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Subject:	COMMISSION STAFF WORKING DOCUMENT Accompanying the document Proposal for a Decision of the European Parliament and of the Council **establishing the 2030 Policy Programme "Path to the Digital Decade"**

Delegations will find attached document SWD(2021) 247 final.

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COMMISSION STAFF WORKING DOCUMENT
Accompanying the document

Proposal for a Decision of the European Parliament and of the Council

establishing the 2030 Policy Programme "Path to the Digital Decade"

{COM(2021) 574 final}

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1. INTRODUCTION

The Commission's Communication "2030 Digital Compass: the European way for the Digital Decade" of 9 March 2021 (hereinafter "Digital Compass Communication" or "Communication") laid out the vision for a successful digital transformation of the European Union by 2030. The EU's ambition is to be digitally sovereign in an open and interconnected world, and to pursue digital policies that empower people and businesses to seize a human centred, inclusive, sustainable and more prosperous digital future. This includes addressing vulnerabilities and dependencies as well as accelerating investment.

In its conclusions of 25 March 2021, the European Council stressed the importance of the digital transformation for the Union's recovery, prosperity, security and competitiveness and for the well-being of our societies. It underlined the need to enhance EU's digital sovereignty in a self-determined and open manner by building on its strengths and reducing its weaknesses and through smart and selective action, preserving open markets and global cooperation. It identified the Digital Compass Communication as a step towards charting Europe's digital development for the next decade. It invited the Commission to widen the European Union's policy toolbox, both at the Union and national level, and to use all available instruments from industrial, trade and competition policy; skills and education; research and innovation policy and long-term funding instruments to facilitate the digital transformation.

In the light of these ambitions and challenges, the Commission proposes a policy programme in the form of a proposal for a Decision of the European Parliament and of the Council establishing the Policy Programme "Path to the Digital Decade" .

To complement the Commission's proposal, this Staff Working Document (SWD) analyses the current digital situation in the European Union and, in light of this analysis, explains in more detail the rationale for the Digital Decade targets and corresponding KPIs as well as the proposed governance framework, mechanisms to set up Multi-Country Projects, and identified enablers.

Chapter 2 introduces the critical factors calling for greater cooperation and the mobilisation of public and private investments within the EU.

Chapter 3 explains how the Digital Decade targets were selected and will be monitored. For each target, it indicates the data source, the rationale for the set target value, the baseline and current trends as well as needed actions and, where possible, the deviation from the current growth path to the one required to achieve the target.

The following chapters explain why the governance framework introduced in the Policy Programme "Path to the Digital Decade" is needed and how it will be implemented to achieve the targets. Chapter 4 illustrates the stages of the proposed cycle of cooperation and coordination between the Union Institutions and the Member States. Chapter 5 exemplifies how a new, complementary mechanism to implement Multi-Country Projects will help to achieve scaled up, coordinated and targeted investments in critical areas to close persistent capacity gaps. Lastly, Chapter 6 explains why radio spectrum has been identified as a key enabler and how the Commission intends to facilitate spectrum coordination and assignment to meet the connectivity targets.

The SWD is based on several inputs, ranging from existing studies to results of an extensive consultation process. To gather feedback on the purpose and scope of the Policy Programme "Path to the Digital Decade", the Commission published a roadmap[1] for a four week feedback period (between 24 June and 22 July 2021) and launched a six week targeted public consultation[2] (from 22 June to 3 August 2021). In order to ensure the widest possible engagement of representatives from of civil society, industry, business and government, the Commission and the Portuguese Presidency of the Council of the European Union co-organised the high level event Leading the Digital Decade (LDD) on 1-2 June. Moreover, the Commission engaged in inter-institutional discussions including a policy debate in the Transport, Telecommunications and Energy Council (TTE) on 4 June 2021; the 15th meeting of the Digital Single Market Strategic Group (DSM SG) on 24 June 2021; and consultations with the European Economic and Social Committee (EESC) and the European Committee of the Regions. The Commission also took into account position papers from Member States and organisations as well as opinions from the EESC, the Radio Spectrum Policy Group (RSPG) and regional parliaments. A Digital Compass Community on the Futurium platform[3] continues to allow stakeholders to learn more about the specific areas covered by the policy initiative and to share their own ideas for accelerating the EU's digital transformation. The consultation results are referenced throughout the document and summarized in Annex I.

2. THE STARTING POINT: NEED FOR COMMON GOVERNANCE AND COORDINATED INVESTMENTS

The acceleration of the digital transformation together with the impacts of the COVID-19 pandemic are reinforcing the central role of digitalisation for our future prosperity, our innovation capacity, our future standard of living as well as our social mode. The crisis also highlighted the geopolitical dimension of digital technologies, their supply chain, and with it the critical stakes linked to EU's industry capacity to scale up and capture the markets of the future.

The long standing rise of digital technologies in all dimensions of Europeans' lives is rocketing, as examplified by the value of data produced in Europe alone, which now amounts to EUR 1.5 trillion a year. However, the crisis also exasperated persistent digital divides, not only between well-connected urban areas and rural and remote territories, but also between those who can fully benefit from an enriched, accessible and secure digital space with a full range of services, and those who cannot. A similar divide emerged between those businesses already able to leverage the full potential of the digital environment and those not yet fully digitalised. In this sense, the COVID-19 pandemic has exposed a new "digital poverty", making it imperative to ensure that all citizens and businesses in Europe can leverage the digital transformation for a better and more prosperous life. Resilient, secure and trustworthy infrastructures and technologies are indispensable to ensure the respect of European rules and values.

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[1] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13089-Policy-programme-Digital-Decade-Compass_en.

[2] https://digital-strategy.ec.europa.eu/en/consultations/consultation-and-discussion-forum-eus-2030-digital-decade-vision.

[3] https://futurium.ec.europa.eu/en/digital-compass.

The pandemic notably shed a harsh light on the critical drivers for change that the EU needs to mobilise urgently in order to ensure a successful digital transformation anchored it in its own values.

Firstly, **there is a need to urgently tackle persistent issues** that still prevent a successful digital transformation and thereby obstruct the EU's technological leadership and widen digital divides. This includes, for example, the lack of digital skills, insufficient infrastructure development, and slow digitalisation of the private and public sector. Despite recent efforts, the total annual investment gap for the digital transformation remains significant and is estimated to amount to EUR 125billion (e.g., EUR 42billion in communication networks, EUR 17bn in semiconductors, EUR 11billion in cloud)[4]. In 2019, only 56% of adults had at least basic digital skills, reflecting limited progresses since 2015 (i.e., increase of only 2 percentage points). In such a context, the EU needs to step up coordinated efforts across Member States in critical dimensions of the digital transformation.

Secondly, **Europe is increasingly dependent on other regions for key digital capacities**, such as processors computing systems, data infrastructure and web platforms. The position of European players is far below EU's global economic weight in these key technology areas. For example, 90% of the EU's data are managed by US companies and less than 4% of the top online platforms are European. European-made microchips represent less than 10 % of the European market today, compared to 40% only 30 years ago. This situation has very concrete and difficult implications: Several automotive production plants have had to stop production in 2021 because of lack of components. Without action, this situation risks deteriorating further. Even though US companies already account for 48% of the world's chip sales, the US government plans to reinforce its investments with USD 52 billion dedicated to supporting semiconductor manufacturing and research in the US. These investments are taking place in the context of a growing technological confrontation between the US and China. China, which is aiming to become the world leader in the semiconductor field in the next decade, is upgrading further its subsidies and research spending on cutting-edge chips and artificial intelligence[5]. Reversing the above mentioned trend and matching our competitors' commitment[6] would require a very significant supplementary collective effort from the Union in all critical digital technologies including 5G, cloud and AI. Only for the microprocessor sector, and taking into account the projected market size of USD 1 trillion by 2030, the EU would have to multiply its annual sales by a factor of 4-5 to achieve 20% in value of the world market by 2030. Such effort should address key strategic digital technologies and would be part of the EU's attempt to reinforce its digital sovereignty, carefully monitoring, assessing and addressing any strategic dependencies weaknesses and vulnerabilities which put at risk the attainment of its digital ambitions as well as its capacity to shape a digital transformation that reflects its values.

Thirdly, a very significant **increase of investments is also necessary**, notably to allow the EU to develop critical and disruptive technologies in a way that fosters its productivity grow.

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[4] SWD(2020) 98 *Identifying Europe's recovery needs,* Table 2 on p 18.
[5] https://www.bloomberg.com/news/articles/2021-03-05/chinese-premier-calls-for-major-breakthroughs-in-core-tech
[6] On 24 February, President Biden signed an Executive Order (EO) on Securing America's Critical Supply Chains. The objective is to help strengthen supply chain resiliency and build capacity by increasing domestic production and decreasing dependence on foreign competitors. A next set of reviews of various is expected to be completed by next February, including defence, public health and biological preparedness, ICT, transportation, energy, and agricultural commodities and food production.

Currently, the public and private investment gap between the EU and digital frontrunners (e.g., US, China) amounts to EUR 350-400 billion a year[7]. This investment gap is particularly important for the financing of disruptive innovation and start-ups and is far from closing[8], with potentially important adverse risk on EU's future prosperity, growth and employment. A pre-COVID analysis highlighted digital disruptive technologies can contribute 1,1 % to annual GDP growth in the period 2017-2030, with a cumulative net effect of 14.1 % higher GDP by 2030[9].

Fourthly, these dependencies and need for investment happen in the context of a **lack of convergence across Member States**. The digital transformation is not operating at a sufficient pace and remains limited in some areas, preventing EU actors to leverage the full potential of the single market through economies of scale. The Digital Economy and Society Index (DESI), which tracks the evolution of EU Member States in digital competitiveness since 2015, shows that most countries with below average levels of digitisation have not progressed much in the last five years[10]. This situation is linked to a lack of common goals and efforts and to remaining obstacles to the single market. Without a common coordination mechanism the current status will not improve and the Union, as a whole, will not achieve the objectives and targets of the Digital Compass Communication. That is why the Policy Programme "Path to the Digital Decade" is designed not as another reporting process but as a game changer that seeks to improve the level of consensus among Member States and to facilitate action through a fully-fledged new governance system enabling to quickly take concrete actions. However, the coordination mechanism designed in the Policy Programme "Path to the Digital Decade" needs to be flexible and dynamic to adjust to new digital technological developments and recognize different starting points among Member States and their level of specialisation. There may be different efforts needed in different fields addressed by the Policy Programme "Path to the Digital Decade" that require well-coordinated effort sharing between the Member States instead of a of 'one fits all' actions.

