REWIRE
CYBERSECURITY SKILLS ALLIANCE

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REWIRE - Cybersecurity Skills Alliance

A New Vision for Europe

R5.3.1 REWIRE Fiches

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Document description	This document identifies, documents and promotes best and good practices aiming at addressing skills and shortages as well as fostering multi-stakeholder partnerships.
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1. INTRODUCTION

Today, society is being increasingly digitalized. Changes and developments are happening faster and faster, and with them, so is the need for industry and companies to hire specialised people. In the cybersecurity sector, two phenomena confront each other: companies need cybersecurity professionals more and more and, at the same time, there is still a huge cybersecurity skills gap and shortage. In other words, "companies are looking to hire cybersecurity professionals in droves" [1] but "the number of unfilled cybersecurity jobs grew by 350 percent, from one million positions in 2013 to 3.5 million in 2021" [2].

Aware of the existing cybersecurity skills gap and shortage, the REWIRE project aims at addressing this issue in different occupational profiles and qualifications of the Cybersecurity Sector. One of the results that the project aims to achieve is to document and promote concrete best and good practices that aim to address skills shortages and mismatches as well as fostering multi-stakeholder partnerships. In this regard, the first REWIRE Fiche was a result of reviewing cybersecurity strategies carried out in different countries, from which we compiled a wide range of initiatives and actions addressing the cybersecurity skills shortage (CSSS).

This report, for its part, will provide a general analysis of the current framework at the European level. On one hand, it will briefly summarise a series of synergies at EU level, and policy initiatives and frameworks that exist to overcome the cybersecurity skills gap and shortage. On the other hand, the report will showcase and present some best practices and initiatives taken at the European level.

The structure of the report is the following:

- Section 2 gives an overview of the current frameworks and policy initiatives in cybersecurity at the European level.
- Section 3 presents some best and good practices found at the European level addressing the cybersecurity skills gap and shortage.
- Section 4 concludes the document with reflections and analysis of the current situation of the cybersecurity sector in Europe.

2. CURRENT FRAMEWORKS AND POLICY INITIATIVES AT EUROPEAN LEVEL

JRC Technical Report on Proposal for a European Cybersecurity Taxonomy

The Joint Research Centre (JRC) is the European Commission's Directorate-General that carries out research and provide independent scientific advice and support to the European Union's policy.

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In 2019, the JRC published a Technical Report on Proposal for a European Cybersecurity Taxonomy [3], after the European Commission's commitment in September 2018 "to launch a pilot phase under Horizon 2020 to help bring national cybersecurity centres together into a network" [4].

The objective of the report – Proposal for a European Cybersecurity Taxonomy – was to align the multiple cybersecurity terminologies, definitions and domains into a coherent and comprehensive taxonomy to make it easier to categorise the EU cybersecurity competencies. To summarise, the results divided the Cybersecurity Taxonomy in three dimensions, as seen in the figure below (Figure 1):

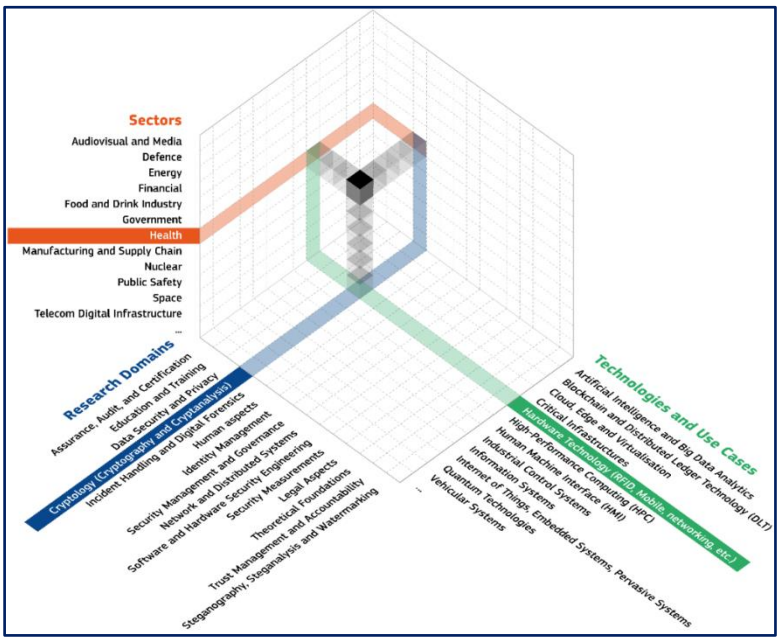

Figure 1. EC's JRC Proposal for a Cybersecurity Taxonomy

EU Cybersecurity Strategy

The EU Cybersecurity Strategy [5] was presented by the European Commission and the High Representative of the Union for Foreign Affairs and Security Policy in 2020. The new strategy has the objective of building resilience to cyber threats and ensuring all European citizens and the business sector benefit from safe and trustworthy digital technologies.

