

# Fostering advanced digital skills

In-depth look at the opportunities and challenges for  
skills in the EU's Digital Europe Programme

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## Executive Summary

This report explores the measures set up in the European Union (EU)'s Digital Europe Programme (DEP) for the years 2021-2027 to increase advanced digital skills within the EU. What are the specific actions that shall fill in the advanced digital skills gap? What is the chosen approach for each thematic area (i.e. technological field) addressed by the DEP's advanced digital skills pillar? What is the DEP's take on increasing highly skilled workforce and how does it complement other programmes and initiatives at European and national level? This report presents an analysis of the European policy landscape surrounding the digital skills issue and of the opportunities and challenges brought by the DEP's specific action for 2021-2027. The results suggest, on the one hand, that the advanced digital skills intervention under the DEP will indeed help better coordinate interventions and pooling resources for this specific challenge. The complementarities of the pillar's actions with the Erasmus+ and Horizon Europe programmes are expected to create a holistic framework to increase advanced digital skills training opportunities, which remain under-exploited in both programmes by themselves. On the other hand, the mainstreaming of the skills issue into the four other pillars of the DEP gives relevance to the actions under the advanced digital skills pillar, despite a relatively low financial investment in said pillar. However, the analysis of the DEP's advanced digital skills pillar, as well as of the existing framework to tackle the advanced digital skills have several shortcomings. The mode of implementation of the pillar (i.e. Digital Innovation Hubs) and external developments such as Brexit could negatively affect the success of the approach. In the case of Brexit, the collaboration between the Member States (MS) and the United Kingdom (UK) – the country with the largest ICT education and training offer in the EU – could suffer restrictions.

# Table of contents

Executive Summary .....	2
1 Introduction .....	4
2 Scope of the report .....	5
3 The current landscape: EU digital skills policy framework .....	7
3.1 Digital single market.....	7
3.2 A New Skills Agenda for Europe: Digital Skills and Jobs Coalition.....	7
3.3 EU renewed agenda for Higher Education .....	9
3.4 The ET 2020 Framework .....	10
4 Zoom in: The Advanced Digital Skills pillar in the Digital Europe Programme (DEP) .....	11
4.1 Digital Europe Programme.....	11
4.2 Pillar 4: implementation modes.....	13
4.3 Performance monitoring and evaluation of the pillar .....	16
4.4 Synergies between the DEP’s Advanced Digital Skills pillar and Erasmus+ (2021-2027) .....	17
4.5 Synergies between the DEP’s Advanced Digital Skills pillar and Horizon Europe.....	19
5 Strengths and weaknesses of pillar 4 of the DEP: a SWOT analysis.....	21
5.1 Internal factors .....	21
5.2 External factors .....	23
6 Conclusion .....	26
Annex .....	27
References.....	29

## 1 Introduction

The EU faces an important gap between market demand and the current share of people with advanced digital skills (European Commission, 2018:4). In light of the ongoing across-the-board digital transformation of society, this gap will increase if the EU MS do not provide an adequate response. The growing demand for basic and advanced digital skills in areas such as Artificial intelligence (AI), High Performance Computing (HPC) and Cybersecurity (CS) is not matched by the offer in most EU MS. Consequently, a majority of the EU MS face shortages of ICT professionals and experts, for software developers, analysts and database and network professionals (European Commission, 2018b:16). In 2018, the EU had 350'000 vacancies in AI, data analytics or cybersecurity (European Commission, 2018b:16). Under the next multiannual budget (covering the years 2021-2027), the EU will heavily invest in AI, HPC and cybersecurity infrastructure to match the technological needs of the MS. Even more experts with the relevant skillset will be needed in those domains. Thus, the digital reskilling and upskilling of the current working force needs to complement the efforts to increase the critical mass of people that are equipped with advanced digital skills through initial education. Despite the fact that education and training are competences assigned to individual Member States, increasing advanced digital skills overlaps with employment policy (for which the EU is competent to provide arrangements within which the EU MS coordinate policy), given the labour-market implications of the skills gap.

The European Council [conclusions](#) of 19 October 2017 addressed the opportunities in digitalisation for innovation, jobs and growth. The same conclusions stresses that a prerequisite to building a successful Digital Europe is for the EU to be equipped with adequate training and education systems, including an increase in digital skills investments. During the Council meeting, the MS agreed on the urgency of addressing the need in digital technologies, while inviting the EC to put forward an approach to AI specifically, by early 2018. The European Council [conclusions](#) of 14 December 2017 reassessed the need for MS, the Council and the EC to further examine measures tackling the digital skills challenge related to e.g. AI and cybersecurity in a lifelong-learning, innovation-driven perspective. There is therefore a common agreement on the need to act swiftly, both at the EU institutional and at the MS level.

In 2018, the EC proposed the Digital Europe Programme (DEP), the first time ever stand-alone funding programme for the digital domain (European Commission, 2018:7). The programme will run from 2021-2027 and include measures to tackle the advanced digital skills gap. Since a DEP has not existed in any similar form in the past, critical questions have been raised on its legitimacy and added value. Does the DEP differ enough from other funding programmes? Does it establish enough and meaningful synergies? Is it the right policy response to the identified challenges? Such questions are the starting point for this report, which, however, focuses on one specific challenge addressed by the DEP: the advanced digital skills gap.

## 2 Scope of the report

The present report aims at critically approaching the issue of education and training in advanced digital skills at the level of the EU as a whole, with a focus on the DEP. As it is not the focus of the report, the approaches of single EU Member States (MS) in tackling the issue of the digital skills shortage will not be thoroughly developed.

Advanced digital skills are defined in line with the definition used in the EC's proposal for the DEP (European Commission, 2018:23), i.e.:

*“Advanced digital skills are specialized skills, i.e. skills in designing, developing, managing and deploying technologies such as high performance computing (HPC), artificial intelligence and cybersecurity”*

The EC – and hence the report – focuses on skills and competences acquired with qualifications at International Standard Classification of Education (ISCED<sup>1</sup>) levels 4-8 (European Commission, 2018:2) or European Qualifications Framework (EQF<sup>2</sup>) levels 5-8 respectively, as well as on those competences that are described under the DigComp as levels 5-8 (see Table 1 below).

The structure of the report is built around three main chapters.

**The first chapter** will aim to draw a picture of the existing EU policy framework in education and training for digital skills. The purpose of this initial chapter is twofold. First, it will allow gaining a better understanding of the overall EU policy landscape and of how the EU frames the digital skills issue. Second, it will allow for a first identification of the challenges relating to education and training in digital skills.

**The second chapter** of the report is also the initial analytical chapter. It will dive deeper into the core topic, inter alia, the advanced digital skills and the related pillar in the EU's 2021-2027 Digital Europe Programme (DEP). This chapter will primarily describe the content of the advanced digital skills pillar (i.e. the objectives of the action, its delivery and indicators of success), the rationale behind it and its specific areas of intervention. This chapter aims to identify what broad issues relating to digital skills and above all, what specific issues related to the advanced digital skills gap the pillar addresses. This part of the report will also provide an overview of the existing solutions under the current ERI Framework Programmes (FPs) (i.e. Erasmus + and Horizon 2020) as well as of the synergies between the DEP's skills approach and the approach of the FPs.

**The third and final chapter** of the report will assess the strengths, opportunities, weaknesses and threats related to the interventions within the DEP's advanced digital skills pillar, in light of the previous chapter's analysis.

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<sup>1</sup> The ISCED is the UNESCO-developed international classification of reference, for organising education programmes and related qualifications by levels and fields (source: 'The International Standard Classification Education [ISCED]', 2019).

<sup>2</sup> The EQF is a common European reference framework, which covers qualifications at all levels and sub-systems of education across the 39 European countries that implement it. The EQF consist in eight reference levels, each described through three learning outcomes (i.e. knowledge, skills and autonomy-responsibility) (source: 'European Qualifications Framework [EQF]', 2019)

The **data analysed** for this report was gathered by attending several EC working groups and peer-learning meetings that took place in the first half of 2019<sup>3</sup>, as well as by desk-based research. The scope of the report and its focus is the European level. This report does not provide a comparison with the Swiss advanced digital skills policy framework; such comparison will be provided in my forthcoming Master Thesis (to be submitted to the University of Lausanne in autumn 2019) on the same topic.

**Table 1** below illustrates three qualification frameworks used at EU level. These three frameworks qualify the degree of competence and the academic achievement corresponding to an ‘advanced’ level, as understood in advanced digital skills. Given that the ISCED firstly relates to academic achievement, the table illustrates the corresponding level (4 to 8) of competence and knowledge in other qualification frameworks.