Fifthly, the current situation will not be able to build the necessary synergies between **the green and digital transitions** enabling the EU to reach its climate target, as digital solutions can help in cutting 15-20% of global greenhouse gas emissions by 2030. Fostering this transition will also request major investment by industry in green digital technologies and start-ups that are focused on developing innovative technology solutions that make an important contribution to reducing greenhouse gas emissions. The investment gap to identify and develop digital solutions for climate mitigation and climate adoption across all sectors of the economy amounts to more than EUR 6 billion a year, targeting digital solutions in reducing GHG emissions in sectors such as transport, smart energy networks (smart grids), manufacturing (industry 4.0), smart cities and sustainable agriculture (precision farming).These baselines and ongoing trends show that without sustained and game-changing actions, the EU will not succeed to shape the digital transformation it aims for - i.e. demonstrating digital leadership to empower businesses and people in a human centred, sustainable and more prosperous digital future - and mobilising the means and processes

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[7] McKinsey. Shaping the digital transformation in Europe, September 2020.
[8] Six times more as compared with the US and 2,5 times more with China. Mind the Bridge. Tech Scale-up Europe – 2019 Report. The US has seen approximately €60 billion of annual investment in AI/big data companies in 2018-2019, compared to approximately €5 billion spent in Europe and approximately €17 billion in China.
[9] https://digital-strategy.ec.europa.eu/en/library/shaping-digital-transformation-europe-working-paper-economic-potential
[10] https://ec.europa.eu/digital-single-market/en/digital-economy-and-society-index-desi

necessary to deliver it. The above analysis is strongly supported by the views expressed by citizens, Member States and stakeholders from industry, business and civil society in the context of the consultation process.

Responses to the targeted consultation further reinforced the need for action.

Almost all respondents agree that the pandemic demonstrated a need to accelerate the pace of the digital transformation (95.5%) and ensure that everyone can fully benefit from it (95,5%). This assessment was often backed up by reference to personal experience. Notably, the pandemic altered respondents' need for and reliance on secure, performant and sustainable digital infrastructures (89.7%), followed by digital public services (86.1%), digital products, tools, and services (85.5%), a digitally skilled population (81.3%), and highly skilled digital professionals (72%).

There is broad agreement across stakeholder groups that it is important to have a solid cooperation mechanism in place to drive European progress on all of these fronts. A large majority of respondents to the targeted consultation identified substantially increasing investments (90.7%) and coordinating the digitalisation efforts of Member States (78.8%) as crucial drivers for the EU's successful digital transformation. Most see strong benefits in the proposed monitoring and cooperation mechanism, finding it extremely or very relevant that it supports the development and implementation of Multi-Country Projects (75.4%), that it sends a clear signal to market actors to incentivise private investments (73.6%), that it ensures the effective delivery of Digital Decade goals on an EU level (70.9%), and that it stimulates cooperation between Member States (68.5%).

Many stakeholders also underline the importance of common governance and coordinated investment for ensuring that the digital transformation advances in the interest of a more inclusive, sustainable and prosperous future for all. Civil society stakeholders called for a robust governance framework to stimulate and direct investments in a socially and environmentally responsible way that places citizen's rights at the center. Industry stakeholders would like to see more coordinated policies to align investment friendly conditions, particularly for the deployment of digital infrastructures, across the EU. Businesses and public administrations emphasized the importance of legal certainty and interoperability for the digitalization of their operations and services.

Against this background, the following sections present further detailed evidence to complement and support the Policy Programme "Path to the Digital Decade" .

3. TARGETS

3.1. Introduction

On targets and indicators, the Policy Programme "Path to the Digital Decade" relies on an enhanced Digital Economy and Society Index (DESI), a composite index that monitors Europe's digital performance and tracks the evolution of EU Member States in digital competitiveness, including the analysis of national digital policies[11]. DESI indicators are based on Eurostat data and alternative sources such as data collections through multi-annual

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[11] DESI's thematic reports will continue to present a quantitative analysis of a broad set of indicators for the four cardinal points and other aspects of digital (such as an analysis of the ICT sector and EU spending on ICT projects) at EU level.

studies. They will serve as the analytical basis for the Report on the state of the Digital Decade (RSDD). In this regard, Member States expressed strong support for enhancing DESI as a monitoring tool for the Digital Decade, with consistent but adaptable indicators to facilitate comparisons across time and space.

When selecting targets, the Commission looked at existing Key Performance Indicators (KPIs), having in mind that targets need to be measurable in order to be monitored. These KPIs are outlined in table below. The choice of lead KPIs was guided by existing KPIs which are currently monitored in the DESI. For the majority of the targets, where a data collection is already in place, the baseline and data source are presented in this Staff Working Document. As explained below, there are also potential KPIs where studies (ongoing or future) or other sources are needed, methodologies still to be developed or relevant data still to be acquired to measure progress towards the 2030 targets.

Currently existing Key Performance Indicators (KPIs)

1. A digitally skilled population and highly skilled digital professionals

    (a) At least basic digital skills *(Member State level)*

    This measures the percentage of individuals with 'basic' or 'above basic' digital skills in each area of the Digital Competence Framework.
    Data source: Eurostat Community survey on ICT usage in households and by individuals.

    (b) ICT specialists *(Member State level)*

    This measures the percentage[12] of the workforce employed as ICT specialists, using a broad definition based on the ISCO-08 classification and including jobs such as ICT service managers, professionals, technicians, installers and servicers.
    Data source: Eurostat labour force survey.

    (c) Female ICT specialists *(Member State level)*

    This measures the percentage of ICT specialists who are women.
    Data source: Eurostat labour force survey.

2. Secure, efficient and sustainable digital infrastructures

    (a) Gigabit coverage *(Member State level)*

    This measures the percentage of households covered by a network capable of gigabit speeds. At the current state of technological development, in line with the principle of technological neutrality, the technologies able to provide gigabit download speeds are fibre to the home, fibre to the building, and cable Docsis 3.1. However each of these technologies is subject to different performance levels for the uplink.
    Data source: 'Broadband coverage in Europe' studies by IHS Markit, Omdia and Point Topic.

    (b) 5G coverage *(Member State level)*

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[12] To ease cross-country comparisons, figures at Member States level will be expressed as the percentage of the workforce.

This measures the percentage of populated areas, including the most remote regions, covered by at least one 5G network.

Data source: 'Broadband coverage in Europe' studies by IHS Markit, Omdia and Point Topic .

3. Digital transformation of businesses

    (a) SMEs with at least a basic level of digital intensity *(Member State level)*

    This measures the percentage of SMEs using at least four of 12 selected digital technologies[13].

    Data source: Eurostat Community survey on ICT usage and e-commerce in enterprises.

    (b) Cloud computing *(Member State level)*

    This measures the percentage of enterprises using at least one of the following cloud computing services:
    - hosting of the enterprise's databases;

    - accounting software applications;

    - CRM software and computing power.

    Data source: Eurostat Community survey on ICT usage and e-commerce in enterprises.

    (c) Big data *(Member State level)*

    This measures the percentage of enterprises analysing big data from any data source (internal or external).

    Data source: Eurostat Community survey on ICT usage and e-commerce in enterprises.

    (d) Artificial intelligence *(Member State level)*

    This measures the percentage of enterprises using at least two artificial intelligence technologies.

    Data source: European enterprise survey on the use of technologies based on artificial intelligence by IPSOS..

    (e) 'Unicorns' *(only at Union level)*

    This measures the sum of realised 'unicorns' (i.e. companies founded after 1990 that have had an initial public offering (IPO) or trade sale above USD 1 billion) and unrealised 'unicorns' (i.e. companies that were valued at USD 1 billion or more in their last private venture funding round, meaning the valuation has not been confirmed in a secondary transaction).

    Data source: Dealroom

4. Digitalisation of public services

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[13] The list of technologies varies every year. In 2020, it included the following: internet for at least 50% of employed people, employment of ICT specialists, fast broadband (30 Mbps or above), mobile internet devices for at least 20% of employed people, a website, a website with sophisticated functions, 3D printing, advanced cloud computing, e-invoices, industrial or service robots, e-commerce turnover accounting for over 1% of total turnover and big data.

The following services are considered for the below KPIs:

- regular business operations;

- moving house;

- owning and driving a car;

- starting a small claims procedure;

- a business start-up;

- family life;

- losing and finding a job;

- studying.

(a) Online provision of key public services for citizens *(Member State level)*

This measures the degree to which people can complete major procedures with the public administration completely online.

Data source*: e-government benchmark studies* by *Capgemini.*

(b) Online provision of key public services for businesses *(Member State level)*

This measures the degree to which businesses (i.e. enterprises defined as economic undertakings established in one of the Member States) can carry out various steps in dealing with the public administration completely online.

Data source: e-Government benchmark studies by Capgemini.

Figure 1: Key Performance Indicators (KPIs)

Clearly, not all of the Digital Decade targets require common efforts across all Member States to be reached and not all need to be mirrored at national level. Instead some of the targets require a degree of specialisation of some Member States. In the latter case, the different potential of Member States to contribute to the Union level targets will be taken into account and developed in the future through national strategic roadmaps. When the current baseline data at the level of Member States is available in DESI, they are presented in the analysis below.

Building on the current practice and with an enhanced set of indicators, the RSDD will analyse the performance at EU level and of each Member State across the cardinal points of the Policy Programme "Path to the Digital Decade", based on the DESI index and a description of national policies. Additional indicators will be introduced to capture all KPIs necessary to monitor progress towards the 2030 targets. As KPIs are in constant evolution in the area of digital, some definitions, data sources and methodologies may change over time to improve the quality of statistics. These changes will be reflected in the subsequent reports. Such modifications may also result in a break in series in the statistical data, requiring adjustments or revision of the related trajectories.

In consultation with the Member States, and in view of effective monitoring, the Commission will review and update if needed annually key methodological aspects of DESI, including the list and definitions of indicators and the data collection methodologies. The relevant authorities of the Member States are required to contribute to this process. The Commission will implement and if necessary extend its current roadmap in this regard. In addition , in

accordance with Article 5, the Commission will adopt via implementing act the KPIs necessary to monitor each target

Several Member States explicitly welcomed the concreteness and level of ambition of the proposed targets and KPIs, and found that they are well chosen to address the structural shortages and gaps hampering the ability of EU citizens and businesses to take full advantage of the digital transition today. Others combined their support with additional suggestions to expand or adjust the initial list of targets and corresponding KPIs.

This SWD presents the KPIs, baseline and trends available at the time of writing.