Based on the rapid increase of cyber-attacks, the transformation of society – especially after the COVID-19 pandemic – the European Union is committed to lead the efforts for a secure digitalization. The strategy presented focuses on enhancing and strengthening the tools and resources available in the European Union, as well as ensuring cooperation among countries, within and beyond the EU.

The EU Cybersecurity Strategy aims at ensuring "a global and open Internet with strong safeguards where there are risks to security and the fundamental rights of people in Europe" [5]. The document makes specific proposals to deploy three main instruments or initiatives:

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- Regulatory
- Investment
- Policy

In addition, the EU Cybersecurity Proposal focuses on three topics of the European Union action:

- **Resilience, technological sovereignty and leadership:** "The EU's critical infrastructure and essential services are increasingly interdependent and digitized. All Internet-connected things in the EU, […], need to be secure-by-design, resilient to cyber incidents, and quickly patched when vulnerabilities are discovered" [5].
- **Operational capacity to prevent, deter and respond:** the EU aims to implement regulatory tools, mobilization, and cooperation, to help Member States in their security.
- **Cooperation to advance a global and open cyberspace:** promoting a political model and vision of cyberspace according to law, fundamental freedoms, human rights, and democratic values is essential. To do so, the EU will continue to enhance international cooperation and ensure a global, open, stable, and secure cyberspace.

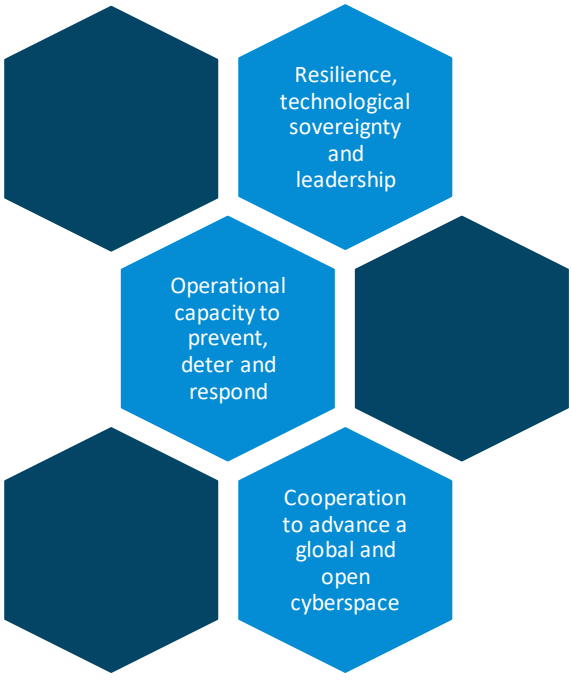

Figure 2. EU Cybersecurity Strategy's focus topics

The European Union Agency for Cybersecurity (ENISA)

The European Union Agency for Cybersecurity (ENISA) was established in 2004, and it is the agency designated by the European Union to achieve a high common level of cybersecurity across Europe. Reinforced by the EU Cybersecurity Act [6], ENISA "contributes to EU cyber policy, enhances the trustworthiness of ICT products, services and processes with

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cybersecurity certification schemes, cooperates with Member States and EU bodies, and helps Europe prepare for the cyber challenges of tomorrow" [7].

Among the different topics that the European Union Agency for Cybersecurity works on, and for purposes of the REWIRE project and this document – addressing mainly the cybersecurity skills gap and shortage –, we will focus on ENISA's work on cybersecurity education and awareness. Trying to raise awareness among all citizens and enhancing cybersecurity skills and competences, ENISA has several publications and initiatives that are worth to be considered.

First, the **Cybersecurity Skills Development in the EU** [8] is a report focused on analysing the status of cybersecurity education and the inability to attract more students in cybersecurity career paths, as well as the difficulties to produce graduates with the correct cybersecurity knowledge and skills. Related to this, ENISA also developed a **Cybersecurity Higher Education Database (CYBERHEAD)** [9], which compiles in an interactive way the available cybersecurity degrees in Europe.