*Table 1 Advanced digital skills (qualification frameworks)*

Qualification Framework	Definition	Level of reference for advanced digital skills	Level-related academic achievement /level-related competence
<b>International Standard Classification of Education (ISCED)</b>	A statistical framework for organizing information on education.	ISCED 4-8	Post-secondary non-tertiary education <b>(4)</b>
			Doctoral or equivalent <b>(8)</b>
<b>European Qualifications Framework (EQF)</b>	A common European reference framework for qualifications.	EQF 5-8	Comprehensive, specialised, factual and theoretical knowledge <b>(5)</b>
			Knowledge at the most advanced frontier of a field of work or study <b>(8)</b>
<b>European Digital Competence Framework (DigComp)</b>	A framework for citizen's digital competence. Outlines 21 competences and 8 proficiency levels.	DigComp 5-8D	Ability to guide others and to apply searches to obtain data <b>(5)</b>
			Ability to create solutions to solve complex problems and propose new ideas <b>(8)</b>

<sup>3</sup> The participation to the EC's working group and peer-learning meetings was limited to MS representatives from the Digitising European Industry and Artificial Intelligence platform and to representatives of nine non-EU states from the Digital Single Market Strategic Group (DSM SG). The Swiss State Secretariat granted me access to said meetings for Education, Research and Innovation (SERI), as part of the Swiss representation.

### 3 The current landscape: EU digital skills policy framework

The DEP is embedded in and framed by a specific policy framework. Regarding the advanced digital skills part, the most relevant policies are the Digital Single Market, the New Skills Agenda for Europe (i.e. the Digital Skills and Jobs Coalition) and the Education and Training 2020 strategic framework.

#### 3.1 Digital single market

In May 2015, the Juncker Commission launched the Digital Single Market (DSM) policy, a transversal effort spearheaded by the EC (European Commission, 2015:2). The DSM's objective is to homogenise digital practices with respect to the European Common Market's underlying four freedoms, i.e. the freedom of goods, capital, services and labour. The DSM aims to take full advantage of the borderless digital revolution and in doing so, create up to EUR 250 billion worth of additional growth in Europe, as well as thousands of jobs to ensure the EU a leadership position in the global digital economy. The policy, set against the backdrop of the overarching strategic framework [Europe 2020](#), is developed along the lines of three main principles:

1. Improved access for consumers and businesses to online goods and services across Europe
2. Environment i.e. fostering the right conditions and a "level playing field for digital networks and innovative services to flourish"
3. Economy and Society i.e. "maximizing the growth potential of the digital economy"

With the consultative involvement of the MS, the European Parliament (EP) and relevant stakeholders were decisive in tackling two practical objectives in the first six months of the DSM's implementation: taking legislative steps and emphasizing the need for digital skills to stimulate start-up innovation and creation.

In May 2017, the DSM's [mid-term review](#) assessed the progress made, highlighting digital rights' harmonization, e-commerce and *ePrivacy* to name but a few. In the review, the EC calls for additional investment in digital skills and infrastructure, from the European and National levels, and from the private sector.

#### 3.2 A New Skills Agenda for Europe: Digital Skills and Jobs Coalition

In June 2016, the EC launched a New Skills Agenda for Europe, in which ten actions address the quality and relevance of skills formation, the visibility of skills and qualifications in order to increase skills intelligence. The [Communication: A New Skills Agenda for Europe](#) sets out the specific goals and actions of the Agenda. Several of the goals touch on increasing digital skills in general e.g. the [Blueprint](#) for Sectoral Cooperation on Skills or the review of the [Recommendation](#) on Key Competences for Lifelong Learning. The flagship action under the agenda is the Digital Skills and Jobs Coalition, which will be described further as follows.

Launched in December 2016, the **Digital Skills and Jobs Coalition (DSJC)** is the flagship initiative under the New Skills Agenda for Europe. The DSJC's main goal is to support cooperation among education, employment and industry stakeholders in order to improve the digital skills of the general population and IT professionals. The DSJC favours bottom-up actions, i.e. any organisation willing to increase digital skills in Europe can become a member of the DSJC and engage into a pledge to action. The pledges are divided into four categories, according to whom they are addressed: 'all citizens', 'labour force', 'ICT professionals' and 'education'. The pledges address training, retraining and capacity building at all levels of digital competency. Building on the positive results of the former initiative 'Grand Coalition for Digital Jobs' and on the 2007 Communication on E-skills for the 21<sup>st</sup> century ([COM\(2007\) 496 final](#)), the DSJC also contributes to achieving the Education and Training 2020 (ET 2020) framework's benchmark on the

Figure 1 EDPR 2018: results in a nutshell

### National digital skills strategy

- Policy responsiveness and implementation at the national level vary among MS.
- In 2017, **20 over 28 MS** had **national digital strategies** or digital agendas in place.

### Digital skills: sub dimension 'internet user skills'

- 2 indicators: % of internet users (aged 16-74) and the % of individuals with basic digital skills (also 16-74)
- The 'internet user skills' sub dimension (e.g. level of software skills) shows that **a very small share of the EU's internet users has advanced software skills**.
- Least-practiced software-related activities: **writing code** in a programming language (7%) and **using spreadsheet advanced functions** (29%).

### Digital skills: sub dimension 'advanced skills and development'

- 2 indicators: % employed ICT specialists (with % of female ICT specialists added as an indicator in the 2019 DESI) and STEM graduates (see [Figure 2](#)).
- ICT specialists' employment grew by 2.2 mio in 2005 to 7.7 mio in 2015
- In 2017, an [empirical forecast scenario](#) estimated that the **demand of ICT specialists would reach 9'174'000 by 2020 while the supply of jobs, 8'675'000** (i.e. an increase of 500'000 jobs from 2015). **A gap of 499'000** between demand and supply of ICT specialists in the EU is thus forecasted for 2020.

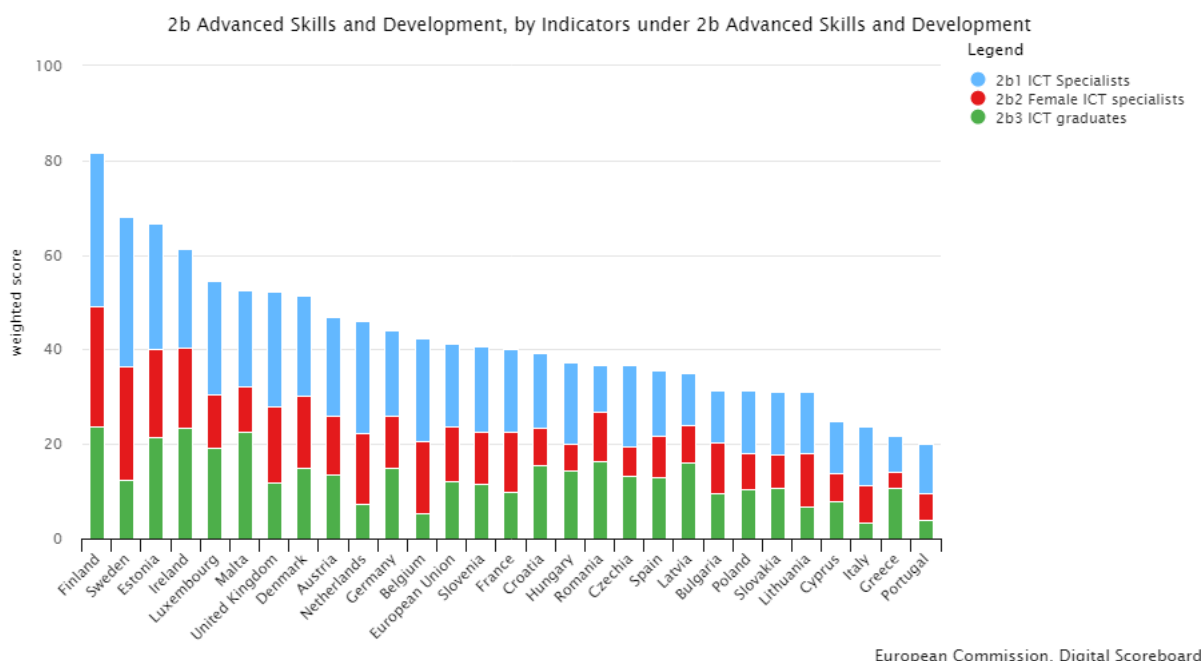
employment of recent graduates. In the framework of the DSCJ, MS were asked to develop comprehensive national digital skills strategies by mid-2017. In 2016, the EC set specific targets for MS, i.e. to establish national digital skills coalitions and develop concrete measures to bring digital skills and competences to all levels of education and training. Every year, the EC tracks the MS' progress annually with these targets and presents the results in the European Digital Progress Report ([EDPR](#)). The EDPR benchmarks the MS' digital developments by profiling the quantitative data



from the Digital Economy and Society Index (DESI<sup>4</sup>). The results of the EDPR’s Human Capital: digital inclusion and skills [report](#) are summarised above, in [Figure 1](#).