3.2. A digitally skilled population and highly skilled digital professionals

3.2.1. Basic digital skills

- *Target:"**80%** of those aged 16-74 have at least basic digital skills"*[14]

- *Baseline (2019): 56%*[15]

- *Source:* Eurostat

- *What is the rationale for the set target value?*

The COVID-19 pandemic has accentuated the necessity of digital skills to be active in society and to participate in the labour market. In an unprecedented and unexpected shift, digital technologies have allowed pupils and students to study remotely, adults to work from home, and the world population to continue socially interacting despite social distancing requirements. A precondition for delivering on the twin transition and for inclusion and participation in the labour market and society is basic digital skills. Therefore all Europeans should have the skills needed to benefit from the digital transformation and no one should be left behind. Achieving the target will require significant reforms and investments at both European and national level in order to support the development of high-performing digital education ecosystems across Europe.

There exists a consensus among stakeholders that insufficient digital education and training are the main bottlenecks on the way to a digitally skilled population. Respondents to the targeted consultation frequently referenced digital divides caused by socio-economic factors, such as income, demographic factors, such as age, or geographic factors, such as limited connection opportunities in rural areas, as a barriers to digital education and skills.

- *What are the baselines and current trends?*

In 2019, only 56% of adults in the EU had at least basic digital skills. There was only a slight increase (2 percentage points) since 2015. The EU will need more than three times higher growth to reach the target of 80% (the current growth rate is only 0.9%). This past growth trend is expected to accelerate due to (1) an increased use of digital tools during the Covid-19 pandemic; (2) less skilled people moving out from the 16-74 years age bracket and (3) more

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[14] Target established in the European Pillar of Social Rights Action Plan: COM/2021/102 final - https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2021:102:FIN

[15] Source: Eurostat - Community survey on ICT usage in Households and by Individuals

digitally skilled young people moving into the same age bracket, and (4) significant investments in digital skills by Member States in their Recovery and Resilience Plans (RRPs).
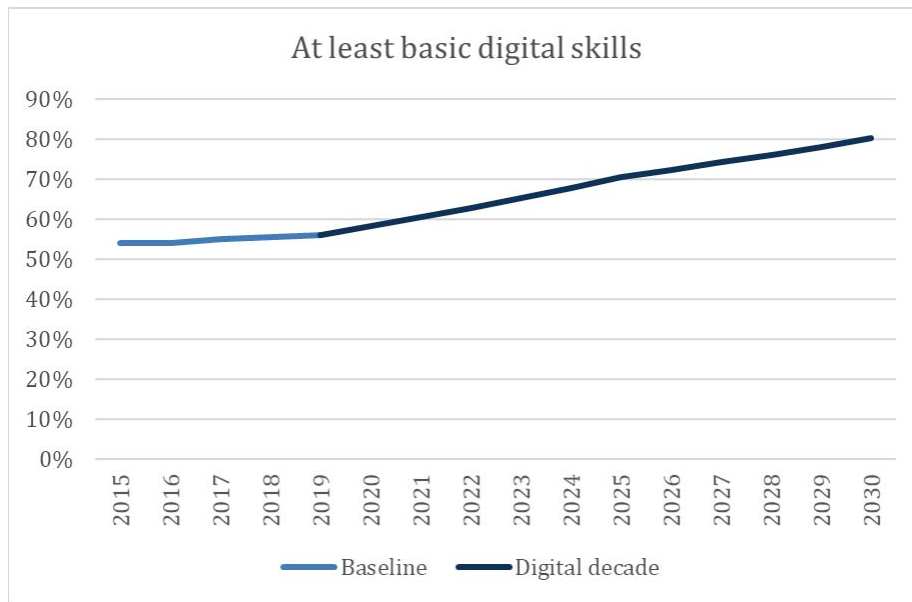
Figure 2: Percentage of adults with at least basic digital skills (EU trajectory to 2030)

Source: Commission services based on data from Eurostat.

As the graph below shows, the situation in different Member States varies significantly. The Netherlands, Finland, Sweden and Germany are the most advanced with more than 70% of the adult population having at least basic digital skills, while Romania and Bulgaria are lagging far behind, with only 30% of the adult population having at least basic digital skills.
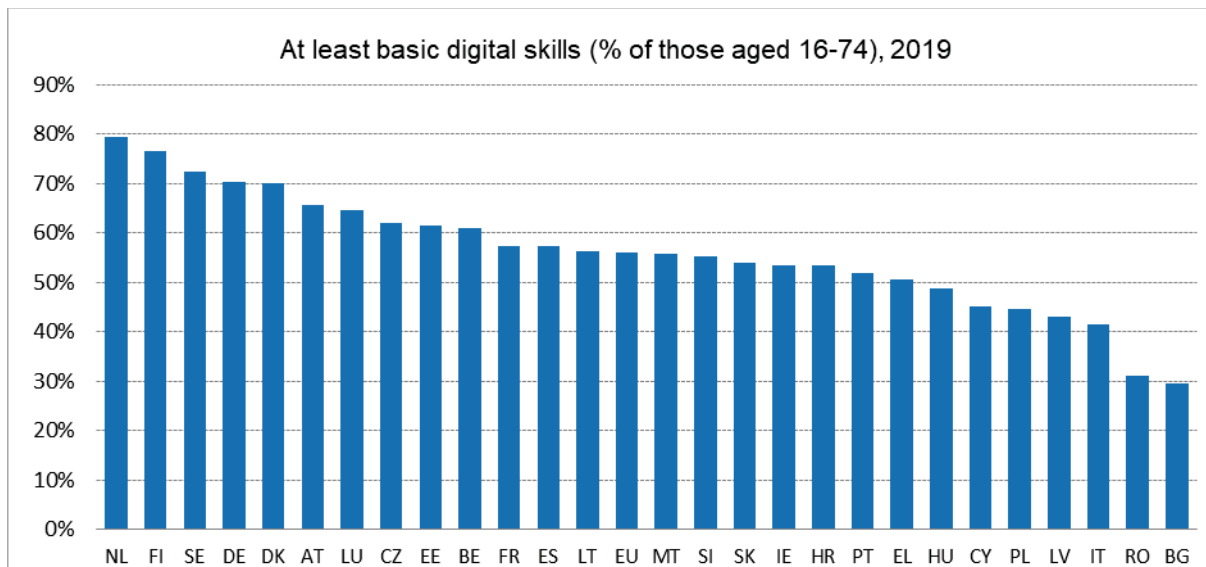
Figure 3: At least basic digital skills (% of those aged 16-74) by Member State, 2019

Source: Eurostat - Community survey on ICT usage in Households and by Individuals.

- *What is needed to achieve the target?*

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In their responses to the targeted consultation, several stakeholders found that Member States' digital skills initiatives would benefit from more guidance and coordinated investment. For example, business stakeholders see a role for the EU in facilitating the exchange of best practices. Social partners emphasized the importance of not only providing but also coordinating funding for digital skills programmes to avoid risking learning disadvantages as a result of unbalanced investment.

The EU already supports Member States with initiatives such as the Digital Education Action Plan 2021-2027[16], which builds on the lessons learned during the pandemic and focusses on a set of concrete actions to achieve its twin strategic priorities of fostering high-performing digital education ecosystems and enhancing digital skills and competences. The European Skills Agenda[17] is a five-year plan that supports the green and digital transitions with initiatives such as the Pact for Skills. It helps mobilise the private sector and other stakeholders to upskill and reskill Europe's workforce. The European Pillar of Social Rights Action Plan[18] supports the development of basic digital skills for the workforce. Moreover, the European Industrial and SME strategy[19], the European Strategy for Data[20] and the Coordinated Action Plan on Artificial Intelligence[21] include actions targeting improving digital skills among the population and workers.

The European Social Fund supports action for digital skills development at local level according to the needs of the territories. The Commission has also carried out a number of different actions to support the development of digital skills in the population. In particular, the Digital Skills and Jobs Coalition has reached nearly 16 million people with trainings and awareness raising activities. The EU Code Week initiative has trained 15 million young Europeans in computing and digital literacy skills. The RRPs include significant investment to boost digital skills: According to a preliminary analysis[22] the budget dedicated to digital skills development accounts for 17% of the total digital budget. A number of countries plan investments and reforms to introduce compulsory digital skills training in primary and secondary curricula, revise text books and train teachers with the necessary competences to use and teach with digital technologies. Reforms to improve adult learning and increase the offer and accessibility of digital training, including to the most vulnerable, are also foreseen, for example by setting up proximity centres to help people learn how to use digital services.

In addition, as proposed also by participants to the consultation process, Member States can put in place a number of reforms and investments to encourage digital skills development for different target groups, which may include:

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[16] COM(2020) 624 final - https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0624
[17] COM/2020/274 final - https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0274
[18] COM/2021/102 final - https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021DC0102
[19] COM/2021/350 final - https://ec.europa.eu/info/sites/default/files/communication-industrial-strategy-update-2020_en.pdf
[20] COM/2020/66 final - https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1593073685620&uri=CELEX%3A52020DC0066
[21] COM/2021/205 final - https://ec.europa.eu/newsroom/dae/redirection/document/75787
[22] The calculations are based on the Recovery and Resilience Plans as approved on 1 September 2021 and on the basis of the methodology for digital tagging set out in Annex VI of the Recovery and Resilience Facility[22], which includes specific Intervention fields for Digital Skills – corresponding to DESI Field 2 Human Capital. These calculations provide a temporary view of the RRF and are without prejudice to the final figures that will only be available once the 27 plans have been adopted.

- Empowering the teaching profession to adopt innovative methods and digital technologies, including through more attractive and stable career paths, flexible pathways into teaching, and improved selection procedures and professional development frameworks.

- Fostering high-performing digital education and training systems by strengthening teachers' initial and continuous training on digital skills, systematic technology integration in pedagogy, updated curricula and assessment approaches, availability of suitable devices, high quality pedagogical content, robust infrastructure, and adequate support to disadvantaged students and those with special needs.

- Integrating computational thinking, computing and digital literacy in the curricula.

- Putting in place funding mechanisms that reduce inequalities in education outcomes between students and schools and allowing schools to respond swiftly to changing needs.

- Investment in digital infrastructure (e.g., high-speed internet connectivity and digital devices). Addressing accessibility and availability of assistive technologies.

- Expanding the availability and accessibility of flexible second chance education programmes tailored to adult learners' diverse needs.

- Addressing SME's barriers in providing training to their workers, e.g., through collaborative approaches between businesses and training providers.

- Making financial support to short-time work schemes conditional on providing relevant on-the-job training to workers (in particular for digital skills).

- Putting in place comprehensive, quality and inclusive adult learning systems, or reforming existing ones to address barriers to participation. Introducing new active labour market policy programmes or adjusting existing ones, drawing on best practices and including a plan for continuous monitoring and evaluation.

- Combining investments in the digital infrastructure of schools with free basic education courses for people with formally low qualifications to ensure that no one gets left behind.

