fact, numerous **standards already exist for components and technologies that are already being integrated into weapons systems**. In this respect, defence-relevant civil standards exist for high performance coatings and paints, nuts and fasteners, compression equipment, metering, sensors, cabling, etc. Civil standards may also be used for certification in areas such as airworthiness and MIS.

Despite the use of civil standards, however, there are a number of challenges associated with standardisation that are specific to the defence sector. Whereas standardisation in the civil sector is concerned with economic efficiency, **the defence sector considers not only economic efficiencies but politico-military factors too**. If standardisation is a way to reduce costs through the uniformity of goods and technologies in the civil sector, in the defence sector the differences between components, technologies, systems, doctrines and communications can be a way to ensure greater strategic effect for deterrence and during military operations. The uniqueness of systems and components is cherished by some governments and militaries to ensure a certain level of strategic autonomy. In this regard, the definition of national military requirements can be a way to reduce the room for standardisation and to support national industries and supply chains. Short of the full standardisation of systems, however, **many states may prefer to define common military requirements among themselves so as to ensure a degree of interoperability** on the battlefield while also retaining the state's desired level of strategic autonomy. In this sense, there is a distinction to be made between armaments standardisation and the definition of common military requirements.

1.3 Objectives of the study

Based on these challenges and factors, this study aims to answer an over-arching question: **how effective are EU approaches to armaments standardisation and how might they be improved and possibly expanded?** With a view to answering this question, the aim of this study is four-fold. First, the study aims to provide an up-to-date state of the art of armaments standardisation in the EU. While a number of studies have focused on armaments standardisation (see Molas-Gallart and Hawkins' study from 1999), none of them discuss standardisation in the context of recent developments in EU security and defence such as PESCO and the EdF. Second, this study will describe EU (and European Aviation Safety Agency (EASA)) and NATO approaches to armaments standardisation and it will analyse where the two approaches converge and differ. Such an analysis is pertinent in the context of the EU-NATO Joint Declarations (2016 and 2018). Third, with a view to scoping out an EU-level approach to defence-related standardisation the study will analyse two case studies related to MIS and RPAS. Weighing up these cases of standardisation and certification, this study will discuss the approaches taken by and the results achieved so far by the European Commission, the EDA and EASA. On this basis, **this study will make recommendations for improving the approaches chosen and for expanding them** beyond these two case studies in domains such as military mobility, cyber defence and energy management for defence.

It is important from the beginning to be clear about the terminology used in this study. As has been stated, this study will move beyond a mere focus on 'arms' as this specifically refers to certain types of military equipment. Instead, this study embraces the wider concept of 'armaments' because this word encompasses technical, maintenance, logistics, training and administrative processes and procedures. Furthermore, this

study employs the term 'hybrid standards' to refer to dual-use goods, services and technologies. The study does not explicitly rely on the term 'dual-use standards' so as not to cause any confusion with dual-use related legislation – which is not the focus of this study.

This study is primarily based on desk research and it is founded on primary and secondary sources including official EU and NATO documents and academic literature. Where possible, the study has also benefitted from informal exchanges with experts in the field and with officials from the EU. In terms of the structure of the study beyond this introduction, chapter two focuses on the meaning of armaments standardisation and it builds on some of the challenges identified in the last section. Chapter three then focuses on how the EU and NATO respectively approach armaments standardisation. Chapter four looks at the two case studies on MIS and RPAS and suggestions for areas where standardisation could be expanded are identified. The study then concludes with some overall observations and it makes specific recommendations for the EU's armaments standardisation efforts.

2 Understanding armaments standardisation

The objective of this chapter is to give the reader an overview of the dynamics involved in armaments standardisation. The first section begins by considering a broader definition of standardisation as it applies to the civil sector. It shows both the opportunities and challenges associated with civil standardisation and it briefly touches upon the work of standardisation organisations in Europe. In this regard, the chapter presents some stylised facts concerning the types of standards that have been agreed in Europe. Looking more specifically at armaments standardisation, the chapter then provides a definition of defence-related standardisation and it reflects on the difference between the standardisation of systems and the standardisation of components. The second half of the chapter also sets out the major challenges and benefits of engaging in armaments standardisation efforts at the EU level.

2.1 Defining armaments standardisation

2.1.1 Civil standardisation

The term 'standardisation' is complex and often misunderstood. As a single word, standardisation encapsulates a multitude of meanings and definitions. For the purposes of this study, it is imperative to be clear about the definition of 'armaments standardisation'. CEN define a standard as 'a technical document designed to be used as a rule, guideline or definition. It is a consensus-built, repeatable way of doing something' (European Committee for Standardisation, 2018a). This definition places an emphasis on consistency and repeatability, and it also highlights that standards are developed and adopted by consensus. Moving beyond a mere focus on technical documents, the word standardisation can also be defined as '**a commonly accepted means by which the processes and physical characteristics of specific technologies are assessed and replicated**' (Molas-Gallart and Hawkins, 1999: p. 5). This definition is most suited to industrial standards that include particular 'materials, technologies and processes' involved in 'the production of industrial goods and services' (*ibid.*). Such a definition stresses the importance of standards in relation to industrial processes and economic activities. What all definitions of standardisation share in common is 'the hope that some organizations or individuals will adhere to the standards concerned, or will at least consider doing so' (Brunsson and Jacobsson, 2002: p. 6).

At first sight, **standardisation may not automatically seem valuable in the context of a competitive market economy environment in Europe**. It could, for example, be argued that standardisation dampens competition in the market place. As Hawkins and Blind state, '[a]t first glance, standards and innovation might seem to be opposing forces. By definition, standardization is about doing things the same way, whereas innovation is about doing things differently' (Hawkins and Blind, 2017: p. 1). Here, the argument would be that it is precisely the differences between goods and services that lead to competition in the

market place. The academic literature on industrial economics perceives standardisation to be a form of 'natural monopoly', although other studies have shown that such an argument does not hold up in certain industrial domains such as telecommunications (see Genschel, 1997). For example, the Apple iPhone and the Samsung Galaxy are both personal devices but, even though both companies share parts and technology architectures, each has its own intricacies, user interfaces and applications; try charging an iPhone with a Samsung Galaxy charger cable, for instance. Here, it is claimed that difference rather than standardisation should be celebrated.

The academic literature shows that standards are 'a rich area of competitive strategy' because firms can promote standards or prevent them from being adopted on an industry-wide basis (Besen and Farrell, 1994: p. 129). This is especially the case in the Information and Communications Technology (ICT) domain. In this respect, **firms will take a strategic decision as to whether to promote or prevent a standard** based on a rational calculation of the market context and the similarity of firms. Firms which exhibit a high degree of similarity may choose to commonly develop a standard (Brunsson and Jacobsson, 2002: p. 6), but firms that are too dissimilar can compete over whether a standard should be developed in case it lends market newcomers or rival firms a competitive advantage (Besen and Farrell, 1994: p. 128).

There are limits to competition over standards, however, not least because factors such as performance, price, guarantees and customer service also affect market competition. What is more, the diversity of technologies (i.e. the difference between an iPhone and a Galaxy) is usually achieved in the finished state of systems and goods following different techniques of integration (i.e. how firms such as Apple and/or Samsung mobilise and integrate components and technologies – sometimes from each other). As Molas-Gallart and Hawkins point out, 'products incorporate many components on which there is little technological competition among rival systems and assemblers' and goods are made up of 'common materials like steel and well-known alloys, thousands of nuts and bolts, electrical cables, seals, etc.' (1999: p. 6). In this sense, it is in the interests of firms and industry to develop standards for common components and technologies so as to avoid costly duplication (in R&D and production) and to ensure the highest level of performance, interoperability and safety. In turn, **the adoption of standards can help build critical mass in markets, provide for innovation, codify the scientific state of the art, unlock investments**, etc. (Blind, 2017: pp. 39-40). From a cost-efficiency perspective, standardisation can lead to the following overall benefits:

- Interoperability: promotes quality and high performance of goods and lowers the costs associated with system redundancies;
- Economies of scale: encourages supply chain integration and facilitates trade in the Single Market and internationally by removing non-tariff barriers;
- Innovation: allows for the pooling of R&D investments and avoids duplicating innovation; and
- Public goods: enhances the safety of products and supports environmental sustainability.

In the civil sector specifically, standardisation is a fact of life of business and firms eagerly seek to develop industry-wide standards for products, components, technologies and raw materials. Over the past decades, the amount of published civil standards has grown exponentially (Werle, 2000: p. 1). As Figure 1 shows, the EU Single Market is home to thousands of published standards ranging over various product groups and industrial sectors and that there is ongoing work programmes on standards in these sectors. Figure 4 provides a non-exhaustive list where each sector is ranked in order of the amount of published standards. **The aerospace sector (with 2 400 published standards and a work programme of 690 standards**) **is in first position**, which is significant given its relevance and importance to the defence sector. The aerospace sector has developed hybrid standards related to tensile strength, stress testing, corrosion and contamination, conductivity and calibration, documentation and instructions, paints and varnishes and many more technical areas (European Committee for Standardisation, 2018b). As Figure 2 shows, even

though there is no discernible trend-line for standards adopted for aerospace, plastics and textiles, multiple standards are published on a yearly basis by recognised ESOs.

An important but often overlooked feature of standardisation is 'certification'. Indeed, standardisation is but one part of an overall process as standards mean very little if they are not 'accompanied by mechanisms to establish and certify conformance. Certification normally involves evaluating the item in question with a regime of prescribed tests' (Molas-Gallart and Hawkins, 1999: p. 12). Therefore, **testing and certification are important standards in their own right because they ensure that firms are adhering to agreed norms and practices**. Above all else, certification is a form of compliance that seeks to enforce adherence to standards and ensure quality (Hudson and Orviska, 2017: p. 275). What is more, certification is more than just testing and affirming a standard at the outset of its publication, because certification also relates to a system of continuous auditing to ensure that standards are adhered to over time (Conroy, 2007: p 10). As will be shown later, certification is also a vital element of EU efforts on armaments standardisation with regard to RPAS.

Figure 1 – Non-exhaustive list of standards per industrial sector/good in Europe

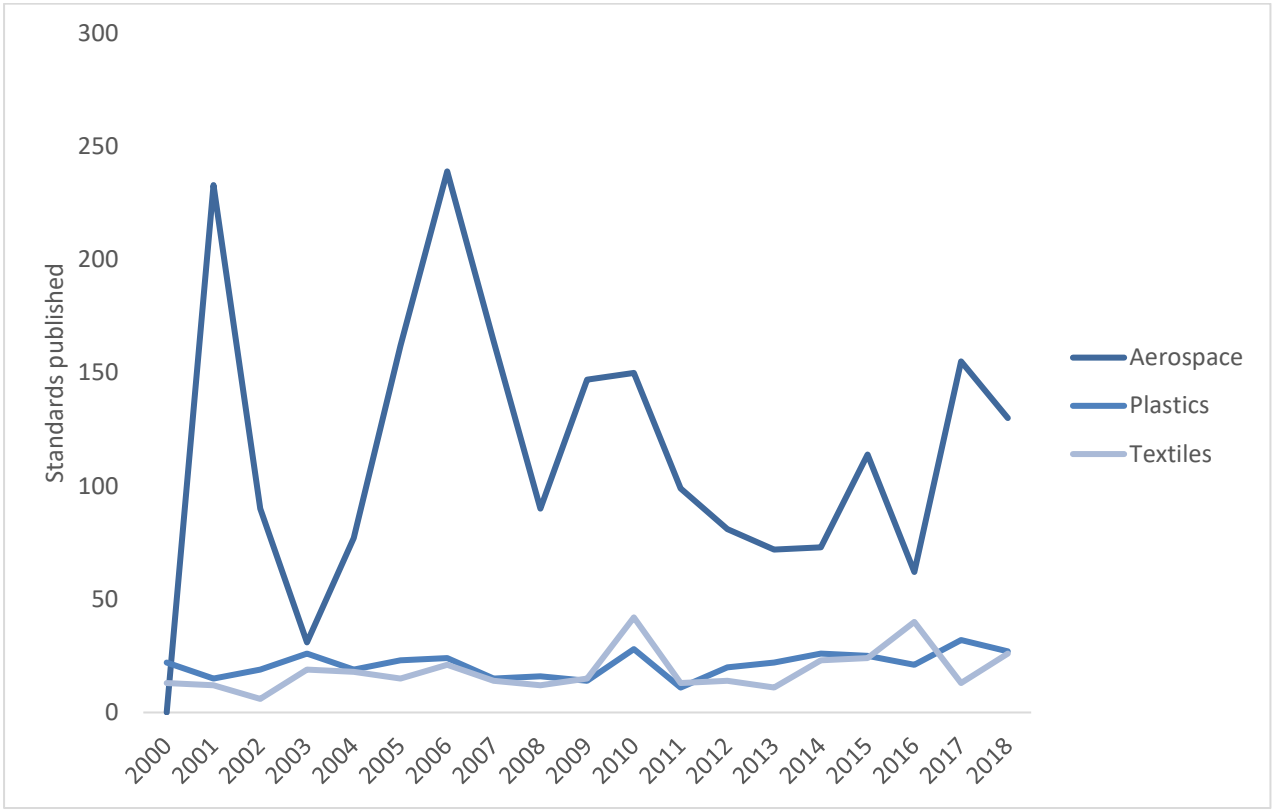
Sector	Technical committee	Published Standards	Standards in progress
Aerospace	ASD-STAN	2,400	690
Plastics	CEN/TC 249	480	77
Textile products	CEN/TC 248	336	53
Welding processes	CEN/TC 121	328	59
Paints and varnishes	CEN/TC 139	283	92
Railway applications	CEN/TC 256	235	112
Packaging	CEN/TC 261	200	12
Plastic piping and ducting systems	CEN/TC 155	199	34
Petrochemical industries	CEN/TC 12	194	29
Petroleum products	CEN/TC 19	189	27
Fasteners	CEN/TC 185	187	18
Water analysis	CEN/TC 230	176	34
Dentistry	CEN/TC 55	170	40
Water supply	CEN/TC 164	160	4
Protective clothing	CEN/TC 162	155	53
Corrosion protection	CEN/TC 262	145	22
Road materials	CEN/TC 227	143	25
Concrete products	CEN/TC 104	133	31
Adhesives	CEN/TC 193	127	17
Ergonomics	CEN/TC 122	125	12
Space	CEN/CLC/JTC 5	114	41
Air quality	CEN/TC 264	111	16
Doors, windows and shutters	CEN/TC 33	104	28
Health informatics	CEN/TC 251	102	21
Industrial valves	CEN/TC 69	81	18
Shipbuilding and maritime structures	CEN/SS T01	74	55
Technical drawings	CEN/SS F01	58	9
Powder metallurgy	CEN/SS M11	57	7
Durability of wood products	CEN/TC 38	53	10
Lifts, escalators and moving walks	CEN/TC 10	39	13
Cement and building limes	CEN/TC 51	34	8
Food products	CEN/SS C01	34	4
Environmental management	CEN/SS S26	24	14

Source: European Committee for Standardisation (2018b)

Finally, it is also worth reflecting on the ways in which standards are created and adopted by governments and industry. In this respect, it is important to bear in mind that '[s]tandards are driven by business and

drafted by experts in the field' through consensus and open participation between a wide range of stakeholders including industry, trade federations, public authorities, academia and non-Governmental Organisation (NGO) representatives (European Committee for Standardisation, 2010: p. 5). Standardisation Organisations (SOs) play an important role in providing expertise to set standards and to help stakeholders achieve consensus. In fact, 'the majority of standardization organizations do not have an official status. Most of them are private consortiums and forums' (Werle, 2000: p. 17). This independent status is important for various reasons. In contrast to centralised, state-heavy, hierarchies that were used in the past, **decentralised standardisation processes were developed over time to account for and manage cross-border supply chains and systems development** (Genschel and Werle, 1993: p. 204). On this basis, SOs can be seen as an inherent part of international governance as standards are used to promote 'collective welfare by coordinating and constraining individual behaviour' (Abbott and Snidal, 2001: p. 345).