On 1 April 2019, the EC announced the creation of a **Digital Skills and Jobs portal** to be launched by the end of 2019. The European Innovation and Networks Executive Agency ([INEA](#)) will launch a [Connecting Europe Facility](#) (CEF) call for proposals in the third quarter of 2019 in order to support the portal. The call will be open to National Digital Skills and Jobs coalitions. The EC’s Directorate-General for Communications Networks, Content and Technology (DG CONNECT) is currently consulting MS regarding their upskilling and reskilling offer at national level. The portal will allow the exchange of best practices and resources between stakeholders. It will also comprise **a repository with all upskilling and reskilling initiatives set up throughout the EU**. The digital portal in question will have a private and a public side. The private side of the portal will be dedicated to networking and collaboration, while the public side will serve as a data repository for sectorial data e.g. on AI space, and will also serve as a training and job search engine, a repository for all available EU funding opportunities.

Figure 2 DESI report (2019): advanced digital skills dimension



### 3.3 EU renewed agenda for Higher Education

On 30 May 2017, the EC published its Communication on a Renewed EU Agenda for higher education ([COM/2017/0247 final](#)), simultaneously to a Council recommendation on graduate tracking ([COM/2017/0249 final](#)) as part of a package. The Communication highlights four core objectives for the agenda, i.e.

<sup>4</sup> Developed in the context of the Digital Single Market policy, the DESI is an index that assess and tracks the EU member states’ digital performance and digital competitiveness, through six dimensions (i.e. connectivity, human capital/digital skills, use of internet services by citizens, integration of digital technology by businesses, digital public services and research and development ICT) (‘The Digital Economy and Society Index [DESI]’, 2019)

1. Tackling future skills mismatches and promoting excellence in skills development
2. Building inclusive and connected higher education systems
3. Ensuring higher education institutions contribute to innovation
4. Supporting effective and efficient higher education systems.

Of particular interest to advanced digital skills, the first objective emphasizes the need to address the insufficient number of European graduates in several fields, including science, technology, engineering, (arts) and mathematics (STE(A)M). The agenda also stressed the need for graduates to acquire transversal skills, including “High-level digital competencies”. To tackle the specific issue, the agenda foresees several actions, including a European initiative to track graduates, and the launch of an EU STE(A)M coalition of varied stakeholders, as to encourage the uptake of STE(A)M subjects.

### 3.4 The ET 2020 Framework

The European Policy Cooperation (ET 2020 framework) is the EC’s strategic tool to gather the MS’ best practices in the field of education. The ET2020 allows MS to share and disseminate their knowledge and national advances in education policy via different structures, e.g. Peer-Learning Activities (PLA) and Working Groups (WG). The four common EU objectives that the ET2020 framework furthers<sup>5</sup> are assessed by a series of benchmarks to be reached by the MS by 2020. The [E&T monitor](#) assesses the progress made by the MS in reaching these benchmarks.

Under the ET 2020 framework, several WGs have been addressing the digital skills issue. Under the current WG mandate period (2018-2020), the WG on Digital Education: Learning, Teaching and Assessment (DELTA) e.g. includes an on-going discussion on digital competences specifically, and on how education systems adapt to the high demand for digital skills (though not only at advanced level). It also gave important input to the EC’s [Digital Education Action Plan](#) (DEAP). The DEAP runs for 2018-2020 and outlines 11 actions to be implemented, amongst which actions 4 to 8 address developing digital competences and skills. I will further elaborate on the content of the DEAP in the [Synergies between the DEP’s Advanced Digital Skills pillar and Erasmus+ \(2021-2027\)](#) subchapter. The WG on Vocational Education and Training (VET) specifically targets the topic of VET in the digital era, including the adaptation of VET curricula to the increased need in digital skills such as AI. Finally, the WG on Higher Education covers the topic of skills as one of its focus areas.

Currently, the EC’s discussions about the scope of the post-2020 ET strategic framework include the willingness to add at least one benchmark addressing digital competences.

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<sup>5</sup> Make lifelong learning and mobility a reality, Improve the quality and efficiency of education and training, Promote equity, social cohesion, and active citizenship and Enhance creativity and innovation, including entrepreneurship, at all levels of education and training (source: European Commission, 2019)

## 4 Zoom in: The Advanced Digital Skills pillar in the Digital Europe Programme (DEP)

### 4.1 Digital Europe Programme

The DEP features as part of the 'Single Market, Innovation and Digital' chapter of the EU's Multiannual Financial Framework (MFF), i.e. the EU overall budget for the years 2021-2027. Building on the aforementioned DSM policy launched by the EC in 2015, the DEP will fund initiatives to approach the digital transformation as to benefit citizens and businesses.

Through the DEP, the EC plans to allocate €9.2 billion to tackle digital challenges in the EU for the time period of 2021-2027. The logic behind the DEP is twofold. On the one hand, it plans on increasing capacity building (i.e. the procurement of equipment, the building of infrastructures and the strengthening of data intelligence). On the other hand, it seeks to secure an adequate skills force by **increasing advanced digital skills through long and short-term training courses and on-the-job traineeships**, while ensuring the widespread use of said technologies in society. This report focuses on the digital skills policy dimension of the DEP.

The DEP is structured into five pillars (see [Table 2](#)). While all pillars address digital skills (see [Pillar 4: implementation mode](#)), pillar 4 is fully dedicated to advanced digital skills development (see [Chapter 4](#))

Table 2 Pillar 1-5 of the DEP



#### Pillar 1: High Performance Computing (HPC)

- Institutionalised Partnership (CH to be a member)
- Building up supercomputing infrastructure
- Building of an integrated EU HPC ecosystem



#### Pillar 2: Artificial Intelligence (AI)

- Direct management (mainly joint procurement & grants)
- Data resources and libraries, large experimentation facilities



#### Pillar 3: Cybersecurity

- Institutionalised Partnership (only EU states)
- Advanced cybersecurity equipment and data infrastructure
- Development of cybersecurity knowledge and skills



#### Pillar 4: Advanced Digital Skills

- Digital Innovation Hubs
- HPC, AI, Cybersecurity, Big Data, Distributed ledger, Robotics



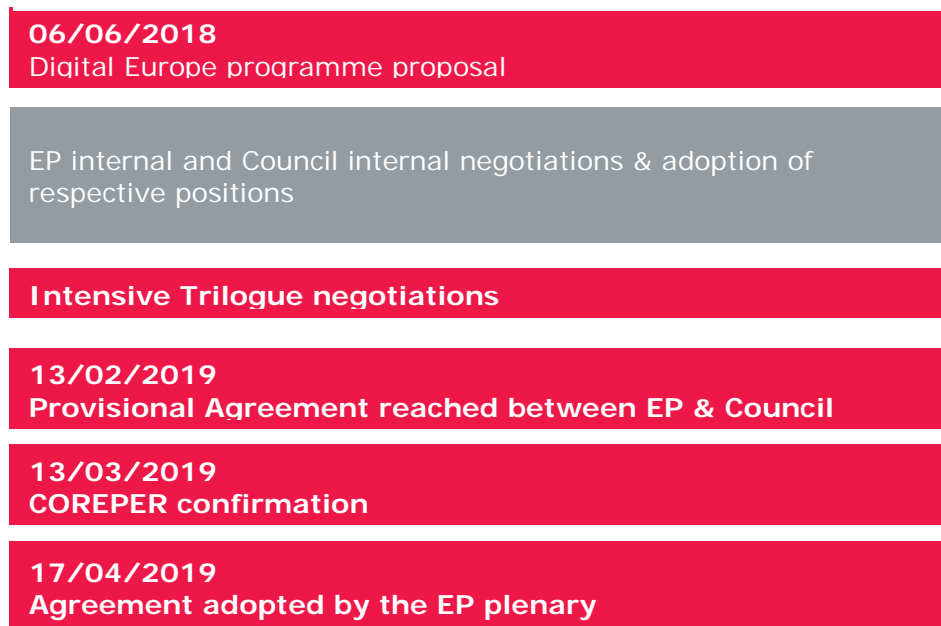
#### Pillar 5: Deployment, best use of digital capacities and interoperability