3.2.2. ICT specialists

- *Target:* "**20 million** employed ICT specialists, with **convergence** between women and men"

- *Baseline (2020):* 8.4 million employed ICT specialists, with 19% being women[23]

- *Source:* Eurostat

- *What is the rationale for the set target value?*

The COVID-19 pandemic has further highlighted the need for advanced digital skills, exposed the EU's dependency on foreign technologies, and emphasised how critical safe and robust

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[23] DESI indicator "2b1".

networks and technologies are in the digital and information space. For a successful recovery and to be able to develop and innovate with digital technology, Europe needs to rely on digitally empowered and capable citizens, a digitally skilled workforce and substantial increase of digital experts.

Throughout the consultation process, business representatives repeatedly pointed to the importance of digital skills for facilitating the digital transformation of SMEs and supporting the creation of innovative companies and unicorns in the EU. Representatives of SMEs placed particular emphasis on the need for a joined approach to upskilling and reskilling of the workforce to cope with the new labour demand.

To emerge from the crisis as a digital leader, the EU must rely on ICT specialists who are able to develop, operate, and maintain information and communications technology systems in a digitally accessible way, respecting EU values. ICT specialists are defined as those who have the ability to develop, operate and maintain ICT systems and for whom ICT constitutes the main part of their job. The European Union currently faces a critical shortage of such specialists across all Member States, hampering the development, uptake and use of emerging key digital technologies. Training and education should therefore support a workforce in which women and men can acquire specialised digital skills in areas such as Artificial Intelligence, quantum computing and cybersecurity, while striving to close the gender imbalance in the field. ICT specialization in digital accessibility can also support the inclusion of people with disabilities in the workforce through their involvement in the accessibility testing of digital environments.

- *What are the baselines and current trends?*

As of 2020, there were 8.4 million ICT specialists, up from 6.1 million in 2013, and with an **annual growth of 4.7 %.** If this growth continues, the EU will have 13.5 million ICT specialists by 2030 under a 'business as usual' scenario. This is far from being enough in order to reach the target of 20 million by 2030. The graph below shows the deviation from the current growth trend that is needed to reach the target of 20 million ICT specialists in 2030.
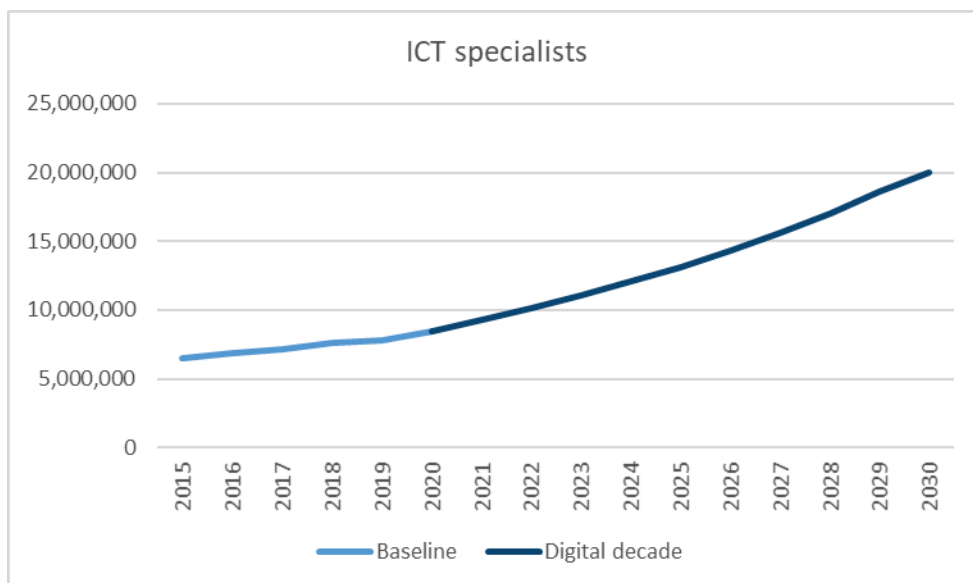
Figure 4: Number of employed ICT specialists (EU projection to 2030)

At EU level, 4.3% of its workforce are ICT specialists, while figures per Member States range from 2% in Greece to 7.6% in Finland. 20 million ICT specialists would correspond to about 10% of the workforce.
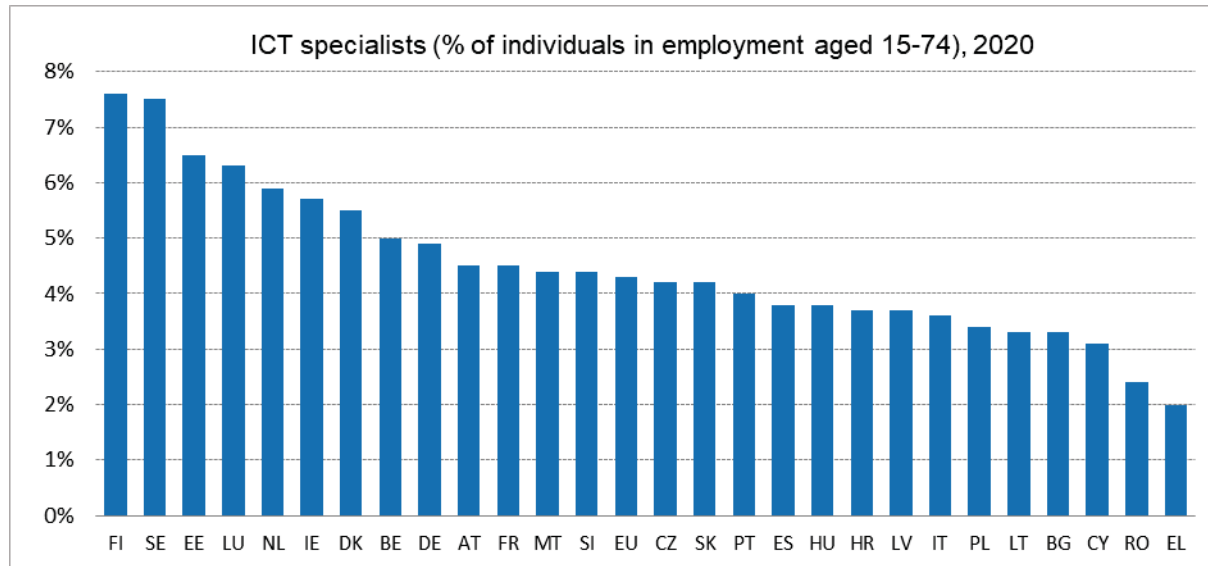
Figure 5 : ICT specialists (% of individuals in employment aged 15-74) by Member State, 2020

The shortage of ICT experts leads to delays in developing new products and services, hampering innovation and growth in all industrial ecosystems, far beyond the ICT sector. The **number of vacancies keeps growing as new jobs emerge**. For example, according to industry research, 168.000 cybersecurity experts were missing in Europe in 2020[24]. Other sources report that there were 341.000 unfilled jobs for data professionals in Europe in 2020[25]. The European electronics industry, for example, is facing an acute shortage of skills in all tiers of its value chain. The number of open positions for electronics engineers is growing at an alarming rate. More generally, nearly 1.1 million job advertisements for electro engineering workers (overall, not only microelectronics) were placed in the EU between mid-2018 and end-2019[26]. The demand for ICT expertise varies depending on the industry[27] and across regions. For instance, the most demanded ICT skills in Central and Eastern Europe are related to manufacturing and resources, while distribution and services will be most important in Western Europe[28].

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[24] https://www.isc2.org/Research/Workforce-Study#

[25] https://datalandscape.eu/sites/default/files/report/D2.9_EDM_Final_study_report_16.06.2020_IDC_pdf.pdf

[26] Cedefop

[27] Eurostat data: Enterprises employing, recruiting and having hard-to-fill vacancies for ICT specialists, by economic activity, EU, 2020 (% enterprises)

[28] IDC, European IT Spending Forecast, 2019-2023: Key Digital Trends Across European Industries

More than 77% of businesses report the lack of staff with adequate skills, as an obstacle to investment posing particular problems for innovative and digitalising firms[29]. There is also a severe gender imbalance, with only one in six ICT specialists and one in three STEM (Science, Technology, Engineering, Mathematics) graduates being women.[30] Finally, this is compounded by a lack of capacity in terms of specialised education programmes in areas such as Artificial Intelligence, quantum and cybersecurity and by a low integration of digital topics in other disciplines.

- *What is needed to achieve the target?*

The Commission already has several instruments in place to contribute to the attainment of the ICT specialists target, in particular the Digital Europe Programme, which devotes almost EUR 600 million to the development of advanced digital skills in cutting-edge domains[31]. Universities, VET, training providers, research and excellence centres will join forces to deliver high-quality training in areas like cybersecurity, artificial intelligence, cloud or data.

Under the Digital Education Action Plan 2021-2027, the Digital Opportunity Traineeships scheme[32] provides trainees with the opportunity to strengthen their ICT-specific skills in fields such as cybersecurity, big data, quantum technology and machine learning, and to boost digital skills for businesses in areas including web design, digital marketing and software development. The Action Plan also includes activities supporting young female students to develop their digital and entrepreneurship competences[33].

The Joint Undertaking on high-performance computing (HPC) is expected to support actions for advanced digital skills development in HPC to train specialists able to design, deploy, operate and exploit the fastest super computers in the world[34]. The Artificial Intelligence Coordinated Plan[35] includes actions to boost the number of AI specialists in the EU, introduce AI and computational thinking in education and also train professionals in non-ICT fields to use and understand AI applications. In the field of microelectronics, a number of CEOs have already committed to upskill and reskill their workforce to reduce shortages in this domain and they have joined the Pact for Skills[36].

Investment for advanced digital skills development appears to be less present in the RRPs compared to basic skills. Measures address notably the strengthening of higher education institutions, both by encouraging cooperation with other organisations, also cross-border, supporting students participation and, in some cases, developing an increased offer in STEM and digital courses, available also to people already in employment.

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[29] EIB investment report 2019/2020 Accelerating Europe's transformation:
https://www.eib.org/attachments/efs/economic_investment_report_2019_key_findings_en.pdf
[30] Women in Digital Scoreboard 2020: https://ec.europa.eu/digital-single-market/en/news/women-digital-scoreboard-2020.
[31] https://digital-strategy.ec.europa.eu/en/activities/skills-digital-programme
[32] https://ec.europa.eu/education/education-in-the-eu/digital-education-action-plan/action-12_en
[33] https://ec.europa.eu/education/education-in-the-eu/digital-education-action-plan/action-13_en
[34] Training and Education on High Performance Computing | European High Performance Computer Joint Undertaking (europa.eu)
[35] https://digital-strategy.ec.europa.eu/en/library/coordinated-plan-artificial-intelligence-2021-review
[36] https://ec.europa.eu/social/main.jsp?catId=1517&langId=en

In addition, as proposed also by participants to the consultation process, Member States can put in place a number of reforms and investments to increase the number of ICT specialists, which may include:

- Developing and supporting the offer of shorter courses with flexible modes of study (part-time, distance) in key digital technologies, leading to micro-credentials.