Figure 2 – Selected standards published in Europe per year (2000-2018)



Source: European Committee for Standardisation (2018b)

In terms of the EU's experiences with civil standardisation, in 2012 the Union adopted Regulation (EU) No 1025/2012 setting out the legal basis for European standards and stating that the three recognised ESOs, including:

- European Committee for Standardisation (CEN): this ESO was established in 1961 to bring together the National Standardisation Bodies (NSBs) of 34 countries (EU and European Free Trade Area (EFTA) members) to develop standards for aerospace, chemicals, defence, energy, food, healthcare, security, etc.;
- European Committee for Electrotechnical Standardisation (CENELEC): established in 1973, this ESO helps develop standards specifically for the electrotechnical engineering domain. CENELEC boasts a membership of various NSBs in 34 European countries; and

- European Telecommunications Standards Institute (ETSI): established in 1988, the ETSI focuses on the standardisation of innovative technologies in the ICT sector. This ESO has more than 800 member organisations spread over 66 different countries across the globe.

Regulation 1025/2012 not only set out the need for greater transparency in the EU with regard to standard setting, but it also stated that NSBs will work with ESOs following a standardisation request from the European Commission to the ESOs. Such a request by the Commission follows **a process of consultation with all relevant stakeholders involved in a particular industrial sector** (e.g. governments, consumers, small and medium-sized enterprises (SMEs), unions, associations, etc.). In this respect, the Commission may either request the development of a new European standard or it may seek a feasibility study on a particular European standard. Finally, it is important to note that a range of EU and non-EU SOs have produced standards that European governments and militaries use for defence-related activities. A non-exhaustive list of such bodies include:

- ASTM International – based in the US, and founded in the late 1890s, this standardisation organisation focuses on a broad range of industrial sectors including consumer goods, medical devices, steel and additive manufacturing and the organisation has developed more than 12,000 standards (ASTM International, 2018);
- European Organisation for Civil Aviation Equipment (EUROCAE) – this organisation was established in 1963 with the task of developing globally recognised aviation industry standards. It works with industrial stakeholders and its member organisations and it is organised according to working groups (e.g. detect and avoid (DAA), unmanned systems, altimetry, etc.);
- Federal Office of Bundeswehr Equipment, Information Technology and In-Service Support (BAAINBw) – this organisation was established in 2012 as part of the German Federal Ministry of Defence. The Office has the task of equipping Germany's armed forces and it therefore also oversees the standardisation of military equipment for the armed forces when civilian standards are unavailable and/or need amending in light of military requirements;
- French National Organisation for Standardisation (AFNOR) – this organisation was established in 1926 and it develops and certifies standards in areas such as construction, electrotechnical solutions, sports, environment, industry, security and health. AFNOR represents France at the International Organisation for Standardisation (ISO) and it has an influential role within ESOs such as CEN and CENELEC;
- German Institute for Standardisation (DIN) – the institute was established in 1917 and it develops standards for the German Federal Republic and globally by representing Germany at the ISO. DIN develops standards for a range of administrative, industrial and scientific purposes through its respective expert committees;
- International Organisation for Standardisation (ISO) – created in 1947, ISO has emerged as one of the world's leading standardisation organisations and it is has published over 22,254 international standards for a range of industrial and technological domains and applications. The ISO acts as a standardisation networking hub and it represents 161 member countries in 783 expert committees (International Standardisation Organisation, 2018); and
- US Department of Defense (DoD) – this US federal government department also produces standards for military purposes in relation to design, performance, manufacturing, testing and life-cycle management. US military standards (MIL-SPECs) are used widely by the US military and a number of allies within the NATO framework have also adopted the DoD's military standards.

2.1.2 Defence-related standardisation

While much of the preceding analysis is applicable to the defence sector, there are nevertheless specificities and nuances that emerge when focusing on armaments standardisation. It is first worth considering some definitions of the term. Much like standardisation in the civil sector, in the defence procurement directive (see 2009/81/EC) the European Commission defined armaments standardisation as 'a technical specification the observance of which is not compulsory and which is approved by a standardisation body specialising in the production of technical specifications for repeated or continuous application in the field of defence' (European Commission, 2009: p. 125). This definition does not deviate from the Commission's broader definition contained under Article 2.1 of Regulation (EU) No 1025/2012 which states that a 'standard' is a 'means to a technical specification, adopted by a recognised standardisation body, for repeated or continuous application, with which compliance is not compulsory' (European Union, 2012: p. 19). The only major difference between the two definitions appears to be the phrase 'in the field of defence'. This is crucial because whereas in the civil sector customers largely define standards, in the defence sector governments and militaries serve as the customers which raises important questions related to performance, security of supply and national industrial protection.

The challenges associated with armaments standardisation have been clear for many decades despite the stated benefits of enhanced armaments standardisation. Calculating the benefits of armaments standardisation is not easy and the closest there is to a scientific calculation is contained in a Commission-tendered report (the so-called 'Sussex Study') which calculated that **armaments standardisation could lead to cost savings of up to 50 %** (Molas-Gallart and Hawkins 1999; Fiott, 2014a). Nevertheless, figures that have been made available tend to stress the capability payoffs of standardisation. For example, in 1992 Matthews reported that one former General from the US military claimed that a **lack of armaments standardisation in NATO has resulted in a 30 %-50 % reduction in the capability of the alliance** (Matthews 1992: p. 9). Furthermore, without calculating the exact cost efficiency of standardisation it has been implied by certain institutions that using civil standards could have a cost efficiency payoff for the defence sector. For example, in documenting the potential crossover from the civil sector to the defence sector it has been estimated that '**up to 90 % of standards in the civilian naval sector could be used in the defence sector**, as well as 75 % of those used in the aeronautic and 70 % in the land sectors' (European Communities, 2010: p. 130).

Systems and components

Understanding the nature of armaments standardisation first requires a differentiation to be made between the standardisation of systems and the standardisation of components and technologies (see for example Hartley, 1990: p. 97). Both the standardisation of systems and components could enhance interoperability and cost efficiency in the defence sector, but they exhibit different characteristics that need to be acknowledged when devising policy. Therefore, hybrid standards relate to the standardisation of components whereas discussions about the non-duplication of capabilities and/or the common requirements of capabilities primarily relate to systems. In essence, components are the ingredients required to develop a system. It follows that **should the costs of components and technologies be reduced and their utility be improved, it would be possible to develop cost and operationally effective systems**.

There are many aspects to debates about the standardisation of systems. For example, Cohen observed many years ago that real standardisation in NATO would lead 'in its extreme form […] to a NATO army, navy, and air force, staffed by uniformly equipped and trained soldiers' (1978: p. 73). There is therefore a need to differentiate between this extreme form of standardisation (i.e. which essentially means developing and procuring one type of weapon system) and standardisation that means that armed forces in Europe can more effectively operate with one another through common requirements (*ibid.*). This is not to say that

the standardisation of systems is not important. As a recent reflection paper published by the European Commission attests, there is a need 'to increase the scope and efficiency of defence spending. **Duplications between Member States can affect the interoperability of their defence equipment**. It can also lead to a lack of preparation and readiness of armed forces and gaps in defence capabilities' (2017c: p. 11). Based on multiple sources, the Commission calculate that for selected weapons systems categories the EU-28 have 178 different systems compared to 30 in the US (*Ibid.*: p. 9).

The standardisation of weapons systems is an increasingly important aspect of armaments standardisation, especially in a context in which 'system of systems' architectures are now being developed. Indeed, the battlespace is increasingly defined by adversaries being able to rapidly integrate different technologies and systems into existing platforms. For example, under the United States' current defence innovation initiative (known also as the 'third offset strategy') is focusing on algorithmic, nano and automated technologies. These developments are designed to ensure that while existing platforms do not need to be significantly overhauled, cutting-edge technologies can be integrated to improve the performance of the systems (see Fiott, 2017a). Here, standardisation of individual systems may be beneficial to the overall integration of systems. The role that standardisation can play in the integration of a 'system of systems' for European capabilities has clear military benefits (i.e. it allows leading technologies to be better and more rapidly integrated), but it also has economic benefits too as it may allow firms to cooperate and compete for the development and production of future capabilities (i.e. the sixth-generation aircraft).

However, **many factors contribute to the duplication of weapons systems including modernisation programmes, legacy platforms, procurement work share and/or licensing and national industrial protectionism**. In particular, the legacy of major complex systems means that there is minimum scope for adopting open and modular architectures in the short term. It is vital that in the future new systems adopt a more open approach to capability development to promote common systems. As the experience of developing Main Battle Tanks (MBTs) in Europe shows, there is a high degree of variance for MBT systems for the aforementioned reasons. For example, Figure 3 shows that in the EU-28 there are a total of 4 727 MBTs currently held on Member States' inventories and a total of 27 different variants overall in the EU.

There are multiple reasons for this variance. First, there is the continued use of legacy models that were procured and/or developed on licence via the now defunct Soviet Union and Yugoslavia. MBTs from these former producers still represent 6 variants and 1,197 units overall in the EU-28 and at least three of the variants were produced under licence in Croatia (the M-84), the Czech Republic (the T-72M4 CZ) and Poland (the T-72M1 D). Second, modernisation programmes have also contributed to the number of MBT variants in the EU. For example, in the inventories of EU Member State armed forces there are least ten different variants of the Leopard 2 tank. Much of the variance can be accounted for by the age of the systems, as each model upgrade is designed to modernise MBTs in relation to armour, weapons, fire protection, sensors, etc. In other cases, variants can be accounted for by production licensing to third states (as was also the case with the Soviet T-72). In this respect, at least four Leopard MBT model variants have been licenced for (co)production in Greece, Spain and Sweden.

Licencing of weapons systems to third countries has an important industrial perspective, as countries seek to develop weapons systems in their country as much as possible in order to support the domestic defence industrial and skills base. Work share programmes may not always be the most economically efficient arrangements. **Country-specific military requirements also conspire to lead to the duplication of weapons systems in Europe, although the identification of common military requirements between states can allow for a degree of national customisation while avoiding high degrees of duplication and improving military interoperability**. In this respect, it should be stated that weapons systems can greatly differ between countries even though the systems bear the same name. The case of the NH90 helicopter is instructive here. Established in 1992 as a multinational programme initially involving France, Germany, Italy and the Netherlands, the NH90 programme was designed to avoid duplication and to ensure

sizeable economies of scale for production by harmonising military requirements. The reality, however, has been that even with the NH90 label 23 different versions of the helicopter were produced at multiple production sites, which diluted the potentially huge volume of production and related economic efficiencies (Bellais, 2018: p. 102). Therefore, **there also remains a strong case for the identification of common requirements for weapons systems at the EU level**.

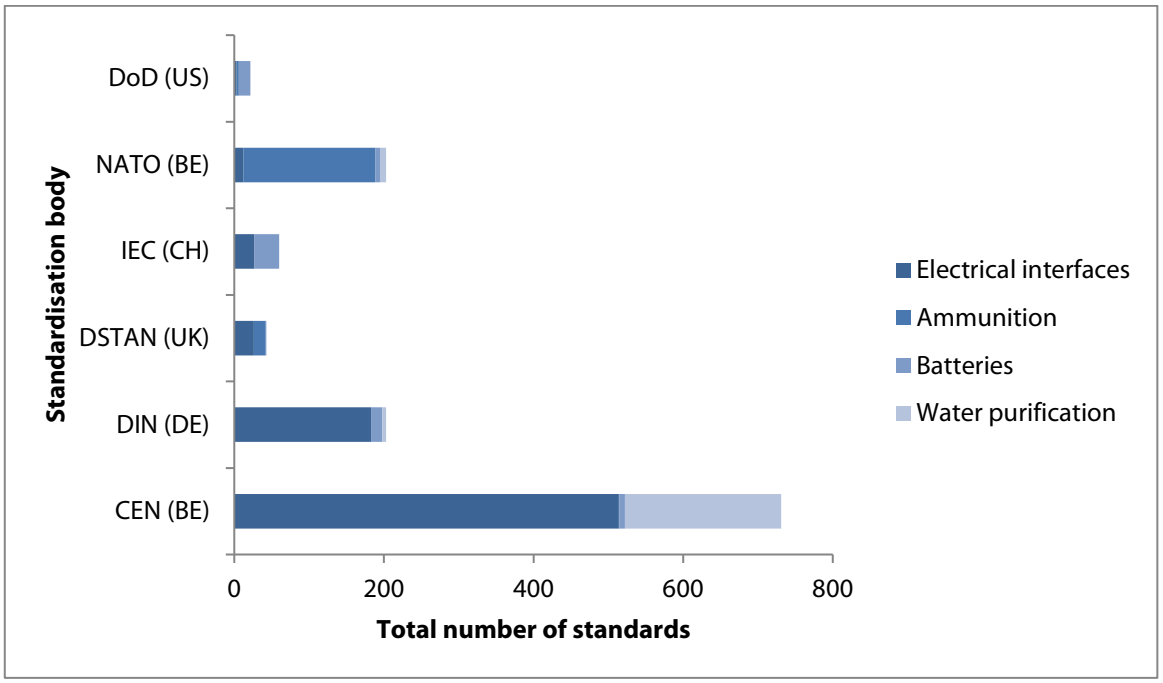
Figure 3 – Main Battle Tanks used by the EU-28, 2018

Origin	Variant	In-service date (circa)	Quantity
Germany	Leopard 2A7	2014	19
	Leopard 2A6HEL (Greece)	2008	170
	Leopard 2A6	2001	37
	Leopard 2A5/A6	1998	217
	Leopard 2A5E (Spain)	1998	223
	Leopard 2A5 Strv 122 (Sweden)	1997	120
	Leopard 2A5	1998	162
	Leopard 2A4 Strv 121 (Sweden)	1995	9
	Leopard 2A4	1979	489
	Leopard 1A4	1965	513
		Sub total	**1,959**
Soviet Union	T-80U	1976	82
	T-72M1 D (Poland)	2009	671
	T-72M4 CZ (Czech Rep)	2003	30
	T-72M	1980	30
	T-55	1949	263
		Sub total	**1,076**
United States	M60A3 TTS	1979	25
	M60A1/A3	1962	100
	M48A5	1976	375
		Sub total	**500**
France	- AMX Leclerc	1993	200
	- AMX-30B2	1960	52
		Sub total	**252**
Poland	PT-91 Twardy	2002	232
		Sub total	**232**
United Kingdom	FV 4034 Challenger II	1998	227
		Sub total	**227**
Romania	TR-580	1980	42
	TR-85M1 'Bizonul'	1997	54
	TR-85	1986	104
		Sub total	**200**
Italy	C1 Ariete	1995	160
		Sub total	**160**
Yugoslavia	M-84	1985	121
		Sub total	**121**
		Total	**4,727**

Sources: International Institute for Strategic Studies, Military Today, Army Recognition

While the standardisation of systems is a way of reducing the number of variants so as to avoid duplication and costs, the standardisation of components and technologies is also relevant. As has been argued elsewhere, major defence systems have not evolved over the ages in terms of design and function (e.g. the basic design of an MBT has not changed since its invention). What has changed over time, however, is the performance of systems and system of systems through the application of new technologies, componentry and learning processes (Bellais and Fiott, 2017). As can be observed with the development of MBTs, successive models of the Leopard 2A have been upgraded to improve armour protection, survivability, surveillance range and command and control (C2) through the use of new materials, technologies and techniques such as the latest composite materials and sensors (Krauss-Maffei Wegmann, 2018b), even as the overall dimensions and characteristics of the system stay relatively untouched. Indeed, **a number of defence-relevant standards have been developed for components by a range of SOs inside and outside of the EU** (see Figure 4).