Another relevant publication from ENISA in this topic was published in 2021, which consists of a report on **Addressing Skills Shortage and Gap Through Higher Education** [10]. This report is divided into two major sections:

- Overview of the cybersecurity skills in Europe
- Policy approaches taken in EU Member States to increase and sustain national cybersecurity strategies

Regarding the initiatives taken by the European Union Agency for Cybersecurity, these focus on raising awareness on cybersecurity among the EU citizens. Examples of such initiatives could entail the European Cybersecurity Month (ECSM) or the European Cyber Security Challenge (ECSC), which will be further detailed later in this same document. In addition, ENISA has also recently presented a **European Cybersecurity Skills Framework (ECSF)** [11].

The REWIRE project participated in the creation of the ECSF in several aspects. REWIRE partner participants were included in the Experts Group set up by ENISA to elaborate version 2 of the ECSF. A draft version was circulated by ENISA to several interested stakeholders in April 2022, including the REWIRE project. REWIRE then provided comments to ENISA in September 2022, to be included in the final version of the ECSF. Finally, the ECSF draft version supported the elaboration of REWIRE Deliverable 3.3.1, which analyses the content of the ECSF and proposes extensions and improvements to this framework.

The European Cybersecurity Skills Framework is a crucial step for addressing the existing worldwide cybersecurity skills gap and shortage. The objective of the ECSF is to:

- Develop a common understanding of the relevant roles, competencies, skills, and knowledge
- Facilitate cybersecurity skills recognition
- Support the design of cybersecurity-related training programs

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The ECSF foresees 12 different role profiles (see Figure 3) – namely 1) Chief Information Security Officer (CISO), 2) Cyber Incident Responder, 3) Cyber Legal, Policy and Compliance Officer, 4) Cyber Threat Intelligence Specialist, 5) Cybersecurity Architect, 6) Cybersecurity Auditor, 7) Cybersecurity Educator, 8) Cybersecurity Implementer, 9) Cybersecurity Researcher, 10) Cybersecurity Risk Manager, 11) Digital Forensics Investigator, and 12) Penetration Tester – in the cybersecurity sector, providing each of them its responsibilities, skills, synergies and interdependencies.

Figure 3. ENISA's cybersecurity role profiles in the ECSF

As expressed in the REWIRE Policy Recommendation I, "having a common and strong European Skills Framework is an essential step into addressing the challenge of the cybersecurity skills gap and shortage. It is also an important factor to cybersecurity education" [12].

European Cyber Security Organisation (ECSO)

The European Cyber Security Organisation (ECSO) [13] was established in 2016 and it is a partnership organisation working on cybersecurity. The main goal of ECSO is to coordinate the European Cybersecurity Ecosystem and support the protection of European Digital Single Market.

ECSO has six different working groups, from which we will focus on Working Group 5: Education, Training, Awareness, Cyber ranges [14]. This working group focuses on cybersecurity capability and capacity-building effort for a more resilient digital Europe. In 2021, ECSO published a report on **European Cybersecurity Education and Professional**

Training: Minimum Reference Curriculum [15], which first presents a mapping of best practices, current frameworks and market analysis and develops afterwards the corresponding curricula.

In addition, ECSO's Working Group 5: Education, Training, Awareness, Cyber ranges also launched various initiatives, such as Youth4Cyber or the Cybersecurity Awareness Calendar that are described below in this document.

3. BEST PRACTICES AND INITIATIVES AT EUROPEAN LEVEL

In this chapter, our goal is to provide some examples of different European initiatives. We have chosen a total of five initiatives to showcase, the majority of which is aimed at raising awareness directly or indirectly. Although the European Cybersecurity Challenge is not an initiative that could be directly classified under the Raising Awareness heading, we believe that it should be showcased at the same time since it indirectly helps in promoting and raises awareness on the cybersecurity profession – especially to young people.