- Introducing performance-oriented funding schemes, setting up competitive programmes for funding of research and educational innovations and independent quality institutions.

- Developing skills projection and graduate tracking mechanisms and using the resulting insights to update the higher education offer.

- Promoting the development of new higher education curricula for engineering, ICT and advanced digital technologies and provide flexibility to hiring non-academic staff proficient in digital technologies, involving employers in curriculum reform.

- Investing in sustainable education and training infrastructure and renovating existing buildings. Investing in courses in advanced digital technologies such as artificial intelligence and cybersecurity as well as in integrated competence centres, industries and universities that can deliver an ecosystem of excellence to attract and retain talent.

- Introducing work-study training programs to reduce the gap between the supply of higher education and the demand of companies.

- Designing a collaborative intelligence programme so that engineers and related professionals around the world can contribute their knowledge.

- Promoting powerful campaigns, starting in primary schools, to encourage young girls in scientific and technological disciplines and spark a broad social dialogue about gender in ICT professions.

3.3. Secure and performant sustainable digital infrastructures

3.3.1. Connectivity

- *Target:* **"All European households** will be covered by **a Gigabit network,** with **all populated areas** covered by **5G"** [37]

For its prosperity, the European Union needs a digital connectivity infrastructure of top performance, security and sustainability, optimised to leverage the latest optical fibre technologies in fixed networks and to connect innovative wireless systems such as 5G, 6G and Wi-Fi.

3.3.1.1. Gigabit coverage

- *Target:* **All European households** will be covered by **a Gigabit network**

- *Baseline* (2020)[38]: 59%

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[37] Continuation and extension of the Gigabit society targets for 2025, which are that all European households, urban or rural, will have access to internet connectivity of at least 100 Mbps upgradable to Gigabit; Gigabit connectivity for all main socio-economic drivers (…) as well as digitally intensive enterprises; all urban areas and major terrestrial transport paths to have uninterrupted 5G coverage by 2025.

- *Source:* Broadband Coverage in Europe studies[39]

- *What is the rationale for the set target value?*

Societal needs for upload and download bandwidth are constantly growing. By 2030, networks with gigabit speeds should become available at accessible conditions for all those who need or wish such capacity. A universal Gigabit target is needed to ensure that all EU citizens and businesses are reached by at least one modern, energy efficient and future proof digital connectivity infrastructure wherever they live or work. Similar to electricity, these data transport networks are the precondition for citizens and enterprises to benefit from new digital communications services and capabilities. In particular, the amount of information that light can carry as a data transmission medium on optical networks that reach all end-users' premises and wireless communications' base stations can be considered as a reference point to what is the most sustainable and future-proof solution to address the exponential growth of data traffic. Although the cost of reaching remote locations with Gigabit networks may be proportionally high, advanced connectivity will play an essential role to avoid the depopulation of those areas, delivering digital services (both public and commercial) and supporting economic activity. For this reason the proposed target has a universal scope.

- *What are the baselines and current trends?*

In 2020, fixed very high capacity networks (fixed VHCN)[40] covered 59% of EU households. In Malta, Luxembourg, Denmark and Spain fixed VHCN is available in at least 90% of households, while in Greece only one in ten households has such coverage.

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[38] Gigabit coverage is currently measured by the DESI indicator "Percentage of households covered by any fixed Very High Capacity Networks (VHCN)" . The types of networks taken into account for the calculation of this indicator are: "Fibre to the Home" (FTTH), Fibre to the building ("FTTB") and Cable "Docsis 3.1", which are generally capable to deliver at least a 1Gbps downlink. Although significant improvements have been made in mobile data rates, at this stage mobile broadband connections are not taken into account. Space-based assets can also contribute to reach the 100% target by covering users located in remote and/or sparsely populated areas hard to reach otherwise, but are not currently considered a functional equivalent to fixed VHCN technologies. For a legal definition of VHCN, see Art. 2(2) of Directive (EU) 2018/1972 and BEREC guidelines on very high capacity networks (BoR (20) 165).

39 IHS Markit, Omdia and Point Topic: "Broadband Coverage in Europe" studies, see: https://digital-strategy.ec.europa.eu/en/policies/desi-connectivity

[40] DESI indicator "Percentage of households covered by any fixed Very High Capacity Networks (VHCN)" . The types of networks taken into account for the calculation of this indicator are: "Fibre to the Home" (FTTH), Fibre to the building ("FTTB") and Cable "Docsis 3.1", which are generally capable to deliver at least a 1Gbps downlink. However, these technologies are respectively subject to different performance levels for the uplink.

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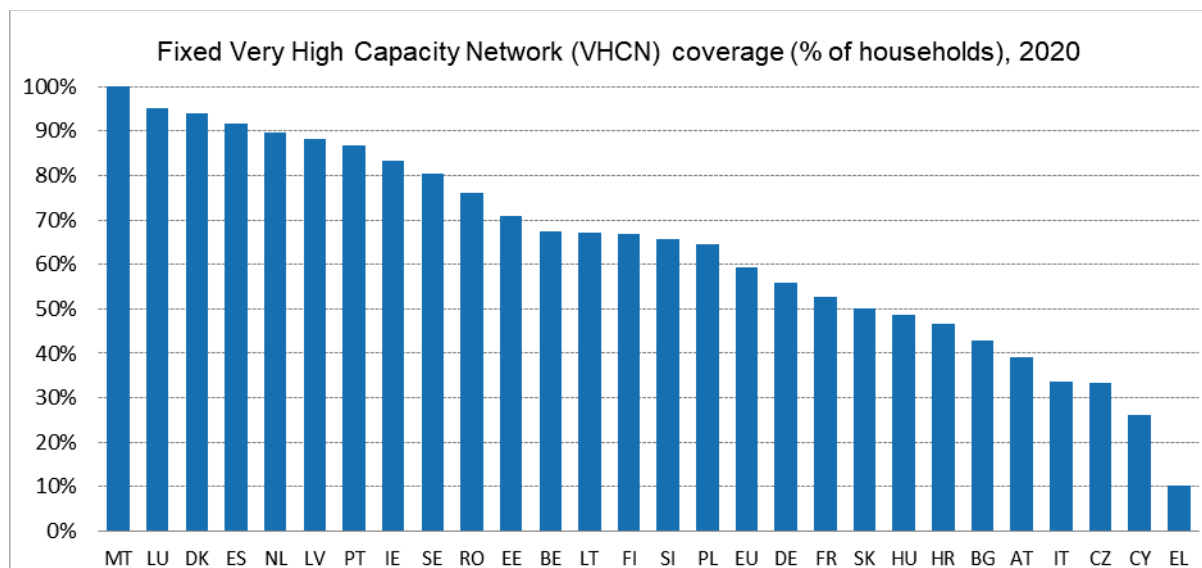
Figure 6: Fixed Very High Capacity Network (VHCN) coverage (% of households) by Member State, 2020

Source: IHS Markit, Omdia and Point Topic, Broadband coverage in Europe studies.

Today, the total European Fiber to the Premises (FTTP) take-up rate of approximately 41%[41] is generally lower than in the Asian countries where fibre networks have already been deployed[42]. A relatively low take-up rate can also be observed in Members States and regions where fibre-based Gigabit offers are readily available[43]. The main drivers of such demand are user experiences with Gigabit connectivity at work or at school/university as well as competitive affordability[44]. In order to meet the connectivity demands of its consumers and businesses in Europe, it will be necessary to accelerate investment in such optical fibre networks within the next few years, which will also have long-term operational cost saving potentential for operators[45].

This is why a relatively high growth rate for Gigabit coverage is assumed in the years to come, followed by a slowdown towards the end of the decade. This is a result of the increasing unit costs when reaching rural areas.

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[41] Analysis Mason "Full-fibre access as strategic infrastructure: strengthening public policy for Europe" June 2020

[42] According to Analysis Mason (2020), this is due to the fact that during the first years of the digital transition, Europe benefited from widely deployed and performant copper broadband networks. By contrast, many Asia–Pacific countries have already deployed optical fibre infrastructures, which are now also booming in Latin America, South and Southeast Asia. Europe is therefore competing not only with other advanced economies like China and Japan, but also with many emerging economies in modernising the connectivity networks on which digital transformation builds.

[43] Such as in Spain, Sweden, and Portugal.

[44] "Entry-level FTTP frequently commands a similar price to, and sometimes even a lower price than, copper-based legacy alternatives. Obviously a better service at a lower price is a winning formula." Analysys Mason, June 2020.

[45] According to Analysys Mason (June 2020), due to the passive nature of PON FTTP networks, operators can realise Opex savings compared to copper and cable networks, which rely on powered active equipment in the field and require cooling. Decommissioning the copper network allows operators to consolidate their central offices and to reduces the energy consumption per line from central office equipment to around a tenth of that for the copper acceleration technologies VDSL2 and G.fast and for DOCSIS 3.1.
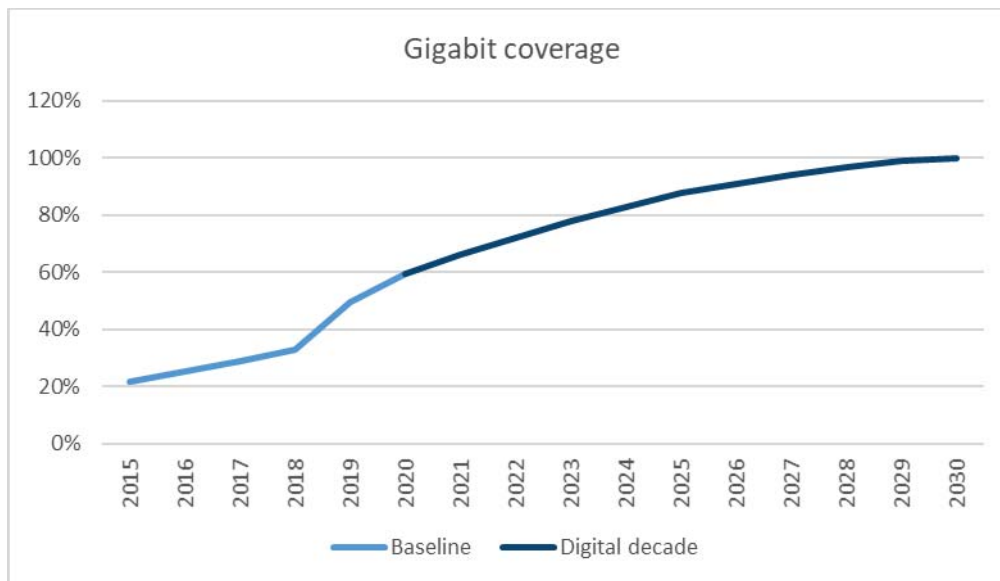
Figure 7: Percentage of households covered by a Gigabit network (EU projection to 2030)

Source: Commission services based on data from IHS Markit, Omdia and Point Topic.