Figure 4 – Selected defence and hybrid standards for key components to date



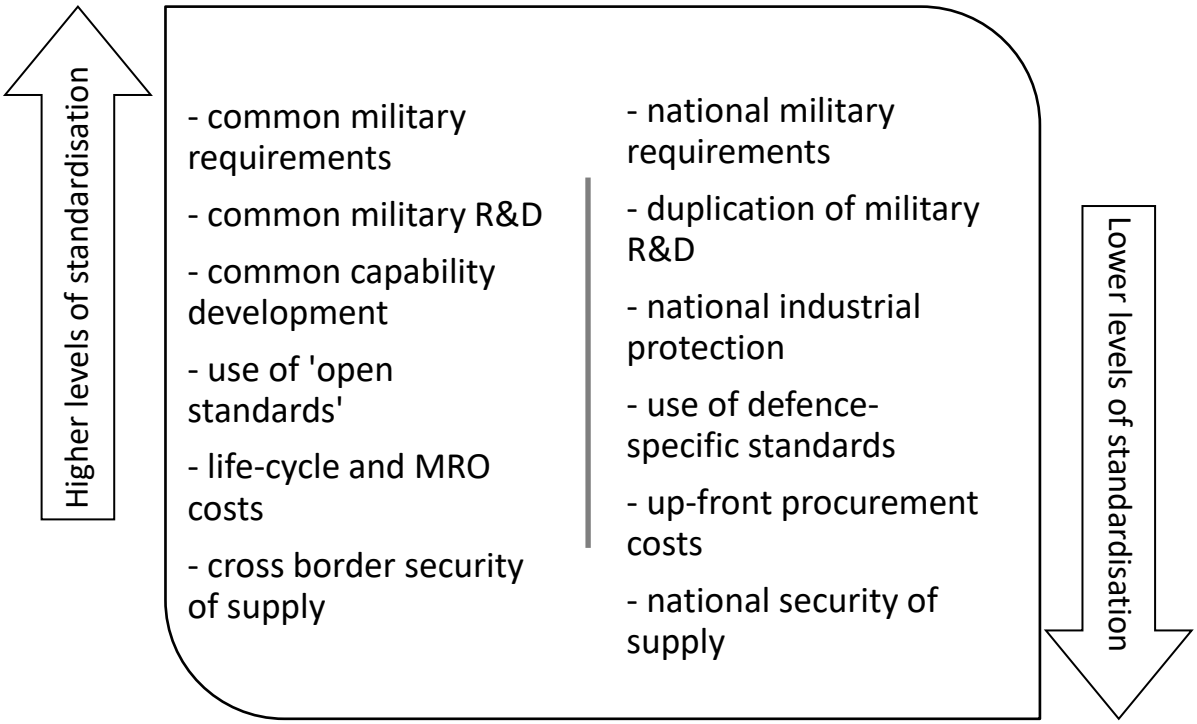
Source: European Defence Agency, 2018d

As Figure 4 shows, in many component areas more standards are available from civil standards setters (e.g. CEN and DIN) than specific defence standards setters (e.g. NATO, the DoD and DSTAN). Of course, this depends on the component in question – i.e. CEN has set 514 standards for electrical interfaces and NATO only 12, but NATO has set 177 standards for ammunition whereas CEN has set only one so far. **Defence-related components and materials can run into their hundreds in any systems integration process and these components may not necessarily always be available from EU suppliers**. For example, a look at a naval radar system reveals the need for a high number of components. Basic radars are traditionally composed of a power supply, a transmitter, a synchroniser, a display, a receiver, a duplexer switch and an antenna. Each of these individual components will themselves be made up of other components and raw materials. Indeed, a radar power supply system will be comprised of a transformer and a circuit board (to name only a few parts) and these in turn will be constructed using windings, resistors, LEDs and transistors composed of copper, aluminium, silicon, Germanium, Gallium Arsenide, Gallium Phosphide and many more materials.

Both the standardisation of systems and the standardisation of components are complex but not impossible processes. Such processes relate to the room available to define common military

requirements for systems and to the security of supply of components for key enablers (e.g. ammunition). Yet, the two major aspects of armaments standardisation that should be considered with relation to systems and components standardisation relate to innovation and interoperability (see Figure 5).

Figure 5 – Armament standardisation polarities



Innovation

From an economic perspective, Hartley observes that the standardisation of systems could lead to cost savings in R&D expenditures, economies of scale through lowering production costs and gains from international trade (Hartley, 1990: p. 98). Here, economic theory stipulates that if EU Member States and NATO allies opt for less duplication and standardise their capabilities governments will not have to spend (or sometimes waste) public finances on national R&D and capability development programmes. Because of the multitude of systems in Europe, **standardisation is a way to reduce the choice of equipment and systems but to do so in a way that reduces costs**, improves the competitiveness of Europe's defence market and enhances military interoperability (Fiott, 2014a). Indeed, the standardisation of systems can lead to lower levels of duplication, enhanced value-added in relation to production runs and cost management over the full life cycle of a system or system of systems, especially through the MRO phase (Hartley, 1990). Nevertheless, Hartley observes that a range of variables can hamper standardisation, including a need for specific features and military requirements, the expected life-cycle costs of equipment and the expected lifetime benefits. Sometimes the up-front costs of a system are low but the life-cycle costs are expensive, and states calculate the balance between up-front vs life cycle costs differently (1990: pp. 109-110).

However, the standardisation of components can also be a way to enhance the efficiency of the European defence market by ensuring that R&D investments are not duplicated. 'Open standards' in particular are a way to reduce costs and improve efficiency. As Zervos and Swann argue, with open standards a systems integrator can 'mix and match' components from a wider supplier base but without open standards 'it is more likely that system integrator will put together his own components to a make a 'turnkey' system' (2009: p. 27). Of course, **the specific problem for the defence sector is that not all standards may guarantee security of supply of components and technologies**. Nevertheless, while standardised components and technologies may well reduce the overall costs of a system (or system of systems), the process of standardisation could allow SMEs to proliferate new technologies for their own benefit and that

of the wider defence market. As the EDA notes, defence-relevant SMEs can play a vital role in the defence market, as the technologies they develop can form the basis of new standards, provided they are patentable and have a proven application (European Defence Agency, 2016: p. 32).

Accordingly, it has been claimed that **standardisation is vital for cross-border collaboration and supply chains**, especially with regard to the more than 2,500 SMEs involved in defence supply chains in Europe (see European Commission, 2014a; European Defence Agency, 2009). **It is important not to simply focus on systems integrators, but the entire defence supply chain,** as most value attached to systems development come from tier firms (i.e. tier 1 firms are specialised systems producers and sub-systems assemblers; tier 2 firms produce or supply electrical equipment, mechanical engineering, metal working, casts and moulds; and tier 3 firms supply commodities and service supplies) (see Antill, Moore and Neal, 2001; Bellouard and Fonfría, 2018). As the Commission acknowledges in the European Defence Action Plan (EDAP), SMEs in many Member States are sources of innovation and they 'often offer dual-use goods or services in a wide range of industries' (European Commission, 2016a: p. 11). The Commission defines SMEs as firms that employ less than 250 persons, and have an annual turnover of less than EUR 50 million or a total balance sheet of less than EUR 43 million (European Commission, 2003). Importantly, the Commission also shows how SMEs are particularly vulnerable because of a range of issues, including access to finance and contracts, even though SMEs are responsible for innovation and disruptive technological shifts (European Commission, 2016a: p. 11).

Yet these are not the only barriers SMEs face with regard to market access and standardisation. First, critics of the economy of scale approach claim that standardisation may 'decrease a healthy competition and the variety of proposed solutions' for defence systems integrators, tier firms and governments (Sempere, 2017: p. 339). Second, because systems integrators occupy a privileged position with regard to sourcing and integrating components, 'the market power of integrators' increases and this 'may allow them to place barriers to entry in the path of new innovative component suppliers' and SMEs (Zervos and Swann, 2009: p. 28). Such a position may stymie defence innovation, even though it can be argued that systems integrators are better placed than tier firms and SMEs to know the needs of the end-user and main customer: i.e. governments and the military. Third, one of the challenges associated with developing hybrid standards is that as 'technologies develop […] military and civilian interests often diverge as the uses of each domain become more specialized. As the technological needs of the two sectors become more nuanced, **the degree to which there are common features will decline, and they often shift from the system to the component level**' (Sempere, 2018: p. 230; see also European Communities, 2010: p. 130).

While the benefits of armaments standardisation are well documented, the principle of national sovereignty pervades decisions about the application of civil open standards and market access for SMEs. The reflex in many large firms, ministries of defence and militaries is to support indigenous industries for reasons such as industrial protection. As Sandler and Hartley observe, 'nations impose their own barriers to more standardization through their continued preference for, and willingness to pay for, independence' (1999: p. 210). Accordingly, standardisation has been traditionally difficult because '[i]t implies compromise by research and development communities on techniques and values and by national military authorities on tactical doctrine and direction national control of production' (Campbell, 1990: p. 65). In this respect, while there is **evidence of increased use of civil standards for components there is still a preference for developing nationally defined weapons systems and platforms**, especially when standards are used or developed for the purposes of military performance. Despite measures designed to promote non-discrimination during procurement tenders (e.g. Directive 2009/81/EC), **domestic standards can be promoted to ensure that foreign competition stands a lower chance of meeting national requirements during the tender**. This is made all the harder because systems integrators occupy a central role in the procurement process, even though tier firms and SMEs are vitally important, and this invariably

means that they select component tier suppliers and SMEs on the basis of cost effectiveness rather than questions related to strategic autonomy (Belin et al., 2017).

These factors serve as barriers to closer civil-defence cooperation and market entry for SMEs. Furthermore, there are questions related to how far defence firms (both systems integrators and tier firms) are associated and/or involved in the process of defining defence-relevant standards. Based on exchanges with industrial representatives, there is **a perception that defence firms are brought in at later stages in the definition of civilian standards and this means there is relatively little opportunity to feed in military requirements into the standardisation process**. It has also been disclosed during exchanges that defence industry representatives are not keen on committing to civil standardisation processes because they fear that their products and technologies are not of interest to civilian stakeholders. Seen from the perspective of the civil sector, defence products and technologies are viewed as a small share of the overall market. In this respect, more work is required to ensure that there is sufficient market buy-in for defence firms during standardisation processes, especially given the growing importance of civil standards to military capabilities such as the A400M and RPAS.

Interoperability

One of the other main areas where armaments standardisation is seen as imperative is military interoperability. The concept of interoperability relates mainly to the standardisation of systems, doctrine and training. **Given that most military operations in the present period occur within a multilateral environment, there is a clear need for systems and replacement parts to meet the needs of interoperability within and between armed forces**. As DeVore states, 'when levels of interoperability are low, joint operations suffer from complex supply arrangements, incompatible communications, and complicated mission planning. Thus, allied states should militarily benefit from armaments collaboration, even in the absence of economic advantages' (2014: p. 419). This point cannot be overstated, especially given that warfare and crisis management over the past few decades has been characterised by coalitions of the willing and network centric warfare. As Arntzen and Grøtan argue, while ICT and improved battlefield communications and precision strike appear to have condensed time and space, they have placed an even greater onus on partnering militaries to ensure that they are technologically and doctrinally similar (2011: p. 250; see also King, 2011 and Strachan, 2013: p. 188). This is especially so in a context where military operations are increasingly challenging, and where it is difficult at the best of times to ensure coherence between multiple military partners (Schmitt, 2018).

Yet **the logic of common military requirements has not easily become the norm for armed forces and/or governments in Europe**, even though standardisation seems logical and rational for allies to follow in a NATO and the Common Security and Defence Policy (CSDP) context. As Taylor has remarked, while NATO is a security community with collaboration at its heart, economic interests and domestic considerations hamper standardisation because '[w]hile weapons standardization can improve military effectiveness in the alliance and save billions of dollars in R&D costs and systems redundancy, it can also mean loss of sales (particularly in third-country transfers) and of control of military high technology for members of the alliance' (1982: pp. 97-98; see also Hartley, 1990: p. 103). The same applies to standardisation at the EU level, too. For the standardisation of systems (or system of systems) to work efficiently, for example, there needs to be **EU-wide agreement on the basic common military requirements required to answer different types of military tasks** (e.g. deterrence and national defence, crisis management operations, humanitarian missions, peace missions, surveillance tasks, etc.). In essence, armaments standardisation rests on an ability of a group of states and militaries to identify common levels and understandings of lethality, manoeuvrability, performance, endurance, etc.

Agreement is not easy given that beyond the standardisation of systems and components lies other forms of non-material standardisation related to the synchronisation of institutions, doctrines, terminology and training (Ford, 2017: p.120). In this respect, broader armaments standardisation might be a hindrance to

securing a military advantage over partners and allies (i.e. sought in order to ensure a degree of specialisation and therefore a niche added value in the context of an alliance or military coalition) and adversaries and rivals (i.e. using technology to serve as a deterrence and/or to overcome military-technological symmetry or parity). Finally, some **military planners resist a high degree of standardisation for fear that it will diminish security of supply** by increasing in some cases the military's dependence on a single supplier (or a small supplier group). As Sandler and Hartley point out, in some cases a 'diversity of weapons and forces is needed as an insurance against the failure of standardized weapons and to meet the variety of future unknown and unknowable threats' (1999: pp. 207-208).

3 EU and NATO approaches to standardisation

The objective of this chapter is to provide a clearer understanding of EU and NATO approaches to armaments standardisation. As will be made clear, both organisations employ a voluntary and non-binding approach to the adoption of hybrid standards. As has been made clear by Molas-Gallart and Hawkins, while standardisation can occur through legal fiat or protracted common use, international organisations have tended to employ a negotiated and voluntary method of enhancing standardisation (1999: p. 5). Of course, any discussion of how the EU and NATO respectively approach armaments standardisation has to take into consideration the different memberships and structures of each organisation. In NATO, for example, it has been shown that the quest for a common benchmark for armaments standardisation based on military requirements such as lethality is greatly influenced by the US (Ford, 2017: p. 139). By contrast, standardisation efforts in the EU are not affected by a single military hegemon such as the US and supranational institutions such as the European Commission and standardisation bodies play an important role. Finally, despite the differences embodied by each organisation it should be stressed that there are no 'Chinese walls' between the EU and NATO and each organisation is able to learn from and influence the other in policy areas such as armaments standardisation (Fiott, 2017b: p. 410).