- Digital Innovation Hubs; digitisation of administration and industry

For what regards the legislative timeline of the DEP, the EP, the EC and the Council of the EU (Council) of the European Union concluded the trilogue negotiations i.e. the negotiations on the legislative text by [reaching](#) a provisional agreement on 13 February 2019. Subsequently, on 13 March 2019, the Council's Permanent Representatives Committee (COREPER) confirmed the common understanding reached by the Romanian presidency and the EP on the proposal. The EP adopted the [partial agreement](#) in plenary on 17 April 2019. As for other programmes, all issues concerning the association of third countries and the budget are bracketed in the current compromise and will not be tackled before an agreement on the next Multiannual Financial Framework (MFF) (i.e. the EU's long-term budget) will be reached and the Brexit situation clarifies, at the earliest towards the end of 2019. It is very likely that an agreement will not be reached this year. Besides, the negotiations on the MFF will continue under the Croatian presidency in 2020. The budgetary indications for each pillar are thus still subject to change under the negotiation surrounding the MFF. Below, [Figure 3](#) presents an overview of the legislative timeline in 2019 (while including the date of the proposal in 2018).

On the Swiss side, the Swiss State Secretariat for Education, Research and Innovation (SERI) is currently evaluating a Swiss association to the DEP. Besides observing and contributing to the European developments (legal texts, planning on programme implementation), it has run a survey in 2019 with a number of stakeholders, in order to enquire about their interest in the DEP in general and the programme's different pillars in particular. The [results of the survey](#) have been published in July 2019. The stakeholders that took part to the survey showed substantial interest in the advanced digital skills pillar.

*Figure 3 Digital Europe Programme: timeline*



#### **Pillar 4: structure**

The financial intervention of the EU under the advanced Digital Skills pillar of the DEP (i.e. pillar 4) should be allocated

EUR 700 mio. It intervenes in one of the five key policy areas that shall support the digital transformation of the industry. The actions laid out in pillar 4 take further the actions put forward in the Digital Education Plan (2018-2020)

(see above in [The ET 2020 Framework](#) subchapter), i.e. those that require advanced digital skills for the fields of HPC, big data analytics, cybersecurity, distributed ledger technologies, robotics and artificial intelligence.

Pillar 4 has three distinct operational objectives or actions, which target the current and future labour force.

**The first action** will aim to support the design and delivery of **long-term trainings and courses** for students, IT professionals and the workforce, further strengthening the existing offer. In order to gather intelligence on the ICT academic offer of the MS, the PREDICT<sup>6</sup> project data was used to map the availability of advanced digital skills academic offer in the EU MS. The highlights of the Joint Research Center (JRC)'s [report](#) on the topic appear in [Figure 4](#) below. The **second action** will support the design and delivery of **short-term trainings and courses** for entrepreneurs, small business leaders and the workforce. The **third action** under pillar 4 will support **on-the-job trainings and traineeships** for students, young entrepreneurs and graduates. In all of the three interventions, the trainings should have a strong cross-border dimension and aim at fostering highly skilled workers' incoming and outgoing mobility.

Figure 4 EU academic offer in AI

### Masters needed ? The EU academic offer in AI

In the Joint Research Center (JRC) 2019 [technical report](#) 'Academic offer and demand for advanced profiles in the EU', the JRC provides a mapping of digital skills in MS according to [two dimensions](#):

1. The **existing academic offer** of bachelor and master programmes in AI, HPC and Cybersecurity
2. The **industry activity in the three fields** as to inform on the type of profile specialisation the industry needs.

### The results of the technical report on the AI academic offer brings the following insights:

- A strong concentration (60%) on master degrees in AI rather than bachelor degrees in terms of educational offer across the EU.
- ¼ of the academic programmes related to HPC, AI and Cybersecurity are specialised
- ¾ of the academic offer are broad programmes (including HPC, AI and Cybersecurity into other fields)
- The United Kingdom hosts more companies and educational programmes in AI, HPC and Cybersecurity than any other member state.

## 4.2 Pillar 4: implementation modes

### 4.2.1 Digital Innovation Hubs (DIH)

<sup>6</sup>The PREDICT project consist in a DG CONNECT (EC) and JRC collaboration, aiming to analyse the supply of ICT and the state of ICT Research and Development (R&D) in Europe, compared to 40 advanced and emerging countries, including Switzerland. PREDICT produces statistics on ICT industries and state-of-affairs (e.g. ICT demand, ICT industry in Asia) as well as on the state of digitalisation, in order to produce policy recommendations. PREDICT is also working on increasing ICT intelligence, specifically for the DEP and for advanced digital skills (e.g. PREDICT was used to map the AI landscape in the context of the [AI watch](#) activities),

Funding for pillar 4 will be primarily implemented through the so-called European Digital Innovation Hubs (DIH), i.e. physical infrastructures that offer specific services. To distinguish DIH under the DEP from DIH established as a to the Communication of Digitising European Industry ([COM\(2016\) 180 final](#)), DEP's DIH are referred to as 'European DIH' (EUDIH). The EUDIH should however create relevant synergies with DIH established in COM(2016)180 final and funded by Horizon Europe or other R&I programmes, as well as with the European Institute of Innovation and Technology (EIT), specifically with EIT Digital. The provisional agreement stresses that a first selection of a network of EUDIH should be established within the first year of the programme, through an "open, and competitive process, from entities designated by the MS". MS can designate already existing hubs for this initial selection. In the spirit of building on existing structures, other established European networks shall create synergies with the EUDIH, e.g. the European Enterprise Network (of which Innosuisse, Euresearch and Switzerland Global Enterprises are part) or the EU Invest hubs. As part of the EUDIH activities, the EP puts a particular focus on their role in supporting Small to Medium Enterprises (SMEs) and entities employing up to 3000 employees (midcaps).

Every European DIH should accomplish four services:

1. **'Test before Invest' i.e. experimentation with the new technology.** SMEs may lack the expertise when it comes to knowing what technology specifically suits their needs and is worth to invest in. Before even providing the 'test before invest' service, European DIH will need to do substantial outreach towards the SMEs, to inform them on the existence of the service (i.e. awareness raising, digital maturity assessment, knowledge and technology transfer & finally, experimentation and testing).
2. **Support for investments.** After this first experimental phase, the hub will help the SME to assess the viability of a potential investment, including through a Return on Investment (ROI) analysis. If successful, the hub would also play a role in facilitating the SME's access to investment schemes. This service also includes understanding business opportunities, supporting the preparation of SMEs' business and financial models, fostering their access to financial institutions and investors and encouraging the use of the EU's InvestEU scheme.
3. **Innovation ecosystem and networking,** insofar as the hubs shall also act as brokers between end-users and suppliers.
4. **Skills & training.** Through this service, the European hubs support **short-term advanced digital skills trainings & job placements.** While specific organisations will supply these training courses, the hub should play a role of promotion towards its stakeholders and raise awareness about training offers available in the region either on the hub's site or in an external organisation. Job placements will be promoted via a job portal (i.e. the [Digital Skills portal](#)) and the hubs shall promote the job portal to their stakeholder SMEs, and promote their site as a work place possibly (European Industry initiative webinar, 2019).

Figure 5 illustrates very practically the role of a EUDIH, within the DEP.

#### 4.2.2 Method of implementation by thematic area

In the context of pillar 4, DIH will manage grants, specifically to support third parties financially for what regards the provision of advanced digital skills. The grants will be implemented differently for each thematic area specifically supported under the DEP (i.e. AI, Cybersecurity and HPC, as well as related areas e.g. blockchain) as follows.