This preliminary projection is based on currently observed trends and expected future trends. Already before the COVID-19 pandemic, while purchases of broadband services have stabilised, data usage has continued to grow at a significant pace. Cisco and other analysts foresee a gradual migration away from broadcast and "managed" television towards online viewing. For example, 92% of global Internet users watch videos online each month and 58% stream TV content via the Internet. At a global scale, Internet users already spend 6:42 hours per day on the Internet, of which 2:16 are dedicated to social media.[46]

The drastic confinement measures taken during the acute phase of the pandemic forced an unprecedented number of people to resort to their home internet access for work, education and leisure. This resulted in a sharp increase of network traffic, driven primarily by video related services. According to ETNO[47], up to 50% increase in voice traffic, up to 40% increase in mobile data traffic, and up to 70% in fixed data traffic were observed. Thanks to the targeted actions of EU operators there were no major episodes of congestion; however, the limits of the existing network infrastructure became evident. The key facts are that, following the pandemic, more citizens will work or study from home, more companies will use digital communication to reach customers and operate industrial processes remotely and more government institutions will use digital technologies to provide public services to citizens and companies.

The availability of Gigabit connectivity services will therefore become an increasingly important factor for the attractiveness of regions, cities and even real estate assets. This will create demand that can accelerate the ongoing trend to modernise digital connectivity networks by replacing copper with fibre cables, thus increasing their capacity and lowering

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[46] WIK Report: "Future electronic communications product and service markets subject to ex-ante regulation Recommendation on relevant markets", 2020 ("WIK Report" see: Study on Future electronic communications product and service markets subject to ex-ante regulation | Shaping Europe's digital future (europa.eu)).
[47] ETNO Policy Note: The role of Digital Communications at the time of COVID-19

the operational energy consumption per data transmitted[48]. Also the deployment of 5G wireless networks will depend on optical fibre backhaul infrastructures to provide very high quality wireless connectivity.

Analysis of household behaviour and upcoming digital use cases suggests that both residential and business consumers will progressively require Gigabit connections to meet their needs, such as use of improved video standards, cloud services, applications based on virtual and augmented reality, artificial intelligence (AI) applications, automated driving, logistics and manufacturing processes. For some of these applications, in particular those relying on real-time, distributed data processing capacities, users will produce and share as much data as they consume, requiring the underlying connectivity infrastructure to support in a reliable manner increased balance of upload and download speeds and low latency. Even though some improvements of existing copper networks can be obtained (e.g., through vectoring technologies over copper networks), ultimately, it is the progressive replacement of copper-based sections of the infrastructure with fibre elements that will drive significant performance gains.

Although today some of the connectivity needs of regular businesses still can be met by standard mass products[49], the connectivity needs of digitally intensive businesses can increasingly only be met with fibre broadband connection reaching closer and closer to the end users, such as Fibre to the Premises (FttP) and upgraded cable connections. Fibre-connections are also key to enabling small and medium-sized enterprises (SMEs) and public sector sites such as schools to drastically reduce own servers, dedicated IT resources and ultimately unnecessary cost.

Well before the end of the decade, digitally intensive businesses in all sectors will need Gigabit connections and data infrastructures with reliable, fast in both uplink and downlink directions, and low-latency fibre access greatly facilitating cloud computing and data processing. The high bandwidth and reliability offered by Gigabit connectivity networks will for instance be important in offices, permitting work outside their premises, faster upload and download of files and more reliable access to Software-as-a-Service and cloud-based software. The flexibility offered by fibre networks together with the increased virtualisation of networks allows the dynamic configuration of up- and down-stream bandwidth depending on business requirements, for instance including holographic and AR-based video conferencing. Many use cases within different industry verticals are also related to developing the necessary IoT systems, with the high bandwidth, security and reliability provided by full fibre networks allowing the transfer of large amounts of data:

- In manufacturing, fibre networks will provide support for industrial IoT based on Wi-Fi 6, or local backhaul for use cases based on 5G, for instance serving as the local area network in industrial or campus sites.

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[48] The race to gigabit fibre | Arthur D Little (adlittle.com)
[49] Explanatory Note accompanying the Commission Recommendation on relevant product and service markets (…), 2020, footnote 94 states that "already today, a significant number of 'high quality' lines have been offered via "mass-market" broadband technologies, including FttH/B, FttC and cable, while the number of symmetric dedicated connections for business (leased lines provided via point to point FttP or copper) has remained stable or in some cases (especially for copper) has been in decline." See: Commission updated the Recommendation on Relevant Markets | Shaping Europe's digital future (europa.eu)

- In the public sector, fibre networks will accelerate the development of 'smart cities' by enabling the application of IoT technology to utilities and services in public spaces, including street lighting, energy, waste and water management.

- In education, fibre networks will enable enhanced digital learning, allowing the download of large amounts of educational content at the same location, immersive learning environments and virtual field trips.

- In healthcare, the higher bandwidths provided by fibre networks will permit more detailed remote patient monitoring using smart sensors, remote video consultation and surgery and remote AI-supported diagnosis.

In addition to the use cases mentioned above, it is probable that other technologies, applications and services will emerge, which will benefit from fibre networks well into the future[50]. High performance computing (HPC) already points at the need for terabit connectivity to allow real-time data processing[51]. All these use cases highlight the importance of reliable Gigabit connectivity offers being available from operators throughout the European Union to support the long-term digital investment of businesses and governments.

As businesses will use digital services, the end users will increasingly take up such Gigabit connectivity offers also at their home and on the move in order to use new digital communications features and capabilities such as high-precision, virtual reality, holographic media, and digital-senses over the networks, and to take part in a digitally enabled society. Moreover, the new ways of working brought about by the pandemic are likely to remain and evolve further in the post-COVID world. For instance, virtual or augmented reality technology can be used to enhance the experience of online meetings. Residential demand is therefore likely to also progressively require higher bandwidths and a more balanced distribution of traffic between uplink and downlink speeds.

- *What is needed to achieve the target?*

Stakeholders see a role for the EU in ensuring that the regulatory environment encourages operators to invest in rolling out and increasing the capacity of their networks to anticipate growing user demands. Several industry contributions to the targeted consultation call for more harmonization of conditions for the deployment of connectivity infrastructure and services, e.g., through complete implementation of the European Electronic Communications Code. Others identify the timely review of the Broadband Cost Reduction Directive and the Broadband State Aid Guidelines as a way to improve legal certainty and foster a more efficient and fast deployment of very high capacity networks, including fibre and 5G networks.

As it is critical that an important part of the networks necessary to achieve those targets is deployed primarily by commercial operators[52], the EU has already adopted a series of

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[50] See Analysys Mason, June 2020.
[51] Study on Future electronic communications product and service markets subject to ex-ante regulation | Shaping Europe's digital future (europa.eu)
[52] The EU requires a very high level of investment in broadband networks to achieve the Gigabit targets in 2030, with most of the gap taking place in suburban, semi-rural and rural. There is a considerable consensus among market analysts and experts on this issue, putting the figure on the investments needed for the European Gigabit Society interim targets (by 2025) in the range of EUR 345 to 360 billion for the EU-27, with about one third of this figure potentially coming from already expected private funding, and therefore leaving an investment gap of about EUR 250 billion. See: Ferrandis-et-al.pdf (econstor.eu)

initiatives designed to establish the right conditions for these investments to take place. These consist of a major reform of the regulatory framework for electronic communications, in the form of a European Electronic Communications Code[53], and of other key regulatory measures. Together, these aim to identify the most efficient measures to support and encourage operators to roll-out fibre and 5G.

For example, the Commission adopted on 18 December 2020 a revised Commission Recommendation on relevant product and service markets within the electronic communications sector susceptible to ex ante regulation[54]. This Recommendation is an important regulatory and harmonization tool, which helps to focus regulatory intervention to those product and geographic markets in which significant market failures persist.

The Connectivity Recommendation[55] aims to identify the most efficient measures to support and encourage operators to roll out very high capacity networks, including fibre and 5G. The Recommendation was followed by the publication of a Connectivity Toolbox[56], agreed by Member States in close cooperation with the Commission, with best practices to reduce network deployment costs and facilitate access to 5G spectrum.

The review of the Broadband Cost Reduction Directive[57] will provide an important opportunity to foster a more efficient and fast deployment of very high capacity networks, including fibre and 5G networks. In particular, the review aims at simplifying procedures and reducing further the administrative burden associated with the deployment of such networks, at enhancing transparency, and harnessing the potential of additional assets suitable for network deployments. Moreover, the Commission is currently revising two recommendations issued in the early 2010s in the field of access regulation, with a view to further encourage the deployment of very high capacity networks, in line with the European Electronic Communications Code.

Finally, in its 2021 to 2027 budget, the EU has made available funds complementing national and local support through several programmes and is updating the relevant state aid rules in line with the 2030 targets[58]. As a first step, the General Block Exemption Regulation has been amended to include inter alia additional possibilities for Member States to support the deployment of fixed broadband networks, 4G and 5G mobile networks, including with vouchers, and certain trans-European digital connectivity infrastructure projects[59]. The funding linked to 5G and Gigabit networks in the already adopted RRPs is estimated aproximately at over EUR 13 billion[60]. In addition, the digital transition is part of the five policy objectives that will be supported by Cohesion Policy Programmes. The Commission also supports directly a number of connectivity projects, including 5G connectivity, through

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[53] Directive 2018/1972 of the European Parliament and of the Council establishing the European Electronic Communications Code, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L1972
[54] C(2020) 8750 final. Available at: https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=72437
[55] Commission Recommendation (EU) 2020/1307 of 18 September 2020 on a common Union toolbox for reducing the cost of deploying very high capacity networks and ensuring timely and investment-friendly access to 5G radio spectrum, to foster connectivity in support of economic recovery from the COVID-19 crisis in the Union C/2020/6270, OJ L 305 of 21.9.2020.
[56] https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=75185
[57] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12463-High-speed-broadband-in-the-EU-review-of-rules_en
[58] See: https://ec.europa.eu/commission/presscorner/detail/en/ip_20_1576
[59] https://ec.europa.eu/competition-policy/state-aid/legislation/regulations_en.
[60] Internal estimations based on the national RRPs adopted as of 1 September 2021.

the new Connecting Europe Facility. In the same period, Invest EU and the European Investment Bank will continue to support connectivity projects through loans and guarantees. Furthermore, the Connecting Europe Broadband Fund (CEBF)[61] will continue to invest in new connectivity projects in underserved areas until June 2023 thanks to private and public investors.