3.1 EU

Armament standardisation in Europe is not a new phenomenon. From 1993 to 2004, the Western European Armament Group (WEAG) dedicated its time and resources to increasing the harmonisation of requirements for equipment. Relatedly, armaments standardisation has also long been on the agenda of the European Commission. For example, in 1997 the Commission published a Communication on 'Implementing European Union Strategy on Defence-Related Industries', which stated that '[s]etting up a European defence equipment market and consolidating Europe's defence industrial base will call for an effort to rationalise the sets of standards currently being used by the defence ministries of the Member States' (European Commission, 1997: p. 19). Interestingly, even in the late 1990s the European Commission recognised that '[w]ith increasing use being made of dual-use technologies in the military systems, the current trend is to make as much use as possible of civil standards' (*Ibid.*). On this basis, the Commission proposed three lines of action: i) inviting industrial circles to draw up a work programme for identifying standards; ii) a regular exchange system on standards between the EU and NATO; and iii) providing Commission support to standardisation organisations while incorporating the specificities of the defence sector (*Ibid.*: p. 20).

Following a study commissioned in 1999 (the so-called 'Sussex Study'), the European Commission pushed for greater standardisation efforts within the EU. One of the major conclusions and recommendations from the Sussex Study (see Recommendation 16) was that the EU should work with ESOs to develop a 'European Defence Standardisation Handbook' (Molas-Gallart and Hawkins, 1999: p. 308). The Commission took on board this suggestion and developed a Handbook on defence procurement that identified and compiled more than 10,000 relevant standards in specific technical domains. However, despite the creation of the Handbook the Commission soon turned towards ways in which standards could be taken up by Member

States. Indeed, in its 2007 Strategy for a Stronger and More Competitive European Defence Industry, the Commission stated that in order to overcome fragmentation of the European defence market by reduced barriers to cooperation and avoiding wasteful R&D, it is necessary to 'promote the use of common standards to facilitate the opening up of defence markets' (European Commission, 2007: p. 6). This focus, and the maturation of the Handbook, saw the Commission transfer the initiative over to the EDA in June 2011. The Agency further developed the Handbook as an online database called the European Defence Standards Reference System.

The EDSTAR database sat alongside another EDA initiative that had been developed in 2007 called the European Defence Standards Information System. As web-based platforms, the idea behind both EDSIS and EDSTAR is to exchange information on defence standards, to allow stakeholders to advertise relevant standards, to promote networking among these stakeholders and to effectively utilise published standards. The key difference between EDSIS and EDSTAR is that EDSIS lists existing standards and it gives stakeholders the opportunity to amend existing or volunteer new standards, whereas EDSTAR is a platform that assists stakeholders implement and use existing standards. Since 2007, **EDSIS has recorded 147 published defence-relevant standards and 89 standards are still active** – of these 89 active standards, 20 are brand new whereas the remaining 69 are revisions of existing standards. The standards registered in EDSIS range from a basic standard for cables and insulated wires to packaging for ammunition and explosives to standards for methanol fuel cell systems (European Defence Agency, 2018a).

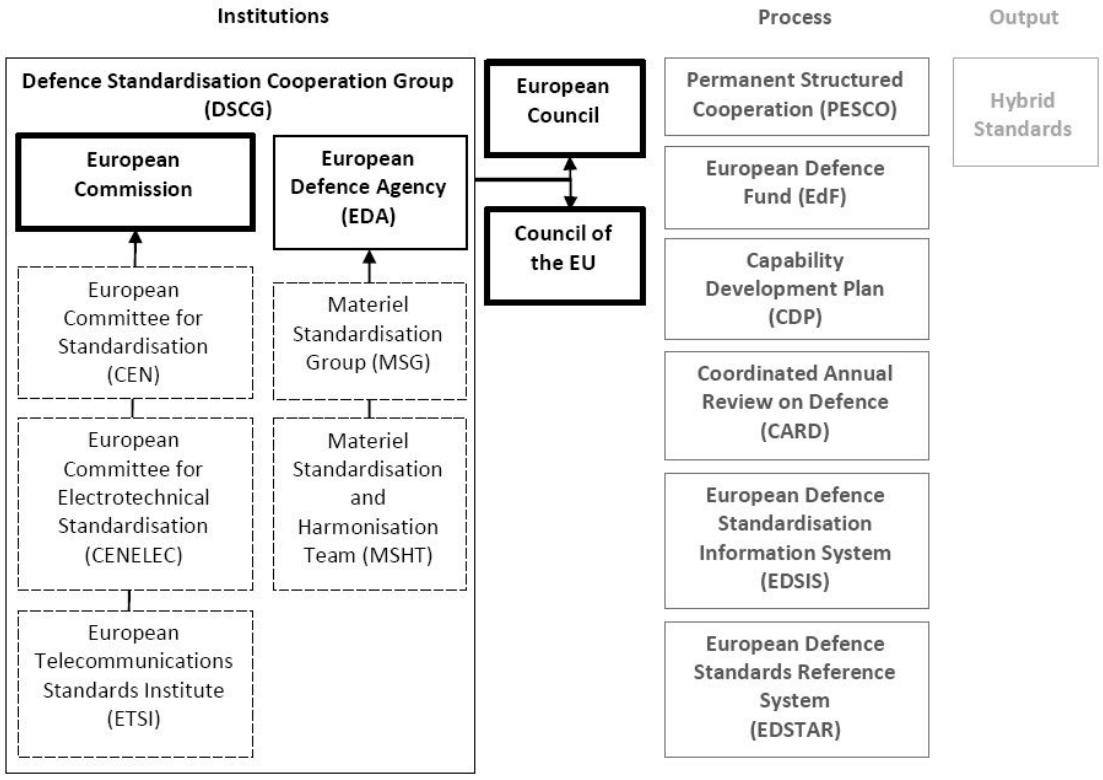
While the EDA does not develop defence standards itself, the **EDSTAR platform currently lists more than 2 400 defence-relevant standards** ranging from high-resistant paints and varnishes to electrotechnical vocabulary (European Defence Agency, 2018b). As part of the EDSTAR initiative, the EDA's participating Member States sit in the Materiel Standardisation Group (MSG) format and the group is chaired by the EDA's Armaments Director. The MSG oversees the state of play of defence standardisation in an EU context and it has the opportunity to make new standardisation requests and proposals (European Defence Agency, 2012). EDSTAR is organised according to various technical domains including ammunition; armoured land vehicle technology; camouflage; electrical interfaces; electromagnetic environments; life-cycle project management; military airworthiness; and many more (European Defence Agency, 2018c). Finally, to aid the Agency's work and to assist with the efforts of the MSG, there is an in-house body within the EDA called the Materiel Standardisation Harmonisation Team (MSHT), which provides advice and expertise to ESOs on defence standardisation.

After the commissioning of the 'Sussex Study' and the development of the defence standardisation handbook, the European Commission continued to develop a number of policy and legal instruments designed to enhance armaments standardisation. For example, following the adoption of the directive on defence procurement (see 2009/81/EC) in 2009, the European Commission made clear in recital 38 of the directive that the **use of standards and technical specifications are to be considered a precondition for defence procurement tenders**. According to the Commission, the use of standards is a way of overcoming 'incompatibility or disproportionate technical difficulties in operation and maintenance' (see Recital 51) (European Commission, 2009: p. 82). In particular, the Commission makes clear that '[t]echnical specifications shall afford equal access for tenderers and shall not have the effect of creating unjustified obstacles to the opening up of procurement to competition' (see Article 18.2) (European Commission, 2009: p. 95). In this respect, the Commission sees the defence procurement directive as a way to enhance armaments standardisation by challenging the principle of national discrimination during defence contract tendering. Furthermore, the purpose of Directive 2009/43/EC on **defence equipment transfers is designed to provide the market conditions for greater standardisation while maintaining a level playing field in the European defence market**. The European Commission has long been an advocate for the use of civil standards in defence because it believes the use of civil standards creates economic

efficiencies. Indeed, the EDA has concluded that the 'product cost savings following a more intensive use of civil standards by the military sector range from 10 % up to 50 %' (European Defence Agency, 2015a).

Building on this logic, on 24 July 2013 the Commission released a Communication spelling out how Europe could head towards a more competitive and efficient defence and security sector (see COM(2013) 542 final). In the Communication the Commission makes clear that it will develop a defence industrial policy based in part on developing hybrid standards to 'benefit security and defence markets' (European Commission, 2013a: p. 4). The Communication shows how most 'standards used in EU defence are civilian' but where '**specific defence standards are required they are developed nationally, hindering co-operation and increasing costs for the industry**' (European Commission, 2013a: p. 8). On this basis, the Commission stated that one of the action points derived from the Communication is to promote hybrid standards for Chemical, Biological, Radiological, Nuclear and Explosive materials (CBRNE), RPAS, airworthiness, data sharing, encryption and critical information communication technologies. Another relevant action point refers to certification and the Commission's pledge to build on the experience of EASA and its role in certifying the A400M aircraft (European Commission, 2013a: pp. 8-9).

Figure 6 – EU standardisation institutions, processes and outputs



The Commission's planned actions were further amplified following the 20 December 2013 European Council summit on defence. During the summit the EU heads of state and government endorsed the Commission's and the EDA's positions that '[d]eveloping standards and certification procedures for defence equipment reduces costs, harmonises demand and enhances interoperability' (European Council, 2013: p. 9). Following these conclusions, **the EDA and the European Commission were tasked to develop hybrid standards for defence** and the two institutions agreed to do this in cooperation with CEN, CENELEC and the ETSI. As a first step in developing these hybrid standards, each of these organisations decided to form what is called the Defence Standardisation Cooperation Group (DSCG) in order to give more structure and focus to the EU's efforts (see Figure 5). Formerly known as the CEN-CENELEC Stakeholder Forum for Defence Procurement Standardisation (SFDPS), the DSCG does not develop standards itself but it aims to be the single interface between industry, governments and militaries in Europe. The second step was deciding on

what areas the DSCG would focus on and a collective decision was taken to concentrate on four specific technical areas including defence shields, impulse noise from military weapons, explosives and pyrotechnics and hearing protection (European Defence Agency, 2015a).

A year later in 2014, the Commission published yet another Communication calling for 'A New Deal for European Defence' (see COM/2014/0387) in which it reaffirmed its commitment to armaments standardisation. Here, it set down a roadmap for a competitive defence industry based on greater standardisation and certification in the areas of MIS and RPAS (European Commission, 2014b). By announcing that it would launch these two pilot areas as case studies to display the added-value of hybrid standards, the Commission set in motion a process that would see the DSCG begin to focus on tangible results. To this end, the Commission's 2015 progress report on its defence roadmap highlighted how the **Commission had been carefully studying the role of the EASA in relation to civil aviation standards and their possible application to the defence sector**. EASA was established in 2002 as an EU agency to promote the use of aviation standards and to certify and approve products and organisations in areas such as airworthiness (see more below). In fact, the Commission used its progress report to state that 'recent submissions by the industry of applications for EASA certification of dual-use [RPAS] show that EASA in close cooperation with the Commission and the Member States has a significant contribution to make in this domain' (European Commission, 2015b: p. 11).

3.1.1 European Aviation Safety Agency

Given the importance the European Commission has placed on EASA in its role in certifying military aircraft such as the A400M, it is worth also considering in more detail the role played by the Agency. EASA deals with a broad range of standardisation and certification initiatives in the civil sector and it has a growing role in discussions about the certification of RPAS. Established in 2002, EASA has a specific mandate to ensure that EU citizens and the environment are protected in the domain of aviation. In particular, the Agency serves as the EU's central regulatory and certification body and it works with Member States and national authorities towards the efficient functioning of an internal single market for aviation. EASA also works with international organisations too and it has representation offices in Montreal, Canada, Washington DC, US, Beijing, China and Singapore. More specifically, **EASA is the EU Agency responsible for certifying and approving aircraft systems for safe use in European airspace**. The Agency also works with Member States and partners to support efforts on air operations and air traffic management, to draft aviation safety legislation, provide technical advice to the Commission and Member States, and, importantly, it has the task of promoting the adoption and use of European aviation standards within Europe and on a global basis (European Aviation Safety Agency, 2018). In this respect, it has been argued in the academic literature that EASA is a part rule-making, part enforcement agency that has substantial authority when it comes to setting safety and environmental standards (Schout, 2008: p. 262).

EASA has a specific approach to certification and standardisation. Primarily, EASA works with Member States to implement EU aviation legislation uniformly and effectively. In this regard, the Agency is responsible for certifying aircraft and it does this by issuing different types of certificates including a type-certification of aircraft and its main components (e.g. engines and propellers) and a restricted type-certification for the pre-certification phase. In order to certify an aircraft on the basis of design and performance, **EASA works with national authorities to oversee the testing of aircraft and it is responsible for approving aircraft maintenance and training organisations too**. The Agency is also responsible for registering technical amendments to aircraft and parts that have been altered after EASA certification (e.g. following a technical modernisation process). While some scholars have argued that the EASA finds it difficult to enforce EU legislation because of a high degree of dependence on the Commission and the Member States, it is has been acknowledged that EASA does play an important role in mutual learning processes among national regulatory authorities and in certifying aircraft types (Groenleer, Kaeding and Versluis, 2010; Schout, 2008).

In terms of its potential importance to armaments standardisation, EASA has gained valuable experience and expertise in certifying air systems for integration into European airspace. This can be observed in relation to EASA's certification of the Airbus A400M aircraft. The A400M is a quadruple turboprop plane that can conduct missions such as strategic airlift (i.e. the delivery of heavy cargo loads such as weapons systems and equipment), tactical airlift (i.e. the transportation of troops and goods) and air-to-air refuelling. According to Airbus, there is currently a total of 63 A400M aircraft in operation (Airbus, 2018). EASA's certification of the A400M's four TP400-D6 engines in accordance with safety and environmental protection standards is **the first time that a military engine has been fully civil certified** (Europrop International, 2018). EASA first certified the A400M in April 2012 with what is called a Restricted Type Certificate (RTC). In accordance with Regulation (EC) 748/2012, an RTC means that EASA grants design approval for aircraft following registration with competent national authorities. When an RTC is issued by EASA, it is confirmed that the aircraft complies with adequate safety and environmental protection standards. In the case of the A400M, the RTC phase included certification of the TP400-D6 engine and propellers (European Commission, 2012). Full certification was approved in March 2013 following over 300 hours of flight testing to demonstrate to EASA that the aircraft was compliant with civil airworthiness and environmental requirements and standards.

EASA's approach to certification is therefore based on rigorous flight testing to assess flight functioning and reliability. Civilian certification of the A400M by EASA now serves as a base line for the certification of the A400M for military aviation purposes, and it is for this reason that EASA's certification of the aircraft is of interest to other areas of aviation standardisation – including RPAS. EASA's military certification of the A400M is challenging given that the aircraft will need to be certified by various national authorities to ensure that the aircraft corresponds and adheres to their particular military certification and qualification requirements (European Aviation Safety Agency, 2013). In this respect, the steps taken towards **the full certification of the military A400M by EASA is seen as a litmus test of improving military airworthiness in the EU** and for relations between an EU Agency such as EASA and national aviation authorities. Finally, the EASA's role here is being viewed through the prism of cost effectiveness as without the Agency the need for multiple national certifications would increase the cost of airworthiness in Europe.