- The **AI skills actions** shall be implemented under direct management, i.e. at EU level, specifically through an EU agency. The EU, via its agency will therefore run the procurement and grant award procedures, distribute the grants to the EUDIH, and communicate the award and rejection decisions. In its efforts to address the challenges of digitisation in the AI field, the EC published a [European strategy for Artificial Intelligence](#) in April 2018. The European strategy proposes a human-centric approach, with several actions to equip citizens at large and experts with AI skills specifically. Advanced digital skills in AI for students and fresh graduates have been and will continue to be supported through the Digital Opportunity Traineeships (DOT) scheme, implemented under the EU's Erasmus+ programme in the period 2018-2020 [N.B. the DOT can be used for any digital-related traineeship, including in cybersecurity and HPC]. The Coordinated Plan on Artificial Intelligence ([COM \(2018\) 795 final](#)) builds on the European Strategy and specifies that AI skills should be covered by the MS's AI national strategies by mid-2019. As specifically laid out in the Coordinated Action Plan, the MS AI strategies shall address AI skills in both higher education and VET e.g. by supporting Masters and PhDs in AI, through the collaboration between AI research excellence centres and the EU's research and innovation programmes, such as Horizon Europe for 2021-2027. The Coordinated Action Plan also foresees Joint degrees of e.g. AI and law or psychology and the mainstreaming of AI-related digital skills in all education and training curricula e.g. the European Institute of Innovation and Technology (EIT) is expected to contribute by integrating AI across curricula in the education courses it supports.
- The **HPC skills actions** shall be implemented through the EuroHPC Joint Undertaking ([JU](#)) established by Council Regulation (EU) 2018/1488 of 28 September 2018, establishing the European High Performance Computing Joint Undertaking. In March 2019, Swiss State Secretary for Education, Research and Innovation Martina Hirayama signed a declaration of interest to join the JU, making Switzerland the 27<sup>th</sup> European country to have joined the JU. HPC skills specifically will be provided via HPC Competence centres. ETH Zurich / CSCS will represent Switzerland in the Finnish LUMI consortium with the goal to acquire, build and deploy a pre-exascale supercomputer in Kajaani, Finland. A coverage of one HPC Competence Centre per EU MS and associated country to the JU is foreseen, as well as on-site training and outreach activities, access to skilled technical experts and on demand services and tools for users.
- The **Cybersecurity skills actions** shall be implemented through a specific body for cybersecurity skills i.e. the Cybersecurity Competence Centre located in each MS. Following the establishment of a [cybersecurity strategy](#) in 2013, the EC adopted a [cybersecurity package](#) aiming at improving European cyber-resilience, deterrence and defence on 13 September 2017. The package includes the proposal to reinforce EU cybersecurity capabilities through a network of cybersecurity competence centres, with a European Cybersecurity Research and Competence Centre in its core. The Centre shall provide solutions and templates for national efforts of rolling out cybersecurity skills and for the training in high-end skills. The academic competence centres (i.e. constituting the network) are expected to draw on guidance from the European Cybersecurity Research and Competence Centre, as well as from the European Network and Information Security Agency (ENISA) (European Commission, 2017:10). The 2017 cybersecurity package, i.e. the Joint Communication on Resilience, Deterrence and Defence: Building strong cybersecurity for the EU ([JOIN\(2017\)450 final](#)) also foresees the creation of apprenticeship schemes in cybersecurity for SMEs, and the mainstreaming of cybersecurity education in engineering, business management and law curricula.



#### 4.2.3 Method of implementation by type of action

- For **long-term trainings and courses** (e.g. Master and PhD degrees) and **short-term trainings and courses** (e.g. EIT-digital certified courses), the relevant body for each thematic area identified above (i.e. an EU agency, JU or a Cybersecurity body) will publish the calls for education providers. The scope of the calls could e.g. address the design and provision of Masters, specialized courses and bootcamps.
- Unlike for the two first operational objectives above, an EU executive agency will publish the calls for **on-the-job trainings and traineeships**. The calls will be addressed to DIH that wish to provide traineeships in an enterprise setting or directly via the DIH. However, it excludes the Digital Opportunity Traineeship that will likely continue to be implemented through Erasmus+ and funded under Horizon – as is currently the case.

The use of JU for HPC skills implementation and of a cybersecurity body for cybersecurity skills implementation reflects the EC's willingness to minimise the cost of a new programme by relying on existing structures. The same rationale explains the use of existing delivery mechanisms e.g. direct implementation via an EU agency for long and short-term trainings in AI skills.

Figure 5 DIH: a fictional example

A DIH submits a proposal, which requests 3 robots and 5 employees for 3 years for a total cost of EUR 1 mio, and commits to certain deliverables (e.g. to carry out at least y. number of experiments with the robots). External experts will assess the proposal. If accepted and selected for funding, the payment will be based on the output of the project, which is checked through reviews. Key Performance Indicators (KPIs) will be defined by the project itself in the proposal and evaluated in the reviews. Reviewers can demand "better" KPIs.

### 4.3 Performance monitoring and evaluation of the pillar

The Annex of the EC [proposal](#) for a regulation of the European Parliament and of the Council establishing the DEP for the period 2021-2027 outline three **output indicators** and two **impact indicators** for pillar 4 and define what a successful implementation would be (see [Table 3](#)). As for the implementation of pillar 4, the level of ambition regarding the DIH is to establish 270 hubs across the EU, reach 90 experiments per hub and reach approximately 42'000 SMEs. Furthermore, at least 500'000 people would need to be upskilled.



Table 3 Performance monitoring for pillar 4 (source: DEP Staff Working document, 2018: 40-49)

Advanced Digital Skills development through DEP			
	Indicator	Success	Data source
Output	# participants in financed master courses	> xx,000 participants in financed master courses	programme management
	# participants in financed training courses	> xxx,000 participants in financed training courses	
	# traineeships completed	> xxx,000 traineeships completed	
Impact	# ICT specialists employed	< from 3.3% to 4.3% in annual growth rate of employed ICT specialists	labour force survey
	# Share of enterprises having difficulty recruiting ICT specialists		DESI/ ICT usage survey of enterprises

#### 4.4 Synergies between the DEP's Advanced Digital Skills pillar and Erasmus+ (2021-2027)

Erasmus + (E+) is the EU's programme in support of education, training, youth and sport in Europe. It comprises opportunities in mobility, policy cooperation and knowledge sharing for students, as well as a wide variety of individuals and organisations. The next generation of E+ (for the funding period of 2021-2027) will include several novelties e.g. major changes in the organization of mobility. Budget-wise, the **EP demands a tripling of the funding compared to the current programme**, while the EC proposes to double it. The finalisation of the E+ regulation also depends on the MFF negotiations. A decision on the budget allocated to Erasmus+ will be ready earliest in autumn 2019.

All three E+ Key Actions (KA) (see [Figure A1 in the Annex](#)) on the structure of future E+) have the potential to address the advanced digital skills issue, through steered mobility and 'digital skills' targeted partnerships and cooperation.

The 'Learning Mobilities' (KA1) will still be the largest action in Erasmus+, with 63% of programme budget supporting its focus on increasing mobility and skills. Since KA 1 is open to all disciplines, it can of course also support people in developing advanced digital skills.

Both E+ and the DEP's advanced digital skills pillar will build on the DEAP ([COM\(2018\) 22 final](#)) which runs until 2020. The DEAP outlines how the EC can help the MS address the challenges of digitalisation in education. The DEP pursues three overarching priorities addressing digital teaching and learning (1), competences and skills (2) and data analysis and foresight (3). Out of the 11 measures comprised in the three priorities, action 5 '[Open science skills](#)' specifically addresses the teaching of advanced digital skills at higher education level. Although not directly addressing training in advanced digital skills, action 10 '[Artificial intelligence and analytics](#)' will seek to predict future shortages in skills by using AI methods.

In the current programme, the same above-mentioned possibilities exist. However, there is only one initiative that specifically tackles advanced digital skills through traineeships (**i.e. the Digital Opportunity Traineeship (DOT)**)

**implemented under Erasmus+ KA1).** The initiative was attributed EUR 10 mio and plans to provide working experience in the digital field to up to 6000 university students and recent graduates by 2020. An intern receives an allowance of around EUR 500 per month. The funding for this monthly allowance comes from Horizon 2020's Pillar II, 'Industrial Leadership', specifically from the LEIT-ICT programme (Leadership in enabling and industrial technologies: ICT). Up to 2019, the 6000 target has been reached halfway through, with up to 3000 students having benefited from the scheme.

Switzerland is associated to Horizon 2020 but not to E+. Since the scheme is implemented under E+, Swiss participation is limited. While students and recent graduates from Erasmus+ programme countries can receive funding to do a Digital Opportunity Traineeship in Switzerland (administered via their home institution), their counterparts in Switzerland are not eligible for funding to support a Digital Opportunity Traineeship in an E+ country. Currently, students and recent graduates from Swiss HEIs wanting to do a Digital Opportunity Traineeship are supported through the Swiss funded Swiss-European Mobility Programme (SEMP) (see [Figure 6](#)).