3.3.1.2. 5G coverage

- *Target:* All populated areas covered by 5G

- *Baseline (2020):* 14% of populated areas with 5G coverage[62]

- *Source:* Broadband coverage in Europe studies[63]

- *What is the rationale for the set target value?*

5G connectivity[64] is a main driver for digital transformation in virtually all sectors of the economy and society and the actual availability of 5G services will dictate the pace of development of many new services and applications that have a potentially high economic and societal value, in particular vertical industry use cases[65]. As a result, it is expected that access to will be needed in all parts of the territory where people live, work, gather and travel. Several respondents to the targeted consultation indicated the need to aim for a step change in quality in addition to mere 5G population coverage.

Mobile coverage is usually measured by regulators and market players (e.g., in the context of spectrum licenses) using "population coverage", i.e. the percentage of the population covered by at least a mobile network at their homes. In most cases, the availability of the mobile service at a given place is determined on the basis of the declaration of mobile network operators (as it is the case currently in DESI). The Digital Compass target of full 5G coverage in all "populated areas" is also based on the population coverage. In addition, one will also have to monitor closely the progress against the intermediate target set in the 5G Action Plan of "all urban areas and major terrestrial transport paths to have uninterrupted 5G coverage by 2025". This target is particularly impoprtant to address the emerging demand for uninterrupted coverage along motorways to enable Connected and Automated Mobility, as well as to ensure the availability of very very high quality 5G connectivity in geographically-limited areas to support applications such as industrial campuses, smart agriculture, or ehealth. These applications have a huge socio-economic impact while not adding significantly to the amount of territorial areas to be covered.

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[61] https://www.cebfund.eu/

[62] Percentage of populated areas (i.e. percentage of all places where households are located, including remote areas) with coverage by 5G - measured as the total coverage of telecom operators in each country. A household has 5G coverage if it is in the stated coverage area for at least one 5G mobile network. Population coverage (in percentage terms) in a given area is understood to be equal to household coverage.

[63] IHS Markit, Omdia and Point Topic: "Broadband Coverage in Europe*"* studies, see: https://digital-strategy.ec.europa.eu/en/policies/desi-connectivity

[64] 5G is the fifth-generation technology standard for mobile broadband standardised by the 3rd Generation Partnership Project and capable of supporting downstream speeds of up to 10Gbps.

[65] e.g. The PwC Study 2021 "The global economic impact of 5G" estimates 5G boost to global GDP by 2030 at US$1.3tn (€1.1 trillion) https://www.pwc.com/gx/en/industries/technology/publications/economic-impact-5g.html

Moreover, beyond mere coverage criteria, it will be increasingly important to closely monitor the level of service quality provided throughout the relevant territories. This is particularly important in the current context where mobile operators mainly use lower frequency bands (mainly frequencies shared with 4G and the 700 MHz band) and existing sites to add 5G modules, which leads to significantly lower speeds and capacities at the cell edges where only a lower 5G signal is available.

In order to achieve a consistent higher quality, low density 5G connectivity throughout the relevant territories significant investments for network densification will be required as well as a more extensive geographical coverage using the 3.5 GHz mid-band (new base stations using mid-band frequencies are rather limited in Europe, whereas other regions such as Korea and China are deploying in the order of 100,000 new base stations). Therefore, the current KPI of '5G population coverage' may have to be complemented in the future with secondary indicators adequately reflecting the actual usability and quality of the 5G service based on Quality of Service levels as well as data concerning specific geographical availability (geographical mapping).

The definition of 5G service quality will require a harmonised approach to enable comparative analysis as well as possible in-field measurements to circumvent the shortcomings of theoretical coverage calculations. The ongoing work on this topic within the framework of BEREC's activities[66] will be instrumental to establish such a common approach to 5G service quality in the EU including for the comparability of measurements and monitoring data.

- *What are the baselines and trends?*

In 2020, only 14% of populated areas in the EU were covered by a 5G network. This is also due to the fact that only half of the Member States started commercial 5G network deployments by mid-2020. Highest coverage levels were recorded in the Netherlands and Denmark (80% of populated areas each), followed by Austria (50%), Ireland (30%) and Germany (18%).

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[66] e.g., BEREC feasibility study on development of coverage information for 5G deployments - Document number: BoR (19) 191 available at:
https://berec.europa.eu/eng/document_register/subject_matter/berec/reports/8848-berec-feasibility-study-on-development-of-coverage-information-for-5g-deployments
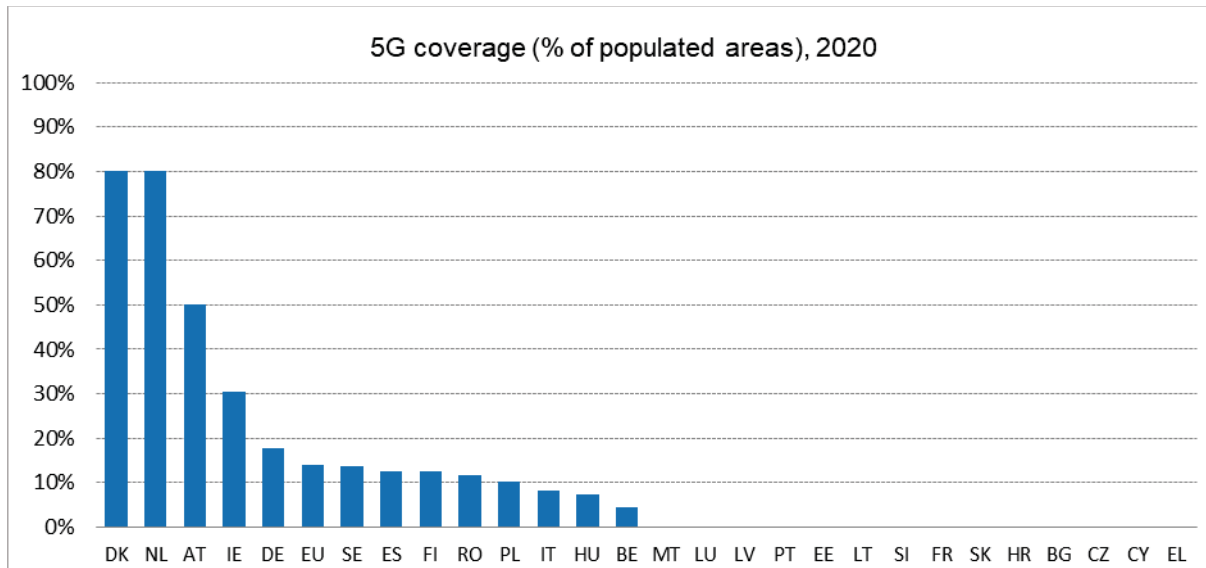
Figure 8: 5G coverage (% of populated areas) by Member State, 2020

Source: IHS Markit, Omdia and Point Topic, Broadband coverage in Europe studies.

The projected 5G coverage growth is based on an increase of the planned investments in 5G infrastructure (by an approximate factor of 25%) to fill in the estimate investment gap to reach the set deployment target by 2030.

The below projection for 5G coverage is based on the historical evolution of 4G coverage (2011-2020) taking into account completed and planned spectrum assignments.
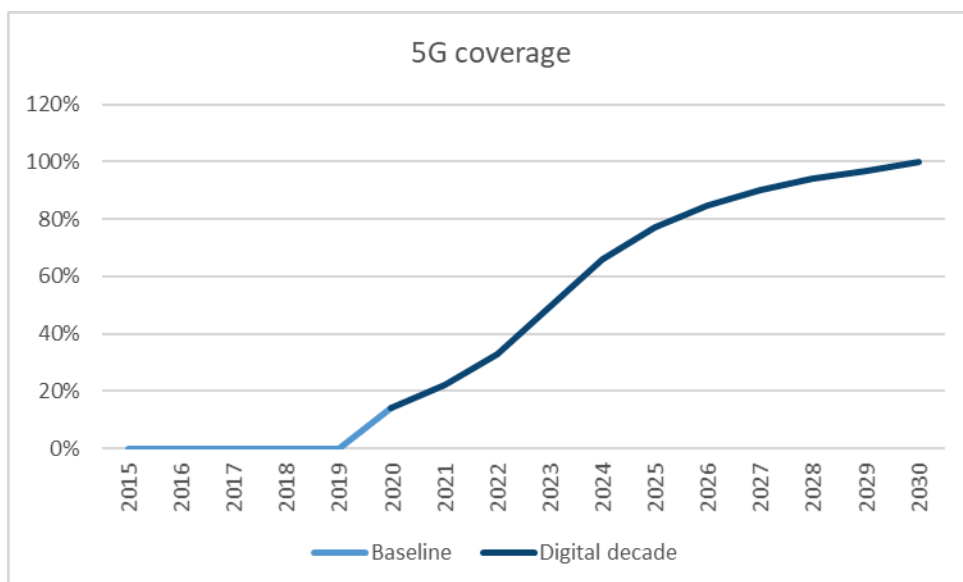
Figure 9: Percentage of populated areas covered by 5G (EU projection to 2030)

Source: Commission services based on data from IHS Markit, Omdia and Point Topic.

- *What is needed to achieve the target?*

The 5G Action Plan for Europe[67] already delivered a common 5G network deployment roadmap and set out ambitious 5G targets for 2020 and 2025, in particular the target of achieving 5G coverage of all urban areas as well as deploying uninterrupted 5G coverage along the main transport paths by 2025. The Commission is closely monitoring the progress of the Plan and took several policy initiatives to support Member States, including:

- Cooperation with Member States to ensure timely availablilty of the 5G pioneer bands.

- The adoption of the implementing regulation on small-area wireless access points[68].

- A structured exchange of Best Practices concerning national broadband strategies and 5G "path-to-deployment"[69].

- Identification of regulatory best practices as part of the connectivity toolbox[70] (Measures to cut the cost and speed up network rollout and to ensure timely and investment-friendly access to radio spectrum for 5G rollout).

- A joint concept with the European Investment Bank on "Boosting Investments in European digital ventures to unleash the full potential of 5G"[71].

- The establishment of the European 5G Observatory which provides periodic reports on the progress of the 5G Action Plan[72].

The achievement of the objectives and targets set out in the Decision will depend on a number of key factors to be taken into account by the Commission and Member States in order to enable the swift deployment of secure 5G.