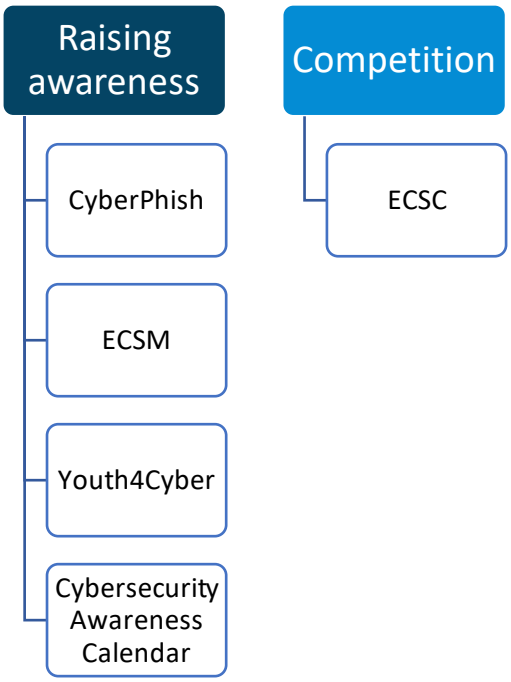

Figure 4. Good practices selected at the European level

CyberPhish Project

CyberPhish: Safeguarding against Phishing in the age of 4th Industrial Revolution [16] is an Erasmus+ project, coordinated by Vilnius University Kaunas Faculty (Lithuania) and with partners in 5 countries. The main goal of the project is to educate higher education students, teachers, universities and education centres, businesses, and encourage their critical thinking on cybersecurity.

According to the European Commission's Digital Skills and Jobs Platform, "despite its short duration, the project achieved considerable results in terms of growing the body of recent

skills intelligence through a strong multilingual approach" [17]. Indeed, the project piloted an innovative curriculum, as well as a wide range of e-learning materials and other tools.

Name	CyberPhish: Safeguarding against Phishing in the age of 4th Industrial Revolution
Country	Lithuania, Cyprus, Estonia, Latvia, Malta
Target group	HE students, educators, university staff, education centres, businesses
Objectives	To educate the different target groups and encourage their critical thinking in the cybersecurity field.
Description	CyberPhish is an international project initiated by Vilnius University Kaunas Faculty in November 2020. The project partners designed a curriculum, e-learning materials, a blended learning environment, knowledge and skills self-assessment and evaluation system simulations for students and other users to prevent from phishing attacks. Moreover, it would also help people to raise their competencies, helping to focus their attention to threats and take appropriate prevention measures.
Measurable results (if any)	1. 514 responses (in 5 countries) to a survey on "Recognising phishing and skills gap 2. CyberPhish course: training, simulation and self-evaluation platform. https://cyberphish.vuknf.lt/ 3. Accessible results available in 5 languages (English, Latvian, Estonian, Lithuanian, and Greek)
Website	https://cyberphish.eu/

European Cyber Security Month (ECSM)

The European Cyber Security Month is a campaign that occurs every year thanks to the collaboration between the European Commission's Directorate-General for Communications Networks, Content and Technology (DG CONNECT) and the European Union Agency for Cybersecurity (ENISA). Launched in 2012 for the first time, the ECSM has turned into "one of the largest EU institutional annual campaigns" [18].

This initiative is an example of a good practice, since it is supported by the Member States and gathers hundreds of partners from different nature, such as governments, universities, think tanks, NGOs, private sector businesses, and so on.

According to the Digital Skills and Jobs Platform, "since the start of the initiative in 2012, more than 525 activities across 36 countries have already taken place. In addition, ECSM has served as a good basis for the further development of cybersecurity events on a national scale" [18].

Name	European Cyber Security Month (ECSM)
Country	EU
Target group	Citizens

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Objectives	To promote cybersecurity and provide updated online security information
Description	The ECSM is an initiative launched in 2012 by DG CONNECT and ENISA, which consists of annual campaigns – taking place in October each year – aiming at promoting cybersecurity among EU citizens and organisations and providing the latest online security information through awareness raising and sharing of good practices.
Measurable results (if any)	Every ECSM campaign is outperforming previous years, especially in the number of activities organised and outreach of people via social media. 1. In 2021, 73% of Member States that were surveyed, replied that their campaigns reduced cyber incidents. 2. In 2020, 9.8M people saw the ECSM content 3. The website contains around 130 tools of awareness-raising material and more than 20 ongoing activities on a national level 4. More than 25,000 followers on Twitter
Website	https://cybersecuritymonth.eu/

Youth4Cyber

The European Cybersecurity Organisation (ECSO) has launched several successful initiatives over the years. Youth4Cyber [19] is one of the initiatives that aims to educate and raise awareness on cybersecurity among young people – aged between 6 and 26 years old.

It is composed of different modules, where each one focuses and is adapted to a specific maturity level, divided into groups of 4 years, from 6 to 26 years old. Moreover, there is also a module on Train the Trainers. The rest of the modules are divided as follows:

- Module 0: Train the Trainers.
- Modules 1-3: basic rules for cyber hygiene and basics of cybersecurity for children.
- Modules 4-5: specific topics to showcase the multiple aspects of cybersecurity so young adults can see the diverse opportunities for a career.