*Figure 6 DOT: a fictional example*

### Digital Opportunity Traineeships: a fictional Swiss example

#### From the student's point of view

Estelle is a last year student in criminology (MSc) at the University of Lausanne, Switzerland. Estelle is aware of the growing need in digital competences in her field of study. Her degree offers little practical experience in e.g. cybersecurity, although both fields tend to overlap. Estelle checks job offers labelled as DOT on the [Drop'pin@EURES](#) or [ErasmusIntern](#) websites, applies to them and consults her university's mobility office for funding conditions. Switzerland self-funds student mobilities for traineeships via the SEMP (Swiss-European Mobility Programme). Estelle's university had applied for funding for traineeships at Movetia, the Swiss National Agency for mobility and exchange, in order to support mobilities to and from European institutions. Estelle is lucky that the cybersecurity consultancy in Hamburg, at which she prefers to do her traineeship, accepts her, given that she comes from a non-Erasmus+ country and that most DOT opportunities are advertised in the MS. Thus, with a traineeship contract and given that Estelle remains enrolled at her home university, the university will pay her EUR 500/month for the six months internship in a cybersecurity consultancy, in Hamburg.

#### From the company's point of view

XYZ, a Hamburg-based SME offering consulting and services within the domains of cyber security, IT security, information security and risk management really needed highly-skilled people. XYZ has trouble finding people with the right skillset on the local and national job market, and prefers to educate them in-house. XYZ decides to use this programme (DOT) to widen its pool of possible hires and to bring people from universities, who have been taught the right methodologies and blend it with the expertise they need. XYZ publishes their offer on the [Drop'pin@EURES](#) or [ErasmusIntern](#) websites and mark the offer as a DOT. XYZ selects Estelle's profile directly from the platform and before the beginning of the traineeship, both parties sign a 'Traineeship Learning Agreement', in which the content and outcomes of the DOT are clearly defined.

#### 4.5 Synergies between the DEP's Advanced Digital Skills pillar and Horizon Europe

The Framework Programmes for Research and Innovation (R&I) are the EU's main instruments for funding R&I activities, while being complementary to national public research funding and to private investments in R&I across Europe. Horizon 2020 is the eighth generation of programmes and covers the time-period from 2014 until 2020. Its successor, Horizon Europe, will run from 2021 to 2027.

The architecture of the next research FP distinguishes three pillars: 'Excellent Science', 'Global Challenges and European Industrial Competitiveness' and 'Innovative Europe'. The three pillars will be complemented by the cross-cutting area 'Widening participation and strengthening the European Research Area (ERA)'. Of particular relevance to digital skills, Pillar II will combine the actions to foster industrial competitiveness with the societal challenges that constituted two separate clusters under Horizon 2020. In Pillar II, Cluster 4 (i.e. 'Digital, Industry and Space') will further key enabling, digital and space technologies, support the digitisation of European industry and focus on establishing industrial technological leadership and autonomy. As previously mentioned, one of the key challenges European industry faces is its reliance on imported technologies and highly skilled ICT workers. In that context, Cluster 4 also addresses the skills mismatch, by securing the EU's technological autonomy.

Both Horizon Europe and the DEP address a number of similar thematic areas (e.g. HPC, AI and Cybersecurity). Moreover, both programmes will fund the Cybersecurity Competence Centre and the HPC Joint Undertaking, which Switzerland has joined recently. However, both programmes differ regarding their type of actions, the scope of their actions, the expected outputs of their actions and their intervention logic. Horizon Europe will be the only centrally managed EU programme in support of research and technological development. With a focus on demonstration, piloting, proof-of-concept, testing and pre-commercial deployment, Horizon Europe differs from the DEP insofar as not covering wide scale deployment. Unlike Horizon Europe, the DEP will also be the funding instrument for infrastructure building and will cover operational and construction costs. For what concerns the skills dimension specifically, Horizon Europe will aim to develop skills and competencies curricula. Conversely, DEP aims to support capacity building on advanced digital skills (i.e. provide the infrastructures and opportunities in which advanced digital skills will be increased). Both programmes will share strong coordination mechanisms for programming and implementation. At the current stage, it is however not fully clear which programme will cover what, and whether similar calls to those calls implemented under the current R&I programme Horizon 2020 and displayed in [Table 4](#) would rather remain under HEU or be launched under the DEP.

Table 4 Opportunities in H2020 for 'advanced digital skills' development

Opportunities in advanced digital skills training under Horizon2020	
<b>Societal Challenges</b> (Pillar III)	<p><u>The call 'Cybersecurity preparedness - cyber range, simulation and economics' (SU-DS01-2018) includes...</u></p> <p>Practical, operational and hands-on training, including new methods of awareness/training offering more qualification tracks to integrate ICT security workers and employers in the European e-Skills market</p>
<b>EIT digital</b> <i>European Institute of Technology (EIT)</i>	<p><u>EIT-digital's offer includes...</u></p> <p>The EIT-digital academy covers the entire spectrum of advanced digital skills (e.g. cybersecurity, autonomous systems, data science) via training offered at master, doctoral, professional and continuing education level.</p>

DEP and Horizon Europe will align their strategic programming and will have governance structures involving not only their respective Directorate-Generals (DGs) but also other DGs, depending on the actions of the programme. Both programmes will also align their operating procedures for their respective implementation (i.e. reliance on common processes and IT tools) and use the Horizon Europe Common Support Centre.

Given the scope of Horizon Europe, i.e. supporting research and innovation, there are few opportunities to boost skills and specifically digital skills development. Yet, amongst Horizon 2020's three pillars (i.e. Excellent Science, Industrial Leadership and Societal Challenges), two horizontal programmes (i.e. Spreading excellence and widening participation and Science with and for society) and three smaller blocks (European Institute of Innovation and Technology (EIT), Joint Research Center (JRC) and Euratom), several opportunities for the development of digital skills exist already, especially in the 'Societal Challenges' pillar. Although Horizon 2020 will end before the DEP starts, the structure of the next Framework Programme (FP) will build on the current FP. It seems therefore relevant to mention the current actions targeting advanced digital skills (see Table 4).

## 5 Strengths and weaknesses of pillar 4 of the DEP: a SWOT analysis

### 5.1 Internal factors

Internal factors refer to the content and structure of pillar 4 in the DEP. For what regards positive internal factors (i.e. strengths), the focus is on the resources dedicated to the pillar (e.g. financial) and the uniqueness of the approach (e.g. the scope of the operational objectives). Negative internal factors (i.e. weaknesses) refer to the elements within the pillar that would negatively affect its efficiency and efficacy.

#### 5.1.1 Strengths

##### 5.1.1.1 Interconnectedness of the pillars

In the Staff Working [document](#) of the DEP, the EC stresses the 'synergetic and complementary' aspect of each of the DEP's pillar. Every pillar acts as a prerequisite for digital transformation. The linkages between the advanced digital skills pillar and the four other pillars is obvious, insofar as an increase in capabilities requires a critical mass of experts and digitally competent workers. Equally, the deployment of digital technologies into multiple areas of society requires a pool of individuals capable of implementing and using new processes. Given the lower financial contribution to the advanced digital skills pillar, this interconnectedness becomes even more crucial. Of particular relevance, the implementation of CS and HPC related services will rely heavily on the physical structures (i.e. Cybersecurity Competence Centres and HPC Competence Centres) developed through the DEP's respective pillars. The DEP Staff Working document [text](#) also stresses the critical importance of the complementarity between DIH, HPC Competence Centres and Cybersecurity Competence Centre. Indeed, **HPC Competence Centres will either collaborate with DIH or even form part of a DIH** as it is currently taking place in some instances. Besides, DIH will have a mainstream expertise in cybersecurity, rendering them co-dependent to the focused Cybersecurity Competence Centres.

##### 5.1.1.2 Focus on specialised long-term courses in AI

[Figure 4](#) delves into the JRC [report](#) on the academic offer and demand for advanced profiles (i.e. in CS, HPC and AI) in the EU. The report establishes that the share of specialised programmes (i.e. programmes deeply focused on the topic, technique or application field (JRC, 2019)) in all of the three fields represents one fourth of all programmes. **Specialised Masters consist in 18% of the total academic offer in HPC, AI and cybersecurity** (JRC, 2019:6). Broad programmes are therefore more common in AI, HPC and CS, both a master and bachelor level. Besides, there are differences between the specialised academic offer in HPC, AI and cybersecurity, with the HPC field showing overall a lower share of specialised masters than the two others do (JRC, 201:27). Broad and specialised programmes have equally strong discrepancies regarding their respective top fields of study, with e.g. machine learning methods being more integrated into specialised programmes (JRC, 2019). [Figure A3](#) (in the Annex) presents an overview of what the EC considers to be broad vs. specialised programmes in HPC, CS and AI fields. A focus on specialised long-term academic offer, through pillar 4's supported calls for education providers would allow a more widespread coverage and availability, for the benefit of learners. As of now, JRC is finalising a report on the academic offer in AI specifically to inform on the need to specialise the AI academic offer. Once ready, the insights of the report will feed into the definition of the Member States' AI national skills strategy, to be presented by the MS in 2019.