3.2 NATO

NATO has a long history of developing armaments standards among its allies. The alliance began working on standardisation in 1951 when it created the Military Standardisation Agency (Schmidt, 2014; see also DeVore, 2015: p. 176). It is for this reason that the alliance can claim more direct experience with developing armaments standards than the EU. Indeed, the alliance has developed and promulgated STANAGs since at least the late 1970s. The STANAGs are NATO standards related to technologies, components, procedures, doctrines and concepts. **More than 1,200 STANAGs have been promulgated throughout and by NATO** (NATO, 2017b). The STANAGs provide for operational and technical standards for some or all alliance members with the objective being to enhance NATO interoperability. Therefore, while NATO allies own and utilise different weapons systems the STANAGs are designed to provide for a minimum level of interoperability between systems and the interchangeability of replacement components. Overall, NATO develops armaments standards in three main ways:

- NATO Standardisation Agreements (STANAGs): as mentioned, STANAGs are documents whereby allied members agree to fully or partially implement a standard for the purposes of interoperability in any given operational, capability and/or industrial domain;
- NATO Standardisation Recommendations (STANRECs): STANRECs are documents which specify standards from NATO and/or non-NATO sources that could be used for a specific system or component by NATO allies; and

- Allied Publications (APs): APs are official standardisation documents that usually accompany STANAGs and/or STANRECs and which authorise the use of a standard based on the consent of several or all NATO allies. Occasionally, APs will serve as the basis for Multinational Publications (MPs) so that non-NATO states can make use of NATO standards too without a breach of confidential information.

Without having led to the complete standardisation of systems, the STANAGs are non-binding and flexible enough to allow for three sorts of standardisation including, *compatibility*, *interchangeability* and *commonality* (Dittmer, 2017: p. 85). Each of these forms of standardisation applies to operational and administrative procedures and armaments. Additionally, each of these objectives represents a different degree of standardisation with *compatibility* representing the lowest form and *commonality* the highest level. NATO's organisational procedures for adopting standards involve multiple stakeholders (e.g. governments, militaries, industry) in a process that begins with the identification of a standardisation at the higher level of political authority. The process then continues with the technical work on the standardisation through specialised NATO bodies.

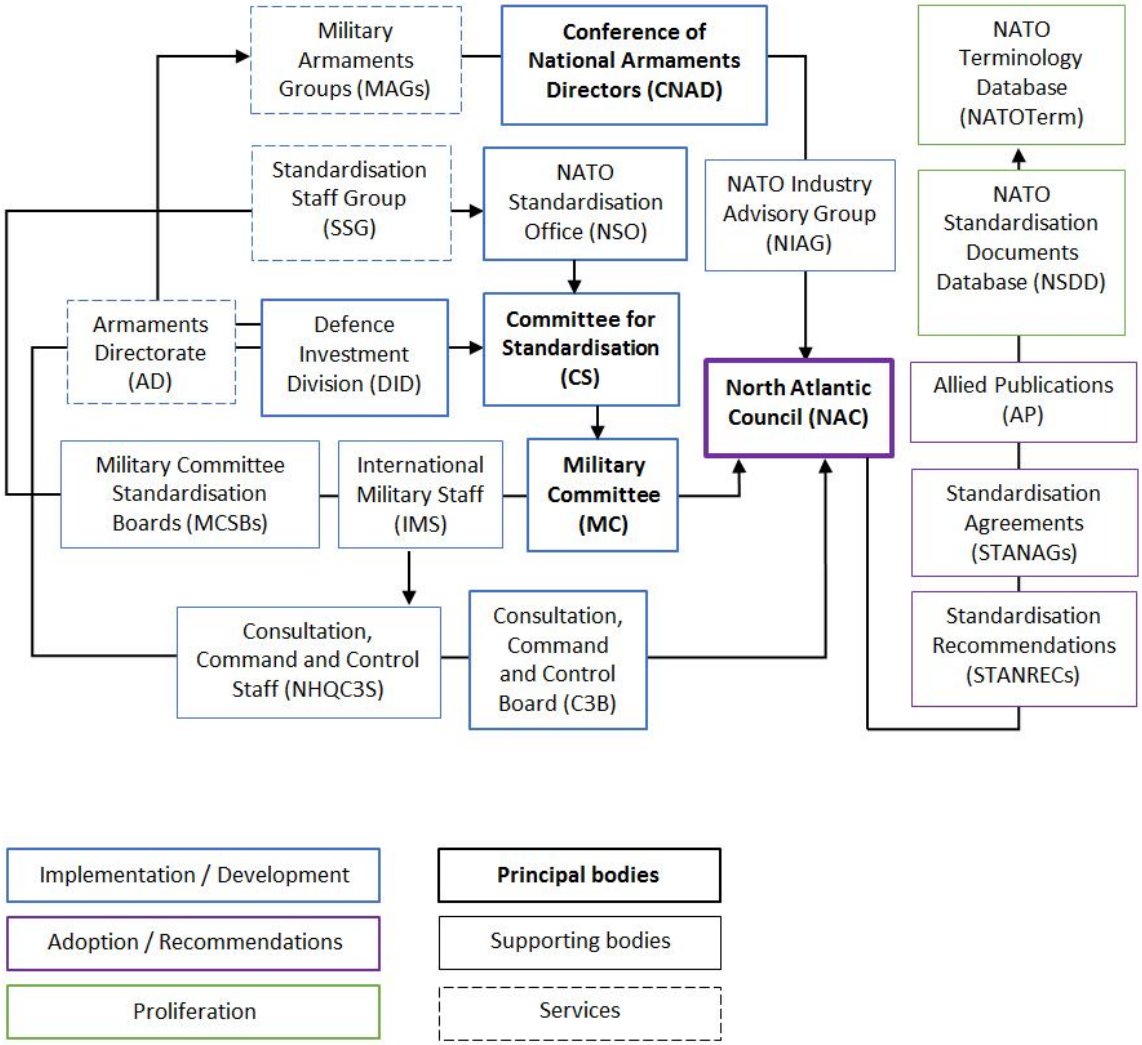
The NATO definition of a standard is 'a document, established by consensus and approved by a recognised body, which provides for common and repeated use, rules, guidelines or characteristics for activities or their results aimed at the achievement of the optimum degree of order in a given context' (NATO, 2017a). Such a definition has guided NATO efforts to enhance allied interoperability. In this regard, NATO standardises in three main areas or ways: *management*, *operations* and *materiel*. 'Management standardisation' centres on the development of rules, policies and regulations through the adoption of common terminology. 'Operational standardisation' focuses on doctrine, training and logistics. 'Material standardisation' involves the development of standards for research, testing, development, production, procurement and life cycle management (Schmidt, 2014: p. 5). It is important to note that **NATO has no sanctioning mechanism for allies who choose not to adopt and use the STANAGs**. The alliance's work in encouraging the proliferation and use of NATO standards is focused on networking, the sharing of best practices from operations and armaments production and consistent awareness raising at the highest political level.

The alliance has a proven set of institutions and bodies that deal with the question of armaments standardisation (see Figure 6). Located at the higher political echelons of NATO, the Committee for Standardisation (CS) plays a lead role in developing and adopting NATO standards and for working with civil standards. In essence, the Committee guides all of the alliance's work on standardisation and it provides guidance to all relevant NATO bodies and agencies. Created in 2001, the CS is composed of 29 senior representatives (and more than 30 partner countries through NATO's 'Interoperability Platform') from all NATO allied member countries and it answers directly to the North Atlantic Council (NAC). The Committee meets at least twice a year and it produces annual reports for the NAC. The CS is chaired by the NATO Secretary General and two permanent co-chairs deal with the day-to-day administration of the Committee: the co-chairs are the Deputy Chairman of NATO's Military Committee (MC) and the Assistant Secretary General for Defence Investment (NATO, 2015).

In addition, to these bodies the alliance draws on the expertise of the NATO Standardisation Office, which, since 2014, has pursued day-to-day work and progress on standards within the alliance. Formerly known as the NATO Standardisation Agency, and operating under the direct authority of the CS and the supervision of the MC, the NSO presides over the alliance's standardisation databases (known as the NATO Standardisation Documents Database (NSDD) and the Terminology Database (NATOTerm)) and it serves as a networking mechanism between stakeholders from allied governments, militaries and industry on all aspects of defence-relevant standards. A core task of the NSO is to provide the MC with support in developing operational standards, and the Office also serves as a liaison for the MC's Standardisation Boards (MCSBs), as well as playing a consultative role during the NATO Defence Planning Process (NDPP). The NSO is directly supported in its work by a Standardisation Staff Group (SSG), which is comprised of staff-level

experts and administrators that are tasked with facilitating and promoting standardisation activities and processes across the NATO institutional framework (NATO, 2017a). The NSO is also responsible for communicating and partnering with civil standardisation bodies.

Figure 7 – NATO standardisation institutions, processes and outputs



With specific regard to standardisation of weapons systems, the Conference of National Armaments Directors (CNAD) plays a vital role in NATO because it is the body tasked with enhancing military interoperability between allies (US Congress, 1990: pp. 49-50). It does this by identifying areas of potential collaboration in the areas of research, development, production and procurement of weapons systems and military equipment. Created in 1966 and directly reporting to the NAC, the Conference meets biannually under the chairmanship of the Assistant Secretary General for Defence Investment. The work of the CNAD is supported by a number of Main Armaments Groups (MAGs) focusing respectively on land, air and naval armaments issues (Maharani, 2009: p. 334; NATO, 2016). Additionally, the CNAD is supported on industrial issues by the NATO Industrial Advisory Group (NIAG). Composed of senior industrialists and established in 1968, the NIAG is responsible for providing the CNAD and NAC with technical advice on a range of industrial issues and it proposes potential areas of armaments collaboration between allies by bringing together industrial, governmental and military stakeholders (Matthews, 1992; Lazar, 2016; Fiott, 2017b).

Additionally, the CNAD is supported by NATO's Defence Investment Division (DID) within the International Staff. The DID works on developing alliance capabilities and interoperability and the Armaments Directorate (AD) supports the DID and the CNAD with expertise and administration. The DID is supported

by NATO Headquarters, Consultation, Command and Control Staff (NHQC3S) too, which also has a responsibility for developing and influencing standards within the alliance. The NHQC3S is a joint body shared by the DID and the International Military Staff (IMS) and it supports the development of standards in relation to C2 and cyber matters. In this regard, the NHQC3S advises the NAC, the MC and the Consultation, Command and Control Board (C3B). The C3B meets biannually and it reports to the NAC, and, as well as advising the CNAD, it helps to recommend standards in relation to communication and informatics, navigation, cyber and dual-use capabilities. It oversees the work on NATO's Interoperability Standards and Profiles (NISP) catalogue of command, control and communication (C3) standards too (NATO, 2017c).

Although the STANAGs are non-binding, NATO has nonetheless developed some notable standards including STANAG 4586 which defines a C3 architecture to enhance RPAS interoperability (Webber, Sperling and Smith, 2012: p. 183). NATO has long been involved in standardisation efforts for weapons systems such as RPAS. In fact, as early as 1984 the relevant working group under the CNAD sought to study the costs of duplication in various allies that were beginning to develop RPAS programmes (Kreienbaum, 2000). In 1988, an *ad hoc* working group on RPAS in the alliance worked to standardise requirements for these programmes and in 1999, a more coordinated approach to RPAS standardisation was endorsed by the CNAD. This resulted in greater exchange of RPAS development programmes in allied countries. NATO has also addressed the dual-use nature of RPAS through the NATO Air Traffic Management Committee (NATMC) (Kreienbaum, 2000: pp. 26-27).

The issue of armaments standardisation has consistently appeared at the highest political level in NATO. Despite mixed success, the issue of standards has historically appeared in NATO through the 1999 Defence Capabilities Initiative (DCI), the Prague Capability Commitment of 2002 and the 2010 Lisbon Critical Capabilities Package (Giegerich, 2012: p. 70; see also Kapstein, 2002: p. 152). Furthermore, the NATO Summit in Chicago in 2012 gave birth to the 'smart defence' initiative with its focus on capability prioritisation, cooperation and specialisation (*Ibid.*: pp. 69-70). Overall, it has been challenging for NATO to enforce standards with alliance members given the sensitivities surrounding the development and adoption of armaments standards. Political considerations about security of supply, national industries and military requirements can conspire to challenge the rational logic underlying armaments standardisation (Sandler and Hartley, 1999; see also Hurley, 1988).

3.3 Comparing the approaches

Based on these initiatives up to the Commission's 2015 progress report, it is possible to highlight some key differences between EU and NATO approaches to armaments standardisation (see Figure 8). Institutionally speaking, NATO has an established set of bodies and a dedicated agency focusing on armaments standardisation but in the case of the EU at two least institutions – the Commission and the EDA – are responsible for standardisation. NATO has a longer track record of developing standards (in the form of STANAGs) than the EU, even though the EU has growing experience. For example, the EDA presides over the Military Airworthiness Authorities (MAWA) Forum which has developed and adopted five defence-related standards (more on MAWA in the next chapter). In the EU, the bulk of hybrid standards have been developed by the three EU-recognised ESOs: CEN, CENELEC and ETSI.

It should be noted that **the European Commission has stakeholder buy-in in the civil and security sectors**, whereas NATO has a dedicated defence-industrial advisory forum on armaments standardisation in the form of the NIAG. For example, as part of its efforts on security research and innovation the Commission established a European Security Research and Innovation Forum (ESRIF) in 2007 to serve as a bridge between the EU institutions and industry. The ESRIF played an important role in developing a public-private dialogue over the use of civil standards and it opened the door for further thinking about how civil standards could be applied to the security and defence sectors.

One area that highlights the difference between EU and NATO approaches to armaments standardisation is legislation. Directive 2009/81/EC has opened the door to setting legal parameters for defence procurement and part of this legal norm sees standardisation as a key part of opening up the European defence market. Directive 2009/43/EC is designed to facilitate cross-border transfers of defence equipment and to create a European internal market for defence. The alliance has no such mandate to develop and apply these forms of legal instruments. While NATO does not have any equivalent to the EU's defence directives, however, this should not necessarily imply that the EU can enhance armaments standardisation via legal fiat. In fact, directives are a form of EU soft law that do not have direct effect in Member States. According to a recent evaluation by the Commission, in the case of Directive 2009/81/EC its **application has been uneven across the Union and it has been under-utilised for high-value defence contracts** (European Commission, 2016b). While the directive is principally aimed at removing market distorting behaviour such as the use of defence offsets, it is nonetheless arguable whether this legal instrument has led to any substantial improvement in armaments standardisation in the EU.

Figure 8 – Comparing EU and NATO approaches to standardisation

	European Union	NATO
Civil sector buy-in	✓	
Database management	✓	✓
Defence sector buy-in	✓	✓
Legislative tools	✓	
Relevant institutions	✓	✓
Standards adopted	✓	✓
Voluntary approach to standardisation	✓	✓
Sanctioning mechanism for standardisation	✓	
Budgetary tools to support standardisation	✓	

Despite these nuanced differences, however, the EU and NATO do share a number of approaches to armaments standardisation. Both organisations rely on the voluntary adoption of standards and stakeholder consultation in order to push for the use of these standards. With the exception of the EU's defence package of directives, **neither organisation has an effective sanctioning mechanism to enforce the use of defence-related standards**. Therefore, greater effort is needed to raise awareness with governments, militaries and other stakeholders in relation to available standards and to provide advice on their application, if so required. NATO bodies such as the NAC, CS, CNAD, MC and NSO propose STANAGs to allied members and the Commission and EDA advertise hybrid standards through EDSIS and EDSTAR. In this respect, while NATO largely develops STANAGs based on the advice of the NIAG and the MC (i.e. industrial and military feedback and proposals), the EU is largely but not exclusively geared to identifying defence-relevant civil standards that are developed by CEN, CENELEC and ETSI. Either way, neither NATO nor the EU can force any stakeholder to adopt and use existing defence-relevant standards.