Name	Youth4Cyber
Country	EU
Target group	Young people (6-26 years old)
Objectives	To raise the level of cyber hygiene and stimulate an interest for a career in cybersecurity
Description	Youth4Cyber is an initiative launched by ECSO, which aims to teach young people on cyber hygiene and basic concepts of cybersecurity, as well as showing young adults different trends and possible career paths in cybersecurity. It consists of different modules, each of them with a different level depending on the target group, that provide

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	an agile methodology able to adapt to each context but with clear guidelines for a minimum level of content or topics to address. This way, Youth4Cyber aims at laying the foundations for a harmonised approach to cybersecurity teaching across the European Union.
Measurable results (if any)	Catalogue of resources containing a list of openly available resources/initiatives from ECSO Members [20]
Website	https://ecs-org.eu/initiatives/youth4cyber

Cybersecurity Awareness Calendar

ECSO's Cybersecurity Awareness Calendar gives on one hand, basic information and facts about different topics, and, on the other hand, it also provides solutions, services, courses and best practices from their members and the community. The Awareness Calendar is shared on social media and ECSO's website every month.

In 2022, the monthly themes have been and will be the following, sorted by month: 1) Cybersecurity certification, 2) Internet of Things, 3) Gender diversity in cybersecurity, 4) Artificial Intelligence, 5) Cyber ranges & range-enabled services, 6) Cybersecurity for verticals, 7) Social engineering, 8) Privacy & data security, 9) Organisational resilience, 10) Cyber hygiene & readiness, 11) Cloud computing, and 12) Threat & vulnerability management.

Name	Cybersecurity Awareness Calendar
Country	EU
Target group	Everyone
Objectives	To raise awareness on cybersecurity, as well as to spotlight on ECSO's members' solutions and services to potential users
Description	ECSO's Awareness Calendar provides some basic facts on selected subjects as well as associated solutions, services, courses and best practices from their members and the community. Each month is dedicated to a certain theme, and ECSO publishes a report on it.
Measurable results (if any)	Monthly report focused on the corresponding topic
Website	https://ecs-org.eu/initiatives/cybersecurity-awareness-calendar

European Cybersecurity Challenge (ECSC)

The European Cyber Security Challenge is an event held every year, which brings together young cyber talent from multiple European countries to network, collaborate and compete. The objective of the ECSC is to encourage young people "to pursue a career in cybersecurity, by enhancing participants abilities and connecting them with the industry" [21].

Name	European Cybersecurity Challenge

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Country	EU
Target group	Students and graduates
Objectives	To enhance cybersecurity talent across Europe and connect high potentials with industry leading organisations.
Description	To help mitigate the shortage of skills in IT and the cybersecurity sector, many countries launched national competitions for students, graduates or non-ICT professionals aiming to find new and young cyber talents and encourage young people to pursue a career in cyber security. Therefore, ENISA launched the European Cybersecurity Challenge initiative, which leverages on these competitions by adding a pan-European scope. The winners of national cybersecurity competitions represent their countries at the ECSC.
Measurable results (if any)	Raising participation in number of countries – from 15 in 2017 to 28 in 2022. Moreover, ENISA publishes an analysis report about the ECSC every year.
Website	https://ecsc.eu/

4. SUMMARY AND CONCLUSIONS

The cybersecurity skills gap and shortage are evident worldwide. More and more cybersecurity professionals are needed, due also to the increase in digitalization. The REWIRE project has the objective of addressing this issue with various activities as described in the various plans and other documents. One of the activities selected to help address this issue is the documentation and promotion of best practices that aim to address skills shortages and mismatches.

This report is a general overview of the cybersecurity frameworks in Europe. The report describes examples of related frameworks, initiatives and entities working on cybersecurity, as well as five best practices and initiatives taken at European level. The REWIRE project continues this analysis also at national and regional levels and relevant publications will follow. Further to that, and to facilitate the extraction of conclusions on best practices, a relevant survey is being designed and will soon be implemented.

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6. LIST OF ABBREVIATIONS AND ACRONYMS

Abbreviation	Explanation/ Definition
CSSS	Cybersecurity Skills Shortage
DG CONNECT	Directorate-General for Communications Networks, Content and Technology
ECSC	European Cybersecurity Challenge
ECSF	European Cybersecurity Skills Framework
ECSM	European Cyber Security Month
ECSO	European Cyber Security Organisation
ENISA	European Union Agency for Cybersecurity
EU	European Union
JRC	Joint Research Centre

Table 1. List of abbreviations and acronyms

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