### 5.1.2 Weaknesses

The structure of the programme and of the pillar have been subject to criticism, including from the MS and, in regards to various aspects developed below.

#### 5.1.2.1 Budget

The budget allocated to the pillar is the first identified weakness of the intervention. As mentioned, EUR 700 mio are dedicated to the pillar's three concrete measures or operational objectives. The EC's rationale for the budget is that the action under the DEP does not aim to fill in the skills gap single-handedly. Rather, the advanced digital skills pillar should build on existing EU action in the field i.e. the Digital Skills and Jobs Coalition, itself building on actions steered at the Member State level (e.g. the adoption of a skill strategy or private sector engagement initiatives).

#### 5.1.2.2 Implementation mode

MS raised fundamental reservations regarding the implementation mode through DIH, not only for pillar four, but also for the entire programme, specifically regarding the geographical coverage of DIH wanted by the EC (i.e. 281 hubs). The feasibility of reaching 281 hubs, in order to ensure a full regional coverage remains an issue, insofar as regional needs and the local SME ecosystem of certain regions might not be receptive to the services provided by a hub. A solution mentioned by the EC during the WG on AI on 18 March 2019 is to offer the possibility for small countries to 'consortiate', in order to specialize together rather than individually. Moreover, the EC mentioned that the '281 hubs' target was the goal to be reached by 2027. Currently (2019), approximately 120 DIH exist and could potentially be selected to serve as EUDIH. In order not to discriminate emerging hubs and to help countries navigate the concept of DIH, the Digital Innovation Hub Enhanced-Learning Programme ([DIHELP](#)) is a mentoring and coaching programme supporting 30 Digital Innovation Hubs across 17 EU countries. **Switzerland is not included, but was eligible since the call was open to Horizon 2020 associated countries.** The project will help the selected DIH to develop and/or scale-up their activities in a 9 months programme (from March to November 2019). In the context of its activities, the DIHELP also organises webinars open to the general public.

Another paramount question regards the 'executive agency' and 'existing agency', in charge of two specific activities under pillar 4:

- An existing agency will allocate grants to DIH, **for AI-related** activities including skills activities (e.g. traineeships, short courses and Masters in AI)
- An executive agency will publishing the calls for **traineeships in any domain** foreseen in pillar 4.

In the first case, the Staff Working [document](#) specifies that for Master/specialised courses and bootcamps/short courses, the EU Agency in question will publish calls for education providers willing to design and provide Master/specialised courses and bootcamps (in AI). One could therefore think of the Education, Audiovisual and Culture Executive Agency (EACEA), given that the agency is supervised by DG Education and Culture (DG EAC), as well as DG CONNECT. Another contender could be the Research Executive Agency (REA), which already coordinates part of the call planning for Horizon 2020 and has a strong relationship with DG EAC and CONNECT. In the second case, traineeships will build on the DOT scheme. There is however no indication that the exact DOT scheme will be reconducted under the DEP instead of E+ and Horizon Europe. Rather, the traineeships under DEP's pillar 4 will build on the DOT scheme and "provide the scale needed to respond to the current demand" (European Commission, 2018).

If the DOT and the traineeship action under pillar 4 are two separate actions, the Executive Agency for Small and Medium-sized Enterprises (EASME) could also be considered for publishing the calls in the context of the DEP.

## 5.2 External factors

External factors refer to the ecosystem in which the DEP and its pillar 4 are set. The ecosystem refers to e.g. the complementarity of the pillar's actions with existing funding programmes (i.e. opportunities). Conversely, negative external factors (i.e. threats) refer to the elements of the ecosystem that can affect or alter the success of the action. For instance, the diverse structure of the EU28 VET policy frameworks can be a challenge for the mobility of VET students, including for cross-border traineeships in the field of advanced digital skills. [Figure A2](#) (in the Annex) summarises the results of the complete SWOT analysis.

### 5.2.1 Opportunities

#### 5.2.1.1 Complementarities with other EU programmes

The actions foreseen under pillar 4 are complementary with the ERI FP to several extents. Pillar 4 offers actions, which already exist under the FPs. In the case of cross-border traineeships in an advanced digital skills field, the DOT is the only action that combines traineeship in mobility and digital skills focus. E+ provides several other actions for the mobility of academics and staff, for which a digital skills focus can be chosen by the individual. However, DEP's pillar 4 intends on building on the DOT scheme, while increasing the scale of the scheme as to respond to the current demand in ICT experts. **For instance, students and recent graduates are eligible for a DOT, unlike VET students.** One could imagine that the action under pillar 4 could also include professional education students. For what concerns the short courses foreseen under pillar 4, the DEP intends on building on the short courses provided by EIT-digital, e.g. in cybersecurity. Here as well, short-courses in an academic setting (i.e. EIT digital academy) would not duplicate SME's internal trainings, which have a more specific scope. Finally, regarding long training (e.g. master, bachelor or doctoral degrees), the funding could create an incentive for HEIs to extend their academic offer in specialised programmes.

#### 5.2.1.2 MS skills strategy

As part of the DSJC initiative, MS have been encouraged to develop national digital skills strategies and to support and facilitate bottom-up skills actions. The EDPR reports that as part of the DSJC, more than 80 stakeholders, i.e. large to smaller companies, education providers and NGOs have already made concrete commitments to help reduce digital skills gaps, encompassing a broad range of actions in areas such as training and matching for digital jobs, certification and awareness raising. Besides, 13 MS have already launched National Coalitions for Digital Jobs, in order to increase the impact on digital jobs at local level. For what regards national digital skills strategy, the EC and national experts, via the DSM sub-group (i.e. the sub-group includes Switzerland) launched a [shared concept](#) in 2017, which helps identifying the challenges and solutions that need to be tackled regarding the digital skills gaps.

### 5.2.2 Threats

#### 5.2.2.1 MS resistance to change existing curricula in AI



By the end of 2019, the EC will have performed a mapping of the current initiatives targeting AI skills in the MS, and will be aware of their state of implementation. As part of the Horizon 2020 call for AI Excellence Centres ([ICT-48-2020](#)), the EC will explore avenues to support the inclusion of AI modules in multidisciplinary Master programmes e.g. in e-health, fintech, e-government, as well as in adult training programmes with a focus on people with higher education and work experience. As of now, DG CONNECT categorized the MS public and private sector initiatives for AI skills according to their policy area e.g. formal education, non-formal education or labour market intelligence. DG CONNECT's initial mapping of the MS input (not yet publically available) shows that **there is a lack of support from the MS on extending curriculum reform to existing courses in tertiary education**. Moreover, 75% of MS national initiatives tackle formal education and training while a minority addresses non-formal and informal lifelong learning and labour market intelligence. Overall, only two AI strategies deal with all three categories, while seven include at least formal and non-formal education.

### 5.2.2.2 Brexit

The withdrawal of the UK from the EU (i.e. Brexit) could have negative implications for the practical implementation of pillar 4. As discussed above, one of pillar 4's 'Strengths' is to focus on increasing the HPC, AI and CS academic offer in specialised degrees (i.e. master's). This approach tackles the existing gap between specialised and broad academic offer at European level, while acknowledging that most of the academic offer in CS, HPC and AI is found at master's level. At the single technology level (e.g. for AI), we observe strong cross-country differences between the offer of specialised masters (i.e. 182 for the UK, 26 in France and zero in Greece).

Overall, the UK enjoys a complete hegemony in terms of the number of specialised masters not only in AI, but also in CS and HPC (JRC, 2019:45). The UK also has more universities hosting specialised masters in CS, HPC and AI than any other EU MS (JRC, 2019:45). Taking the example of CS, the UK leads in terms of the number of CS-related companies, showing a high industry penetration in all CS domains (JRC, 2019:39). Even more relevant is the fact that in the three fields, the UK's academic offer aligns with the EU industry activity in the corresponding field (JRC, 2019:39). For instance, the CS subdomains of 'network security', 'information security' and 'risk assessment and prevention' are the top-three CS fields, in which most European companies get involved (JRC, 2019: 38). The UK academic offer in CS mirrors that industrial focus. In comparison, France and Germany have higher level of industry penetration than the other EU MS in CS, but there are noticeable discrepancies between the two countries' academic offer in CS and the EU industry focus, which implies certain skills mismatches (JRC, 2019:39). In that respect, the concentration of specialised masters in the UK could be detrimental to the success of pillar 4's approach in light of Brexit.