3.4 New EU defence initiatives

Despite the aforementioned initiatives and dynamics, however, **the EU has recently adopted a number of new initiatives that may alter the EU's approach to armaments standardisation,** and lead to greater uptake of defence-relevant standards. These initiatives principally include Permanent Structured Cooperation and the European Defence Fund. A new impetus towards armaments standardisation in the EU began with the 2016 publication of the EUGS, which explicitly called for the rationalisation and standardisation of defence capabilities. Furthermore, Council Conclusions from 14 November 2016 (see

14149/16) set out the EU's level of ambition on security and defence with a view to implementing the EUGS. In these Conclusions, the Council called on the EDA and Member States to find ways to improve 'critical enablers for co-operation such as standardisation, certification, test and evaluation, as well as training and military education, while ensuring coherence and avoiding unnecessary duplication with national and multinational structures' (Council of the EU, 2016a: p. 10). In the same month, on 30 November 2016, the European Commission published the EDAP. In this Plan, the Commission yet again outlined the importance of standardisation and certification for defence, and it highlighted its achievements in developing hybrid standards for dual-use products, in areas such as security research and cybersecurity (European Commission, 2016a: p. 16).

3.4.1 European Defence Fund

The Commission has formulated a different approach to promoting armaments standards through the use of financial incentives, in the form of the EdF. Here, the overriding logic is that EU funds can only be invested in defence research (the 'research window') and capability development ('capability window') programmes, if a minimum of 2-3 Member States participate and if it leads to common research and capabilities, and therefore interoperability and standardisation. For example, in its 2017 Communication on 'Launching the European Defence Fund' the Commission is clear that the **financial incentives provided under the EdF should 'contribute to greater efficiency in national defence spending, maximise innovation by achieving greater scale, reduce the risk of duplication, foster interoperability between armed forces and encourage greater standardisation of equipment**' (European Commission, 2017a: p. 3). The use of financial incentives represents a new and interesting approach if applied consistently and properly.

Furthermore, following the publication of its proposal for a Regulation on the EDIDP on 7 June 2017, the Commission states that one of the promising aspects of the EdF is that '**common technical specifications that will be legally required by the regulation, will drive the Member States and their defence industry towards common standards**' (European Commission, 2017b: p. 20). Breaking with past initiatives, it is clear that the Commission sees financial incentives such as the EDIDP as a way to further encourage EU Member States to standardise equipment and systems. In its position adopted after the first reading of the proposed Regulation on 3 July 2018, the European Parliament concurred that 'an agreement on common technical specifications should be a primary condition to be eligible for funding under the [EDIDP]' (European Parliament, 2018a).

Work to enhance armaments standardisation through the EdF has already begun. For example, an EU-funded pilot project on defence research worth EUR 1.4 million was used over the 2016-2018 period to fund three research programmes: 1) EuroSWARM for the development of situational awareness for military unmanned swarm systems; 2) SPIDER for the development of situational awareness in urban combat environments; and 3) TRAWA for DAA systems on RPAS. Each of these pilot projects was designed to enhance armaments standardisation in communications, sensoring, data fusion, networking, mapping and detection technologies. This work has been taken further in the context of the Preparatory Action on Defence Research (PADR) – which follows on from the pilot projects and is the preparatory initiative for a possible longer-term European Defence Research Programme (EDRP) after 2020. For example, one project financed under the PADR is the Generic Open Soldier Systems Reference Architecture (GOSSRA), which aims to **use approximately EUR 1.5 million to develop an architecture for soldiers that will improve and standardise communications and situational awareness technologies** (i.e. data collection and sensors). GOSSRA aims to use hybrid standards, and the consortium partners on the project hope that the project may serve as the basis for the development of a STANAG (European Defence Agency, 2018).

In this respect, the **PADR is not only a tool that can be used to develop NATO standards, but it may also be a tool to unlock defence-relevant civil standards**. These benefits are relevant in the context of

EU-NATO defence cooperation. Accordingly, one of the specific objectives listed in the 8 July 2016 EU-NATO Joint Declaration is to '[d]evelop coherent, complementary and interoperable defence capabilities of EU Member States and NATO Allies'. This declaration was endorsed and followed up Council Conclusions on 6 December 2016, that focused on the implementation of the declaration through 42 specific action points. The NAC endorsed the same action points in parallel. Included in these action points was the need to '[e]nhance interoperability through increased interaction on standardisation with the aim to avoid duplication in the development of standards, identify projects where standardisation-related activities could be harmonised […]' (Council of the EU, 2016b: p. 9). The Joint Declaration on EU-NATO Cooperation signed on 10 July 2018 reiterated the need for European forces to improve their interoperability.

3.4.2 Permanent Structured Cooperation

Following the 13 November 2017 notification to the Council to establish PESCO, Member States made clear that Permanent Structured Cooperation on defence 'provides a crucial political framework for all Member States to improve their respective military assets and defence capabilities through well-coordinated initiatives and concrete projects based on more binding commitments' (Council of the EU, 2017a: p. 1). This form of cooperation is comprised of 20 binding commitments and waves of capability and operational projects. More specifically, PESCO binding commitment 9 calls for a '**[c]ommitment to drawing up harmonised requirements for all capability projects agreed by participating Member States**'. Of the six elements contained under PESCO binding commitment 12, the sixth one calls for 'simplifying and standardising cross border military transport in Europe for enabling rapid deployment of military materiel and personnel'. More specifically, however, binding commitment 13 recognises the need to interoperable forces and here the PESCO notification calls for a commitment to agree on common evaluation and validation criteria and technical and operational standards for EU force packages, in alignment with NATO standards. Binding commitments 19 and 20 also reiterate the need to ensure that PESCO capability projects lead to a more competitive European defence industry and European Defence Technological and Industrial Base (EDTIB) (Council of the EU, 2017a: pp. 3-5).

All of the PESCO binding commitments are subject to an annual review (conducted at least once per year) and a strategic review (conducted at different phases e.g. 2021, 2025, etc.). Thus, in principle PESCO should combine with the financial incentives provided under the EdF to **ensure that standardisation is placed on a higher political level, and streamlined in all of the EU's current and future defence research and capability development endeavours**. In essence, both PESCO and the EdF can serve as a market pressures that can induce cooperation between industrial and governmental stakeholders. For the first time, the EU has developed an annual process that should give heads of state and government and Member States greater political oversight over the progress on armaments standardisation. Accordingly, the combination of regular political oversight and financial incentives may create a particular EU dynamic for armaments standardisation. It should be recalled that while NATO has an institutional framework that provides for political oversight for armaments standardisation, the alliance has yet to introduce financial incentives and conditionality as a way to boost the use of its STANAGs.

What is unclear at present, however, is how armaments standardisation will feature in the PESCO review processes. Here, questions are likely to emerge with regard to whether (or not) the PESCO secretariat (jointly composed of the EDA and the EU Military Staff (EUMS)) should have a specific mechanism for ascertaining whether existing defence-relevant hybrid standards are being used by national procurement agencies and armed forces. This is particularly the case with regard to the PESCO projects that have standardisation as a core feature of their work. For example, there are already PESCO projects that seek to standardise national medical sanitary principles, medical command concepts, radio-defined software, logistics concepts and procedures, cross-border transport procedures and more (Council of the EU, 2017b). In combination with EdF projects, PESCO projects that experience a high degree of standardisation could

be used as case studies, to be presented to the European Council as evidence of the benefits of armaments standardisation.

4 EU experiences with hybrid standards

The aim of this chapter is to look into more detail at the EU's approach to armaments standardisation. It does so through an analysis of two case studies that derive from the European Commission's 2014 Communication that elaborates a roadmap for more enhanced European defence cooperation. The two case studies include standardisation and certification for MIS and RPAS. The analysis in this chapter is therefore divided between these two studies and each dedicated section aims to provide information on the importance of each capability domain to the EU, the specificities of developing and certifying standards in these areas and how various actors at the EU level act in relation to the development of hybrid standards. Based on the analysis of these case studies, the chapter also proposes other capability and technology areas that could be exploited by the EU in the future in relation to the development of hybrid standards. This section of the chapter is particularly pertinent given initiatives such as the EdF and PESCO, and the need to define projects for the PADR and the EDIDP up to 2020 and beyond.

4.1 Maritime information sharing

In the context of technological developments and increased digitalisation, MIS is an increasingly important element of the EU's overall maritime strategy. The maritime domain is home to technologies such as cloud services, big data, the Internet of Things (IoT), autonomous vessels and blockchain (e.g. for supply chain digitalisation and real time cargo tracking). Digitalisation in the maritime domain is a key commercial and security driver and enabler. For example, in its 2018 Crew Connectivity Survey of 5,889 respondents, Futurenautics showed that between 2015 and 2018 there was a **45 % increase in internet usage on board bulk carriers, a 40 % increase for container ships, 33 % for general cargo and 41 % for tankers** (Futurenautics, 2018: p. 23). Crew members and masters carry a range of technologies on board maritime vessels including laptops, tablets, smart phones, wearables, etc. Furthermore, the maritime domain has seen the introduction of autonomous systems for the purposes of surveillance, safety and inspection. In this respect, the standardisation of models, sensors, semantics and codes and recorders is important with potential economic and security benefits.

MIS is vital to the proper functioning of the maritime domain because it can enhance security, ensure port integration, facilitate efficiency in global supply chains and protect the environment. MIS infrastructures include satellite sensing, communications, geographic information systems, visualisation systems, web services, sensor networks and autonomous systems. These technologies may improve navigation, fuel usage, meteorological awareness, maintenance, training, performance, procurement and supply. The use of such technologies and systems helps maintain the proper functioning of vessels and it ensures control integration between ports and the land. **The mining, analysis and use of data are vital elements of MIS as diverse and numerous maritime factors can be used to improve security and enhance competitiveness**. Yet data collection is only half of the story as it is more costly and more technologically challenging to fuse maritime information for a defined purpose. Given the diverse actors involved in the maritime domain, standardisation is seen as a way to create consistency and reliability when sharing maritime information.

However, the maritime domain is characterised by its own specific economic and security factors. First, it is marked by potential choke points, pollution, environmental degradation, natural disasters, territorial disputes, terrorism, piracy and human and narcotics trafficking. Second, **the maritime domain is affected by sizeable communications distances and there is a high degree of traffic**. A number of stakeholders and economic actors use the maritime space with government agencies (coastguards, border guards, navies) operating alongside economic operators (shipping companies, insurance firms, natural resource

exploiters (oil, gas, wind)) and others (oceanographic agencies, marine scientists). Each of these actors has different MIS needs (e.g. defence actors may require higher resolution imagery and positioning than other actors) and so standardisation becomes even more challenging.

Standardisation of MIS is further complicated by the risks posed by cybersecurity. A lack of resilience to cyber risks and threats can have far-reaching implications for information security and privacy, and it can lead to a loss of financial investments and insurance-related liabilities. In this respect, the standardisation of technologies and procedures of cybersecurity in the maritime domain is a critical pillar of the EU's steps towards a single cybersecurity market (European Commission, 2017d). Cyber resilience is an increasingly important element of MIS. As the same 2018 Futurenautics crew survey shows, **while more than 65 % of 5,889 crew members surveyed said they felt confident using new technologies, 47 % of respondents stated that they had sailed on a vessel that was the target of a cyber-attack** (Futurenautics, 2018: p. 28). In this respect, it is clear that steps towards MIS standardisation have both economic and security dimensions in a context where a multitude of maritime actors have different business and public policy needs and requirements.

4.1.1 EU engagement with MIS standardisation

In the 2014 EU Maritime Security Strategy (EUMSS), information sharing was made a priority and it called for an 'enhanced common situational awareness and better sharing of information, operational concepts, *modi operandi* and experience' (Council of the EU, 2014a: p. 6). As the Strategy goes on to state, '[i]ntegration of different data sources in the maritime domain on the basis of existing national and international law is a key task […] the more information is aggregated and integrated, the more complete is the maritime picture created and more value is delivered to the operational end-users, in a cost efficient way' (*Ibid*.: p. 11). In this respect, **the EU places importance on being able to collect and share information between civilian and military authorities**, but it also stresses that standardisation and certification are key enablers for civil-military interoperability and competitiveness (*Ibid*.: p. 12).

Building on the EUMSS, the 2014 action plan seeking to implement the strategy highlighted a number of priority areas for standardisation and certification including for port and maritime transport security, harmonising requirements for the next generation patrol vessels and systems, training of maintenance personnel, energy efficiency and cybersecurity (Council of the EU, 2014b). The revised EUMSS action plan of 2018 stresses the importance of maritime surveillance and it proposes the development and consolidation of initiatives such as the Common Information Sharing Environment (CISE) and the Maritime Surveillance Network (MARSUR), plus it aims to better link together relevant Agencies such as the European Fisheries Control Agency (EFCA), the European Maritime Safety Agency (EMSA), the European Border and Coast Guard Agency (Frontex) (European Commission, 2018a: p. 1) and instruments such as the Copernicus Security Service for maritime surveillance. One policy challenge is **to enhance coordination between the multitudes of EU bodies that are involved in MIS**. Nevertheless, the EU has taken a number of steps to enhance MIS, including:

Union Maritime Information and Exchange System (SafeSeaNet)

Since 2002, the EU has maintained a data sharing platform for vessel traffic monitoring called Safe SeaNet (SSN). The monitoring and information system is hosted by EMSA and it brings together national authorities to share information on maritime safety, environmental protection and maritime traffic. Established under Directive 2002/59/EC and using established industry standards, SSN makes it easier for maritime actors such as masters, owners, agents, operators, etc. to exchange maritime information. **Standardisation has played an important role in the establishment and functioning of SSN** and there may be lessons-learned for recent initiatives such as CISE. Maritime operators need to provide information to SSN and this includes information such as the technical names for dangerous and polluting goods and ship identification

information, all of which rely on international standards. The SSN system has developed valuable experience in awareness-raising for relevant standards (GMVIS Skysoft, 2014).

Maritime Surveillance Network - MARSUR

MARSUR is an EDA *ad hoc* Category B project that was initiated in 2006 by 18 EU Member States and Norway. MARSUR is designed to facilitate MIS through exchange of maritime information such as ship locations and movements, identification data and visualisation. As part of the project, the EDA serves as a hub of exchange between national naval and maritime authorities and it has a key task the avoidance of duplication of technologies and approaches. In terms of the project's deliverables, a live demonstration was held on 30 June 2011 between project members to prove the system-of-systems concept developed under MARSUR. A month later on 27 October 2011, 15 EU Member States signed a technical agreement to move towards a fully interoperable and standardised demonstrator architecture for MIS. Three years later on 28 October 2014, the **MARSUR Exchange System was deployed as part of the demonstration phase** and following on from this the EDA has promoted the use of MARSUR for CSDP operations and missions. To this end, the EDA sponsored MARSUR training in January 2017 and a capability demonstration at the EUNAVFORMED Operation Headquarters in May 2017. In this respect, there is potential to enhance connectivity with national information systems and to promote greater use of MARSUR capabilities across the EU (European Defence Agency, 2017a).