Theoretically, the lack of correspondence between industry needs and education offer in most EU countries could be compensated by inter-country labour force mobility and student mobility. Both types of mobility are inherent to pillar 4. The EU added value of the DEP foresees a cross-border dimension to the traineeships, on-the-job certifications and long-term courses in pillar 4. From a labour mobility perspective, if a regional EUDIH cannot fulfil the needs of a professional, wanting to gain skills in CS by attending a three-week course in cryptography, the EUDIH will direct the person towards a hub that can provide such service. From an academic mobility standpoint, pillar 4 will encourage learners' intra-European mobility as well, by ensuring that more European countries have the relevant CS, HPC and AI academic offer. In both cases, the UK would be an important player for cross-border training, upskilling and reskilling in AI, HPC and CS. However, Brexit could potentially have a negative impact on the opportunities for the UK's incoming learning and training mobility. Article 10 of the EP's [Regulation](#) on Digital Europe foresees third countries association conditions to the programme and mentions that third countries' full or partial association to the



DEP will be based on a case-by-case assessment of the Specific Objectives (i.e. the five pillars). Association modalities still need to be defined, given the uncertainty on the EU-UK post-Brexit legal bound and pending the MFF.

## 6 Conclusion

Undoubtedly, there is added value in DEP's pillar 4 approach at decreasing the advanced digital skills gap across the EU. The interdependency of the pillars is noticeable by the fact that the 'skills' issue is addressed across the programme, and not just in the dedicated pillar. Moreover, the somewhat low funding allocated to the advanced digital skills pillar is counterbalanced to some extent, by the large investments in the other pillars i.e. in cybersecurity, HPC and AI infrastructures, since they will serve a purpose for training and intelligence.

The analysis of the complementarity of the DEP's approach at increasing advanced digital skills, with the actions under future Erasmus+ and Horizon Europe brings several insights. Pillar 4 complements the actions under Erasmus+, insofar as the DEP's action is targeted and could be easily combined with Erasmus+' more thematically free approach at e.g. mobility and cooperation. In the case of Horizon Europe, based on the analysis of the Horizon 2020 actions in e.g. cybersecurity, we observe that a skills and training component is often included. Yet the same type of action for HPC and AI skills is non-existent. In that case, the DEP's advanced digital skills pillar is complementary to the Research and Innovation programme, because it provides the same opportunities for a broader range of technological focuses.

However, the advanced digital skills dimension of the DEP somewhat lacks depth, when it comes to the issues of upskilling and reskilling an already digitally competent workforce. The proposed approach (i.e. on-the-job trainings and short-certifications schemes), **as well as the traineeships scheme could be lacking relevance for professionals and VET students**. Regarding the upskilling and reskilling of ICT professionals (in order to adapt to e.g. technological advances), SMEs may prefer a more tailored and bottom-up approach to train the digitally advanced workforce they either already have or need. SMEs could thus favour guidance on how to develop institutional training schemes internally rather than actions steered at the EU level.

Besides, the impact Brexit will have on the collaboration between the Member States (MS) and the UK in ICT education and training remains unknown. Given the importance of the existing offer in AI, HPC and CS in the UK, the country remains a crucial player for the success of DEP's pillar 4.

An open question in the DEP's approach to increasing the amount of highly digitally skilled people remains the delivery mechanism foreseen in the programme, the EUDIH. The delivery method is both an advantage and an impediment. EUDIH could prove extremely efficient, if successful in becoming one-stop shops for cybersecurity, HPC and AI. Indeed, EUDIH could also be the solution to the lack of cohesion between the advanced digital skills actions under the ERI FP. However, the geographical scope targeted by the EC remains an issue for several Member States.

Future studies and reports on the topic of advanced digital skills could focus on the impact of sectoral skills blueprints on VET curricula, in order to interaction to increase (train, reskill and upskill) students & future workforce.

## Annex

Figure A1 Erasmus+ programme: Key Action structure (source: SwissCore and the Mission of CH to the EU's joint report, 2018)

Fields	Key Action 1	Key Action 2	Key Action 3
Education & Training (E&T)	<p>Mobility of Higher Education student and staff, of vocational education and training (VET) learners and staff, <b>school pupils</b> and staff, and <b>of adult education staff</b></p> <p>Language learning opportunities (incl. Online Linguistic Support)</p>	<p>Partnerships for cooperation and exchanges of practices (incl. <b>small-scale partnerships</b>)</p> <p><b>Partnerships for excellence</b> (incl. <b>European Universities</b>, <b>Centres of vocational excellence</b>, joint master degrees)</p> <p><b>Partnerships for innovation</b> (incl. <b>Alliances</b> and <b>Forward-looking projects</b>)</p> <p>Online platforms and tools for virtual cooperation (incl. eTwinning, EPALE, School Education Gateway, Erasmus Virtual Exchanges)</p>	<p>Support to European policy development (incl. Open Method of Coordination, international surveys, support of Eurydice)</p> <p>Support to tools and measure that foster quality, transparency and recognition of competences, sills and qualifications (e.g. Europass, Euroguidance)</p> <p>Policy dialogue and cooperation (incl. international organisations)</p> <p>Contribution to qualitative and inclusive programme implementation (incl. alumni network)</p> <p>Cooperation with other EU instruments (incl. learning mobilities in fields such as public governance, agriculture)</p> <p>Dissemination and awareness raising</p>
Youth	<p>Mobility of young people</p> <p>Youth participation activities</p> <p><b>DiscoverEU</b></p> <p>Mobility of youth workers</p>	<p>Partnerships for cooperation and exchanges of practices (incl. <b>small-scale partnerships</b>)</p> <p><b>Partnerships for innovation</b></p> <p>Online platforms and tools for virtual cooperation (incl. European Youth Portal, Erasmus Virtual Exchanges)</p>	<p>Support to European policy development (incl. Youth Wiki)</p> <p>Support to tools and measure that foster quality, transparency and recognition of competences, sills and qualifications (e.g. Youthpass)</p> <p>Contribution to qualitative and inclusive programme implementation (incl. SALTO Resource Centres)</p> <p>Others</p>
Sport	<p>Mobility of sport coaches and staff</p>	<p>Partnerships for cooperation and exchanges of practices (incl. <b>small-scale partnerships</b>)</p> <p>Not-for-profit sport events</p>	<p>Preparation and implementation of policies</p> <p>Others</p>

Figure A2 SWOT analysis

SWOT ANALYSIS	Positive	Negative
Internal	<b>Strengths</b> <ul style="list-style-type: none"> <li>• Interconnectedness of the pillars</li> <li>• Targeted action on long-term courses</li> </ul>	<b>Weaknesses</b> <ul style="list-style-type: none"> <li>• Budget</li> <li>• Implementation mode</li> </ul>
	External	<b>Opportunities</b> <ul style="list-style-type: none"> <li>• Complementarity with other Funding Programmes</li> <li>• MS skills strategy</li> <li>• Shared competence for Research and Employment</li> </ul>

Figure A3 Examples of specialised versus broad academic offer in AI, HPC and CS (source: JRC, 2019)

<b>AI-specialised</b>
"Artificial Intelligence - Cognitive Science", "Automation and Computer Vision", "Advanced Computer Science (Computational Intelligence)", "Applied Image and Signal Processing", etc.
<b>AI-broad</b>
"Internet Science and Technology", "Applied Mathematics", "Life Science Informatics", "Biofluid Mechanics", "Finance and Banking", etc...
<b>HPC-specialised</b>
"Big Data and High Performance Computing", "High-Performance Computer Systems", "Advanced Distributed Systems", "Distributed Systems and Web Technologies", "Computer Networking", etc.
<b>HPC-broad</b>
"Information Systems and Computer Engineering", "Telecommunications Engineering", "Renewable Energy Systems", "Sport, Health and Exercise Sciences", " Visual Computing", etc.
<b>CS-specialised</b>
"Computer Forensics", "Security in Computer Systems and Communications", "IT Security Management", "Cyber Technology", "Advanced Control Systems", etc.
<b>CS-broad</b>
"Criminology", "Computer Science for Autonomous Systems", "Business Information Systems", "IT Management", "Governance and Law in Digital Society", etc.

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