Common Information Sharing Environment - CISE

The EU is currently developing a CISE for the maritime domain and it is designed to facilitate the exchange of information and integration of surveillance systems and networks across the EU's more than 400 maritime authorities (European Commission, 2016c). With a planned operational timeline of 2020, project members are currently working on the development of standards for IT solutions where a harmonised approach to data modelling, terms, conventions, meanings and data formatting can be achieved (European Commission, 2014c). Such efforts are taking place under a Framework Programme 7 project called EUCISE2020, which includes 15 Member States and 50 public authorities (European Commission, 2018b). Interestingly, standards are being developed between the project stakeholders through ETSI which is not only assisting with the creation of standards but will also officially adopt the standards on behalf of the CISE project. However, while a range of existing civil standards will be scanned under CISE it should be noted **that a key challenge for MIS standardisation more generally is that standards may not exist**, and when they do, they may not always match the needs of all customers or stakeholders. This problem is particularly acute with regard to defence actors because of specific naval needs and requirements.

Ocean 2020 - PADR

Under the EdF/PADR a project called Ocean 2020 has been initiated worth some EUR 35 million with the aim of boosting maritime surveillance and interdiction missions at sea (this is the largest single grant awarded under the PADR so far). The project, which started in April 2018, **aims to integrate RPAS and unmanned subsurface vehicles into the EU's fleet operations by providing naval commanders with an enhanced situational awareness**. Ocean 2020 will see cooperation among 42 partners from industry and research institutes across 15 Member States and the objective is to stage live demonstrations of the project in the Mediterranean Sea in 2019 and the Baltic Sea in 2020. While it is too early to ascertain whether the project will be successful in terms of standardisation, it should be noted that Ocean 2020 is a 'system-of-systems' programme and that many of the enablers of the overall system (and their constituent components and technologies) such as unmanned helicopters may already conform to hybrid standards. Ocean 2020 offers a **good opportunity to develop and utilise standards at an early stage of capability development**.

Harbour and Maritime Surveillance and Protection (HARMSPRO) - PESCO

One of the projects launched within PESCO in 2018 relates to harbour protection and maritime surveillance (HARMSPRO). As project participants Italy, Greece, Spain and Portugal hope to deliver a new maritime capability that will allow the EU to enhance security in its littoral waters and harbours by **improving surveillance and protection through the integrated use of sensors, software and surface, subsurface and air assets**. The project began in May 2018 and in a similar vein to Ocean 2020 the project should build on existing standards (Council of the EU, 2017b).

4.2 Remotely Piloted Aircraft Systems

RPAS have a recognised and demonstrable civil and military application and they can be used for a range of security and defence-related activities including surveillance, disaster relief, environmental and enforcement monitoring, border control, crisis management and much more. According to the European Commission the **RPAS sector is likely to employ more than 100,000 people and earn over EUR 10 billion per year by 2038** (European Commission, 2018c). Technologically speaking, while RPAS technology has improved development is still underway in many key technology areas especially with regard to C3, DAA and space/satellite links. In this respect, there is an opportunity to enhance standardisation in technical domains such as sensors for imagery and situational awareness, data links and self-protection devices especially given the uptake of RPAS for a range of commercial and public purposes. Nevertheless, despite technological advances in the RPAS technologies the fundamental concern is that the 'absence of a pilot on board […] brings the challenge of matching the ability of the pilot to "see and avoid" and "remain-well-clear" of other traffic and dangerous situations, such as potential collisions with other airspace users or obstacles and severe weather conditions' (International Civil Aviation Organisation, 2018: p. 2).

One of the key challenges facing the EU with regard to RPAS and standardisation relates to the integration of civil and military RPAS into European non-segregated airspace. A key aspect of the integration of RPAS into European airspace relates to the technological maturation of RPAS systems as there remain questions about a loss of C2 links between pilots and systems, a loss of data links between the RPAS system and ground control stations, a loss of geographical positioning system signals and a loss of engine control. As the Commission's EDAP makes clear, while initiatives such as the Single European Sky (SES) and the Single European Sky Air Traffic Management Research Joint Undertaking (SESAR JU) are principally focused on civil aviation there is **a growing need for military requirements to be taken into consideration when developing standards and for certification** (European Commission, 2017; see also Lavallée, 2017). This recognition is vital in a context where RPAS are used for security and defence purposes, which means that there could be potential cost efficiencies with regard to R&D. Given the technological specificities of RPAS, their usage in European airspace has been limited because the technology must subscribe to higher levels of safety than can perhaps currently be achieved (European Defence Agency, 2007: p. 21). Standardisation therefore could result in RPAS technological development and safe integration into European airspace.

4.2.1 EU engagement with RPAS standardisation

The EU's response to these challenges is noteworthy. Starting in 2012, the European Commission established a 'European RPAS Steering Group' (ERSG) to serve as a hub for key stakeholders involved in the integration of RPAS into the European airspace, including EASA, the European Organisation for the Safety of Air Navigation (EUROCONTROL), EUROCAE, SESAR JU, EDA, the European Space Agency (ESA) and many other areas (European Commission, 2013: p. 4). One of the first substantial activities of the ERSG was to produce a 'Roadmap for the Safe Integration of Civil RPAS into the European Aviation System' and the ERSG's final report **identified three key areas of focus including regulation, research and societal impacts**. One of the major conclusions from the final report was that there was a clear need for military requirements and needs to be considered when working towards the safe integration of civil RPAS. The

report also reiterated the importance of R&D and the role this can play in proposing new standards for C3, DAA and flight operations (i.e. taxi, take-off and landing) (*Ibid*.: p. 8).

Based on the findings of the ERSG roadmap and report, the SESAR JU started to integrate military RPAS requirements into the overall SES initiative and the inclusion of RPAS is now an important feature of the European ATM Master Plan. To this end, an expert group was established in 2016 to **develop a dual-use strategy for RPAS regulation**. Following the initiation of nine demonstration projects starting in 2013, the SESAR JU confirmed such developments by stating that following its demonstrations five key areas needed addressing before RPAS could be safely integrated into the European airspace: 1) the harmonisation of regulations and certification; 2) policies and procedures for interaction between air traffic control and RPAS; 3) DAA capabilities and compliance with established requirements; 4) reliable C3 capabilities and linkages; and 5) training and licencing for RPAS pilots (SESAR, 2016: p. 8).

EU agencies such as EASA and the EDA and European organisations such as EUROCAE are responsible for a range of RPAS-related activities. For example, **EUROCAE has a dedicated working group on RPAS** (labelled WG-105 / Unmanned Aircraft Systems) with the aim of developing standards and guidance documents for RPAS integration into non-segregated European airspace. WG-105 is sub-divided into six teams that work on issues such as traffic management, C3, DAA, airworthiness, risk assessments and ERA. Each of these focus areas relies on the expertise of industrial representatives from companies such as Airbus, Leonardo, Saab, Safran, Thales Group and a range of specialist firms. In developing standards for RPAS, EUROCAE works with international partners such as RTCA (an international public-private venture) that are developing minimum operational performance standards for RPAS. RTCA's special committee SC-228 was established in May 2013 and it brings together European firms and operators with counterparts from the US (e.g. Rockwell Collins and Boeing) (RTCA, 2018).

Beyond these initiatives, the EU's experiences in relation to RPAS standardisation takes many forms ranging from the standardisation of on board RPAS technologies and enablers (i.e. sensors and data networks) to the certification of RPAS for the purposes of military airworthiness and civil airspace integration. Past and recent initiatives include:

Military Airworthiness Authorities Forum (MAWA)

One notable success with regard to standardisation relates to the harmonisation of military airworthiness regulations. Initiated in 2008, the MAWA Forum has been tasked by European defence ministers to develop a common regulatory and certification framework for military airworthiness. As the chair of the MAWA Forum the EDA serves as a facilitator and networking hub for the MAWA participating Member States and the Forum partners and liaises with EASA, NATO and the Aerospace and Defence Industries Association of Europe (ASD Europe). These states retain their sovereign rights with regard to the adoption of airworthiness regulations but through the MAWA Forum they have pushed for mutual recognition. It is noteworthy that the MAWA Forum has led to tangible results with the adoption of five European Military Airworthiness Requirements (EMARs) including for aircraft certification (EMAR 21), aircraft maintenance (EMAR 145), training organisations (EMAR 147), personnel licencing (EMAR 66) and management of continued airworthiness (EMAR M). In partnership with EASA, these EMARs have already been applied in support of the service support for the A400M transport aircraft being (to be) used by Belgium, France, Germany, Luxembourg, Spain and the United Kingdom. **EMARs are the first military airworthiness requirements to be developed in the world, and even non-EU states such as Australia have started using them** (European Defence Agency, 2018e: p. 46). To build on this work, in 2013 the EDA and EASA signed an agreement to apply the EMAR experiences to airworthiness of systems such as RPAS and a working group was established in 2014 to harmonise airworthiness requirements for RPAS (European Defence Agency, 2017b).

Mid-air Collision Avoidance System (MIDCAS)

The MIDCAS project was initiated in 2009 as an EDA Category B project to move towards the integration of RPAS into non-segregated airspace. In April 2013, the first test flight was conducted to demonstrate the ability of RPAS to operate safely Beyond the Line of Sight (BLoS) and more test flights were conducted in 2015. These test flights were designed to develop image processing algorithm, sensor models, visible band cameras and an infrared camera. Interestingly, the MIDCAS project served as a platform for the Agency to work closely with EUROCONTROL, EUROCAE and the EASA on RPAS integration which was important given the vital linkages between these bodies for civilian aviation. For example, EUROCAE (under its Working Group WG73) was involved in the systems engineering phase of the project where any standardisation-related issues could be immediately communicated to EUROCONTROL, EASA and NATO. As a follow up to the project, **a standardisation support phase was initiated with the objective of demonstrating DAA functions in RPAS**. This phase resulted in technical feedback and analysis for collision avoidance standardisation. In short, many civilian based DAA technologies could be of use to the defence sector and the eventual integration of military RPAS into European airspace.

Demonstration of Satellites Enabling the Insertion of RPAS in Europe (DeSIRE II)

Following the DeSIRE I project from 2011-2013, in 2015 the EDA and the ESA launched a second DeSIRE project designed to support the development of government, institutional and commercial services provided by RPAS operating in non-segregated airspace (European Defence Agency, 2015). The project ran for 18 months and had a budget of EUR 2.6 million in order to demonstrate the safe operation of RPAS in civilian airspace. Much like DeSIRE I, this second **demonstration project sought to test fly RPAS using a satellite link for airspace traffic management**. It achieved this on 18 November 2016 and 5 April 2017 following demonstrations and simulations designed to test the performance of Satellite Communications links with RPAS units (European Space Agency, 2015). Additionally, the EDA has developed a number of other initiatives including a European Medium Altitude Endurance (MALE) RPAS user community in 2013 to serve as an interface for users in relation to exchange information on operational experiences and possible avenues for cooperation on training, logistics and MRO. Furthermore, the EDA has initiated a number of pertinent projects including the 'Enhanced RPAS Automation (ERA)' project in 2015 to enhance RPAS automation for take-off, landing and taxi. Additionally, it should be noted that in February 2018 the EDA launched a market survey calling on operators to provide information to the Agency on commercially available RPAS solutions for the purposes of improving the EU's situational awareness in crisis management – the deadline for responses was 31 March 2018 and the results are still pending (European Defence Agency, 2018). Again, here it is hoped that civilian technologies that already bear civil standards can be used for the purposes of defence.

Standardisation of RPAS Detect and Avoid (TRAWA) – Pilot Project

Launched as one of three projects under the pilot project on defence research, TRAWA was awarded a grant worth EUR 433,000 to standardise DAA sensors on board RPAS and to develop requirements for a remote pilot human-machine interface. The TRAWA project is also designed to lead to the successful integration of RPAS into civil airspace based on DAA technologies. The underlying logic of the project is that there is **a clear need for standards in relation to the exact separation distance between an RPAS pilot and the RPAS and the response times that need to be adhered to when the RPAS detects a nearby aircraft**. Such standards will be of use to civil and military RPAS pilots and for air traffic control management systems in Europe (NLR, 2017). To this end, the EDA has already begun its cooperation with EUROCAE and EASA and the project will follow EUROCAE's ED78A standardisation procedure (European Defence Agency, 2016). This standardisation procedure provides guidelines for the approval of the provision and use of Air Traffic Services (ATS) supported by data communications. In effect, ED78A sets the minimum operational

performance specification for ATS. A first public workshop on the TRAWA project was held in September 2017.

4.3 Enhancing the EU approach to standardisation

The examples of the EU's approach to and experiences with MIS and RPAS display growing EU action on armaments standardisation. Notwithstanding the inherent challenges associated with armaments standardisation, EU bodies such as the Commission, EASA and EDA, have not neglected the importance of standardising and certifying key technology and system domains. It is clear from the analysis above that the **EU's process of armaments standardisation is a decentralised one, with the Member States and European Commission relying on specialised agencies to take the work forward**. It is also clear that the EU has put energy into developing and promoting civil standards and their potential applicability to the defence sector. Much like NATO, the EU's process of armaments standardisation can be described **as an open network of consultation, awareness-raising and demonstrations** with the objective of adopting and promoting the use of standards. With regard to the rationalisation of the EU's armaments standardisation efforts, it is apparent that a multitude of bodies are currently working on MIS and RPAS standards, and a key question is whether there is a duplication of efforts. Based on the evidence provided so far, it can be observed that the EU does rely on a number of specialised agencies that serve as interfaces with industry and the Member States, and there is evidence that EU agencies and ESOs cooperate through fora such as the DSCG.

Despite the existing level of coordination between EU agencies and ESOs, however, the issue of armaments standardisation requires clearer guidance on the part of the European Commission and the EU Member States. Thus far in the EU's evolution on armaments standardisation, the Union has developed standardisation databases, legal instruments, consultative venues and processes, lessons learned mechanisms, technology demonstrations and many more initiatives. Despite these experiences, the EU now finds itself in a position where a range of financial incentives and legally binding commitments have been developed that have a significant bearing on the Union's armament standardisation efforts. In fact, financial conditionality under the EdF and the binding commitments under PESCO mandate the use of civil and defence standards during the EU's defence research and capability development efforts. What is more, initiatives such as the EdF and PESCO open up further domains of armaments standardisation that could form the basis for EU action in the short to medium term. In what follows, it can be observed that other standardisation domains may benefit from the EU's standardisation network and approach. Such domains include but are not restricted to:

4.3.1 Military mobility

Military mobility has emerged in recent years as a crucial part of the EU's response to the security and defence of the Union. The concept hinges on the idea that **Europe's militaries should be able to move freely in the EU for operational purposes** (i.e. reassurance measures, exercises and training). Currently, a range of physical, legal and regulatory barriers hinders this free movement. Physical barriers include not having the adequate transportation infrastructure in place to physically allow for European armed forces and equipment to cross borders (i.e. load bearing on trains, load bearing of infrastructure such as railways and bridges). Legal barriers refer to the protection of personnel and equipment when they do cross borders, and issues such as social and health care, criminal liability and prosecution, data protection and the transportation of dangerous goods. Regulatory barriers relate to non-tariff barriers such as customs checks and clearances and information exchange between national transportation authorities. Removing these barriers has become a focus of the EU's security and defence efforts in the context of the EUGS and PESCO. In fact, military mobility forms one of the 17 projects that are part of the first wave of PESCO projects.

The task of improving military mobility in Europe assumes close coordination between EU bodies such as the Council of the EU, the EDA, the European External Action Service (especially the EUMS), the EU Military Committee (EUMC) and the Commission's Directorate General (DG) for Transport, with NATO, in the context of the Joint Declarations. Thus far, the EDA has developed a roadmap on military mobility based on the recommendations of a working group it led (the so-called Ad Hoc Working Group on Cross-Border Military Transportation). On this basis, a Joint Communication was published on 10 November 2017 that recognised that a wide range of civil and NATO standards, and how the work already conducted by the EU in **developing hybrid standards could be applicable to enhancing military mobility** (European Commission/HRVP, 2017). Following this Communication, an Action Plan was released on 28 March 2018 showing the way forward for the EU in terms of marrying up transportation infrastructure and legal instruments with the military requirements of Europe's militaries (European Commission/HRVP, 2018). More concretely, in early 2018 the European Commission proposed to commit EUR 6.5 billion under the next Multi-annual Financial Framework (MFF) towards improving civil-military infrastructure for military mobility, over the period 2021-2027.

Yet a key challenge that needs further attention is how **to ensure that existing civil and hybrid standards can apply to military mobility, in the face of often diverse military requirements** in each Member State. While work is ongoing to scope out the potential of utilising trans-European Transport Network (TEN-T) infrastructure for military mobility, it is important to align military requirements and civil standards. In this respect, the work being conducted by the EDA and the EEAS in surveying existing civilian rules with regard to customs arrangements and military requirements (work due to be ready by spring 2019), is important. However, it appears as though there is still a need to specifically study the issue of hybrid standards in more detail. Here, a possible way forward could be to ensure that the DSCG has a greater focus on military mobility standardisation. This is important given the horizontal nature of military mobility and how it touches both MIS and RPAS standardisation, too. Consider, for example, how CEN has developed over 260 specific standards for tram and railway engineering in relation to track safety, noise emissions and more (European Committee for Standardisation, 2018b). Such standards have a potential benefit to the development of any new and/or modernised transport infrastructure under military mobility.

4.3.2 Cyber defence

A major element to the EU's defence and standardisation efforts relates to cyber defence. Cyber defence is of growing importance across all domains of the EU's activities on promoting cyber resilience and combating hybrid threats. In the specific context of the CSDP, cyber defence is particularly important because it may have implications with regard to the EU's Solidarity (Article 222 TFEU) and Mutual Assistance (Article 42.7 TEU) clauses. Cyber defence is vital for a number of reasons including: the protection of EU forces during EU-led operations and missions under the CSDP. This is especially true given the range of C3 technologies and processes used by EU forces during crisis management operations. As the European Parliament's Resolution on cyber defence of 13 June 2018 makes abundantly clear, there is a continued need at the EU level to ensure that '**cyber defence requirements and standards' are integrated 'into the planning and conduct of missions and operations**' (European Parliament, 2018b). To this end, the EU has thus far integrated cyber defence into its regular crisis management exercises (e.g. MULTILAYER 2016 and PACE17), and a first table top exercise on cyber defence (EU CYBRID17) was held on 7 September 2017. These exercises emerge as part of a broader EU approach to cybersecurity including the Cyber Security Strategy, the Protocol on Countering Hybrid Threats and the transposition of the Network and Information Security Directive (see 2016/1148). Furthermore, within PESCO, the 'EU Cyber Rapid Response Force' project also seeks to bolster the EU's cyber defences, and training on cyber defence is underway under the auspices of the European Security and Defence College (ESDC) and the EDA.

Cyber defence is an issue that branches into many other policy areas (transport, aviation, health, trade, etc.), and for this reason a 'whole-of-EU' approach is required to developing and promoting hybrid standards for

the purposes of cyber defence. In this respect, standards can be developed and/or adopted for technology development and usage, administrative procedures, resilience, etc. On this basis, it is incumbent **on EU institutions to study the application of hybrid standards for cyber defence**. For example, consultation with EASA, European Centre for Cybersecurity in Aviation (ECCSA) and the NATO Cooperative Cyber Defence Centre of Excellence (CCD COE) should be continued and enhanced on addressing aviation-relevant standards that could be applicable to cyber defence. With regard to space-based capabilities, there is a clear benefit to consulting the ESA with regard to improving the cyber resilience of satellites and space infrastructure through the development and use of hybrid standards. In this respect, greater attention to the EU's Cyber Defence Strategic Research Agenda (CSRA) is needed, and relations between the EDA, Commission, ESA and the European Cyber Security Organisation (ECSO) and relevant ESOs, should be advanced.

4.3.3 Energy management for defence

Energy management for defence is an increasingly essential issue for governments and militaries in Europe, and effective management of **energy generation, supply and storage has implications for security of supply and operational effectiveness**. Interestingly, energy management is being developed within PESCO under the 'Energy Operational Function' (EOF) project. EOF has as its main objective to develop new systems of energy supply for military camps in the field, and to integrate energy efficiency in the development of new combat systems. In a context where there is significant scientific and technological progress on energy storage systems, and where clean energy is increasingly playing a role in renewable energy strategies, the military plays an important role in practicing energy management and investing in energy management R&D (Nuttall, Samaras and Bazilian, 2017; see also Fiott, 2014b). In this respect, a range of existing environmental standards is applicable to the defence sector, including ISO 50001 on Energy Management Systems and Near Zero Energy Buildings (NZEBs) standards. Yet, transferring civil energy management standards to the defence sector is challenging for many reasons.

According to a study conducted by the EDA in 2017, the challenges associated with standardisation and energy management in defence include: 1) a lack of energy management reviews by defence organisations with a view to stocktaking existing environmental standards; 2) **the energy requirements of operational buildings and infrastructure do not necessarily adhere to existing standards,** because of different and defence specific needs such as great energy demand; 3) a lack of agreement between the Member States on a clear definition of NZEB standards; 4) not all defence infrastructures located on one site as a cluster of buildings have the same energy needs; 5) no common operational procedures for energy standards in EU-led military missions and operations under the CSDP (European Defence Agency, 2017c).

The EU has already initiated a number of projects and formed consultative bodies on energy management in defence, including the Consultation Forum for Sustainable Energy in the Defence and Security Sector (CF SEDSS) and the European Defence Energy Network (EDEN). Initiatives such as CF SEDSS and EDEN have led to work on photovoltaic power generation, the use of defence estates and alternative fuels. Nevertheless, there is still some way to go before civil standards related to energy management are fully accepted and adopted by militaries and ministries of defence in the EU. **The Member States still retain certain exemptions from the EU's energy efficiency legal framework**, including the Energy Efficiency Directive (see 2012/27/EU) and the Renewable Energy Directive (see 2009/28/EC). Therefore, building on these efforts within the context of the Commission's overhaul of the ESS and the introduction of PESCO and the EdF, could be a profitable work avenue to improve the EU's operational effectiveness and cost efficiency in defence.

5 Conclusion

The standardisation of armaments has been a long-standing focus of EU efforts to enhance the Union's military effectiveness, to improve capability development, and to support the competitiveness of the European defence industry. Armaments standardisation is a process that can lead to cost savings for defence spending, by injecting added-value in defence production processes and the avoidance of capability and equipment duplication. **Standardisation is a method of improving interoperability within and between European armed forces and a process that is can enhance the operational effectiveness of Europe's militaries**. Both the EU and NATO have taken measures over many years to enhance armaments standardisation in Europe. Yet the nature of the contemporary global defence market is that many more technologies and components integrated into military systems are sourced and/or produced in the civilian sector. The line drawn between defence equipment and capabilities and civilian products and technologies is increasingly blurred.

This study has highlighted the complex nature of standardisation, and it has explained how standardisation can broadly be defined as a process leading to the continuous, repeated and efficient use of technical guidelines, processes and rules. **Standardisation in a European context has tended to be of a voluntary nature, with the need for consensus between a range of stakeholders from industry, governments, international organisations and civil society**. A challenge in promoting the adoption and use of standards is that there is little in the way of an enforcement mechanism to mandate the use of standards by industry, governments and armed forces. This study has also stressed the challenges associated with armaments standardisation, especially with regard to the role that civil standards or hybrid standards may play in the defence sector. Furthermore, there is sometimes disagreement over whether standardisation can reduce costs while also maintaining competition in the market place. Finally, this study has shown how the use of open standards in the defence sector can be problematic, given the need to maintain security of supply.

This study has shown how **the EU and NATO broadly apply a voluntary and negotiated approach to the development and adoption of standards**. As highlighted in chapter three, the STANAGs are not binding standards. It has also indicated that the different membership composition of each organisation affects the style of the approach. The EU has no overarching hegemon such as the US in NATO, so supranational institutions such as the European Commission can play an influential role. Nevertheless, in the context of the EU-NATO Joint Declarations, it is clear that European members of both the EU and NATO expect the two organisations to work closely on armaments standardisation. In both organisations, there is an emphasis on maintaining databases and registers of applicable standards (i.e. NSDD, NATOTerm, ESTAR and EDSIS), networking among key stakeholders and awareness-raising within the military planning and defence procurement community. One key difference between the EU and NATO is the existence of EU soft law on defence procurement, with an effect on standardisation (e.g. the defence directives). Despite these efforts, however, this study has argued that new defence initiatives such as PESCO and the EdF may well lead to greater emphasis on and up-take of defence-relevant standards, in line with Council Conclusions since 2016 and the EUGS.

Nevertheless, the EU and NATO have already taken a great number of steps to enhance armaments standardisation in Europe. **Armaments standardisation has been on the policy agenda of the EU and NATO for many decades, and a range of measures has been developed,** including databases, working groups and – most crucially – standards themselves. To highlight the EU's approach to armaments standardisation, this study focused on the cases of MIS and RPAS standardisation. The study has shown how the EU adopts a network approach to developing standards, and how central authorities such as the European Commission rely on specialised Agencies such as EASA and the EDA to maintain relations with key stakeholders such as industry and governments. Agencies play a key role in armaments standardisation,

although there is a need to avoid duplication of efforts and to guarantee that the work packages, policy findings and work practices of each EU Agency feeds into the EU's overall standardisation efforts. This study has also speculated on other policy domains that could benefit from enhanced coordination and support with regard to the development and use of hybrid standards. These domains included military mobility, cyber defence and energy management as growing areas of the EU's security and defence.

5.1 Recommendations

Building on these broader observations about EU armaments standardisation, it is possible to note a number of areas, challenges, and issues, that could be addressed as part of the EU's standardisation efforts. These recommendations range from a reiteration of existing measures that should be supported, to potentially new avenues for further cooperation on hybrid standards. The recommendations based on this study include:

- **Enhance inter-institutional cooperation** – one of the approaches taken by the EU is to cluster bodies and agencies into for a, in order to discuss and develop approaches to armaments standardisation. Such fora include the DSCG, and bodies such as EDA, Commission and the ESOs are involved in regular discussions, including with NATO and other ESOs such as EUROCAE when necessary. These fora are indispensable not only because they facilitate networking and awareness-raising, which are vital to the development and adoption of standards, but because they allow specific expertise and interests to be channelled into standardisation processes. Here, defence firms should be actively brought into discussions and at the earliest stages of defining standards. For example, the EDA is able to provide input on the defence-specific interests and nature of standardisation and to share it with ESOs. Yet, as has been indicated with regard to initiatives such as military mobility, cyber defence and energy management, many more industrial stakeholders may need to be brought into the discussions taking place in the DSCG. This is not a specific call to replace the DSCG with another body, but rather to indicate the need to manage the proliferation of actors and stakeholders that have a role in armaments standardisation. It is recommended that each organisation involved in hybrid standards conduct a collective auditing of success stories and failures with regard to the use of hybrid standards.

- **Leverage the European Defence Fund** – the EdF represents an opportunity to advance the development and adoption of hybrid standards in defence research and capability development. In theory, the financial incentives offered under the EdF could significantly advance armaments standardisation. This study assumes that the conditionality attached to the PADR and the EDIDP will be maintained after 2020, with the further elaboration of the 'research window' (with a possible EDRP) and the 'capability window'. In order to seize the opportunity afforded by the EdF, careful consideration needs to be given to the optimal phases from basic defence R&D right up to the commercialisation of defence capabilities where the use of hybrid standards should be emphasised. In particular, it may be necessary to adopt a life-cycle approach to capability development under the EdF in order to potentially reduce costs at the R&D and MRO phases of EdF projects (especially by using the Financial Toolbox and drawing on existing STANAGs). The test phases of both the PADR and the EDIDP represent an opportunity to highlight lessons learned on standardisation for EdF support after 2020. EdF projects should serve as 'best business cases' for standardisation. Early experiences could lead to an eventual dedicated share of EdF funding to standardisation, but first there is a need to identify the most effective areas of standardisation as the EdF progresses.

- **Operationalise Permanent Structured Cooperation** – the PESCO annual and strategic reviews offer the EU an opportunity to take stock of armaments standardisation efforts, and to promote best practices among Member States. In line with the Council Conclusions from 14 November 2016 (see 14149/16), each of the review processes should be used to highlight how Member States have

progressed on standardisation in relation to PESCO binding commitments 12, 13, 19 and 20. In particular, each annual review could incorporate and call for standardisation practices before new waves of PESCO projects are agreed (especially if these PESCO projects will benefit from funding under the EdF). Indeed, even the National Implementation Plans (NIPs) could be used to ascertain how each relevant national authority is (or not as the case may be), integrating hybrid standards. For the longer-term PESCO strategic review, each phase (2021, 2025 and beyond) could be used as a stock-taking exercise to measure the degree of standardisation for each PESCO project, and whether standardisation is promoted as part of the management practices of each project. For such an exercise to be operationalised, it will be incumbent upon the PESCO Secretariat (working in close tandem within the DCSG and with ESOs and dependent on institutional resources) to design a benchmarking system, to measure the progress of each project and how they are managed. Such a system will rely on EDSIS and EDSTAR, but it should also work closely with NATO and capability development management bodies, such as OCCAR.

- **Promote EU defence-related legislation** – following the recent evaluation of the EU's defence directives, it is clear that the European Commission is working on ways to improve the consistent and even application of the directives across the EU. These efforts have a standardisation dimension that should not be lost when applying the defence directives. In this respect, the Commission should be specifically encouraged to support the Member States in fully applying the provisions of defence procurement directive Article 18(3a). Article 18(3a) provides for the need for technical specifications, based on national and international standards, to be drawn up in procurement contracts. Furthermore, with regard to the Commission's recent recommendation on supporting cross-border market access for defence and security SMEs (see EU 2018/624), there is scope for the Commission to provide further guidance to defence-relevant SMEs with regard to standardisation and certification, given that SMEs face particular challenges in this regard.
- **Optimise databases and registers** – this study does not counsel the creation of any new databases or registers, as this will serve as a distraction from the challenge of encouraging defence-relevant actors to use these databases and registers. It is already useful to have instruments such as the NSDD, EDSTAR and EDSIS. Nevertheless, this is not to say that these registers cannot be used for purposes other than the promotion of new standards. For example, there is evidence that such registers can also play a useful role in listing obsolescent standards. CEN-CENELEC have already called for EU level mechanisms that clearly identify and list obsolescent standards, and the EDA has begun scoping work on this issue (European Defence Agency, 2016c). Managing obsolescence is important because standards that are outdated or inapplicable pose a risk to life-cycle management and associated costs (European Committee for Standardisation, 2014: p. 17). A more integrated and urgent approach to obsolescence would be beneficial to actors and firms that may not always have the capacity to identify outdated or inapplicable hybrid standards. In this respect, existing databases and registers should be optimised.

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