Efficient investment in 5G networks: Besides the support of 5G use cases with high societal value, such as connected and automated mobility, for which a broad set of national and European funding programmes is available, including, for instance, the Recovery and Resilience Facility (RRF), CEF Digital, as well as other national funding programmes, it is important to stimulate private investors with a clear policy framework enabling new investment models optimising individual return on investment. Such models include co-investments and network infrastructure sharing. Another way to increase private investment relies on developing new business opportunities from vertical industry users and provide strategic public support to 5G venture financing.

Accelerated deployment of secure 5G networks in light of the requirements of the 5G cybersecurity toolbox: The implementation by Member States of the new 5G cybersecurity requirements can act as incentive for operators to invest in modern and more secure network equipment, including accelerating the deployment of fully-fledged ('stand-alone') 5G core networks and of 5G radio access networks. It will be beneficial to continue the coordinated approach at EU level on 5G cybersecurity, led by national authorities in the NIS Cooperation Group with the support of the Commission and ENISA, in order to fully implement the EU Toolbox, monitor new technological and market developments and assess potential new risks.

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[67] COM(2016) 588
[68] https://eur-lex.europa.eu/eli/reg_impl/2020/1070/oj
[69] See Report to the Communications Committee COCOM18-06 of 22/09/2018 at https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=55605
[70] https://digital-strategy.ec.europa.eu/en/news/connectivity-toolbox-member-states-agree-best-practices-boost-timely-deployment-5g-and-fibre
[71] https://www.eib.org/en/publications/accelerating-the-5g-transition-in-europe-executive-summary
[72] www.5gobservatory.eu

The Green Deal and energy efficiency of 5G networks: Mobile networks represent the single largest consumer of energy of all system categories in the telecommunications sector. The issue at stake is therefore the key contribution of 5G and later 6G networks to meeting the objectives of the Green Deal. Therefore, the existing best practices in this domain[73] could be reviewed, in order to assess whether common measures and/or goals are needed. A common approach would contribute to the well-functioning of the single market as well as to secure a level playing field between market players.

Societal concerns regarding the deployment of 5G networks: Another key factor is to address societal concerns, e.g. with regard to an alignment of the public communication strategy on health aspects or possible transparency measures concerning rules applicable for the deployment and operation of network elements such as base stations. Public sector stakeholders agree that raising awareness can tackle misinformation and thereby increase public acceptance of the technology. To this end, social partners proposed a comprehensive EU monitoring exercise to adequately inform citizens about rollout plans and health impacts.

EU roadmap towards 6G: The commercial deployment of 6G networks is not expected to start before 2028-2030. However, 6G networks will rely on infrastructural elements already deployed in the context of 5G networks. 6G deployment roadmaps need to complement the 6G research agenda, including needs and suitability of 6G spectrum, pro-investment measures, in particular to enable emerging 6G ecosystems taking the synergies between 5G and 6G infrastructures into account. It is important to address how the Joint Undertaking initiative on Smart Networks and Services towards 6G could enable the necessary supply capacities for 6G, thereby fostering digital sovereignty in Europe, strengthening the value chain, and creating an infrastructure and service platform putting Europe in a strong position for 6G infrastructure and services.

3.3.2. Semiconductors

- *Target:* "The production of cutting-edge and sustainable semiconductors in Europe including processors is **at least 20% of world production** in value."

- *Baseline (2020):* 10% of world production in value

- *Source:* SIA/ESIA, World Semiconductor Trade Statistics (WSTS)

- *What is the rationale for the set target value?*

Semiconductors are the underpinning technology for a secure and sustainable digital transition. Emerging data processing capabilities, new applications for AI, the shift towards edge-computing and the growing need for cloud and infrastructure to support a distributed workforce, accelerated by the Covid-19 pandemic, all require the computational power, reduced energy consumption and added security offered by cutting-edge semiconductor technologies. The market for AI chips is expected to be a major driver of growth for the whole industry during the Digital Decade.

As of 2021, the EU has a small amount of total manufacturing capacity compared to other regions in the semiconductor value chain because of decreasing levels of investment. This creates dependencies in EU industries (e.g., automotive, industrial automation,

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[73] e.g., European Green Digital Coalition

communications) from third-country chip manufacturers which can result, as happened during the COVID-19 pandemic, in supply shortages that can disrupt entire industrial sectors. The EU wants to reverse this trend, and the Member States have already started with the launch of the first Important Project of Common European Interest (IPCEI) on microelectronics, which resulted in a new advanced 300mm wafer fabrication plant ("fab") in Germany and will lead to new process lines in fabs in Italy, France, and Austria for analogue and discrete components. Concerning digital processors, Europe is leading in microcontrollers, but misses the necessary design capacity and manufacturing facilities for the more advanced logic components, and is therefore highly dependent on imports and foreign foundries.

Over time, leading-edge chips have become more difficult and more costly to produce, resulting in a reduction in the number of manufacturers able to satisfy customers' needs. In 2020, the only two companies manufacturing chips at 5nm were located in Taiwan (TSMC) and South Korea (Samsung).

Geopolitical tensions further undermine a level playing field and harm competition, as countries like China and the US subsidise with large amounts of public resources to minimise strategic dependencies. The US government plans investments of USD 52 billion in semiconductors. The CHIPS Act[74] proposes to invest USD 22 billion to support the reshoring of advanced semiconductor manufacturing firms and the American Foundries Act[75] seeks to support semiconductor manufacturing and research in the US with USD 25 billion in grants. China aims to boost spending and drive research into cutting-edge chips and artificial intelligence in its latest five-year targets[76]. About a trillion dollars of government funding have been set aside under the overall technology initiative, part of which will be used by central and local governments to jointly invest in a series of third-generation chip projects[77].

Europe has no foundries that offer manufacturing of components with feature sizes below 22nm. Consequently, the EU's semiconductor footprint compared to other regions is small in particular in the digital sector. For example, the EU shares of global revenues for semiconductor chips is only around 6% for the computing and communication segments. This is problematic because the miniaturisation of feature sizes is at the core of both faster and more power-efficient microprocessors used in communications, consumer electronics and computing that will drive demand over the Decade. Therefore, with no additional actions, Europe's share in chip manufacturing, especially for advanced nodes, is likely to further decrease.

As AI proliferates, as computing shifts towards the edge of the network, and as secure chips become a precondition for the security of networks and data infrastructures, the EU needs to step up its capabilities in digital logic where it has only a 9% share today (see chart below), in particular the processor chips that are needed to help make sense of the ever-increasing quantities of data.

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[74] "Creating Helpful Incentives to Produce Semiconductors" (CHIPS) for America Act. This bill establishes investments and incentives to support U.S. semiconductor manufacturing, research and development, and supply chain security. https://www.congress.gov/bill/116th-congress/house-bill/7178
[75] https://www.congress.gov/bill/116th-congress/senate-bill/4130
[76] https://www.bloomberg.com/news/articles/2021-03-05/chinese-premier-calls-for-major-breakthroughs-in-core-tech
[77] https://www.bloomberg.com/news/articles/2021-06-17/xi-taps-top-lieutenant-to-lead-china-s-chip-battle-against-u-s
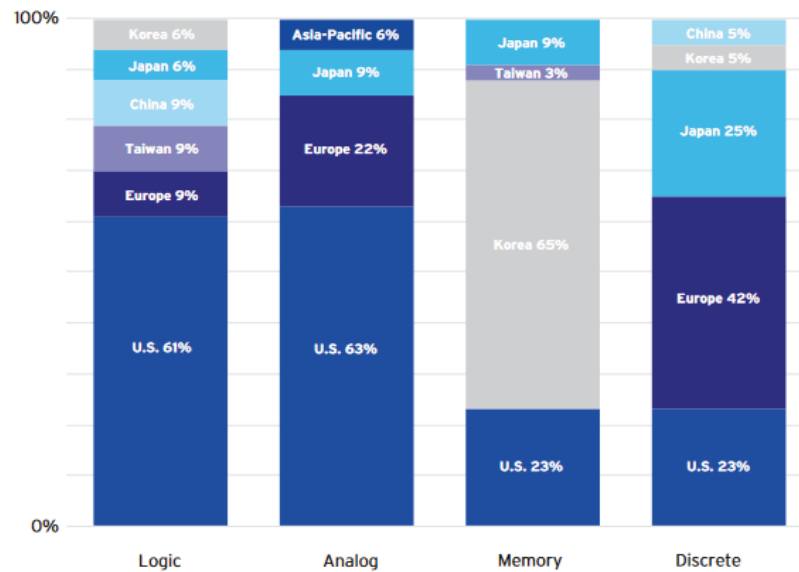
Figure 10: EU semiconductor industry market share by subproduct

Source: Semiconductor Industry Association[78]

Processing data at the speed needed to capture its benefits will require an important shift in the production of processor chips. Scaling up the computing performance with today's technologies will make computing one of the biggest energy consuming activities. Future chips should therefore exhibit radically lower energy consumption to be able to harness the benefits of data growth. This is an opportunity for growth in burgeoning markets such as AI and edge-computing, and to make further inroads into the computing and communications markets where EU industry has limited presence today.

Investments in manufacturing capacity need to be matched by demand. An EU foundry would predominantly serve European customers, and there are few semiconductor companies in the EU designing chips on 7nm or 5nm nodes today. The EU's weakness in design, which creates the demand for semiconductor manufacturing companies, was highlighted in the update of the 2020 Industrial Strategy package[79]. The Industrial Strategy update presents a first analysis of dependencies in the semiconductors ecosystem, and in other sensitive ecosystems. This analysis shows a number of European weak points:

- Europe has notable weaknesses in design and design automation tools. These parts of the supply chain are mainly under US proprietary control.

- The EU has no production capacity for the most advanced chips.

- The current shortage of semiconductors is slowing down the recovery of key economic sectors in Europe, including the automotive industry, and in the long-term could affect promising economic strongholds, such as the 5G/6G value chain.

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[78] https://www.semiconductors.org/wp-content/uploads/2020/07/2020-SIA-State-of-the-Industry-Report-FINAL-1.pdf

[79] swd-strategic-dependencies-capacities_en.pdf (europa.eu), or the 2018 report https://ec.europa.eu/information_society/newsroom/image/document/2018-26/boosting_electronics_value_chains_in_europe_B4A48BEC-FDC8-5B40-42B8227ADABD9E3E_53119.pdf and the 2020 study Study-on-the-Electronic-Ecosystem_Decision_Feb2020.pdf (ipcei-me.eu)

- Packaging, assembly and testing, and chip fabrication are located mostly in Asia. Advanced packaging technologies are increasingly important to address increasing power and energy-efficiency requirements, e.g., by electrical vehicles and edge-computing applications.

To reverse the trend of a declining share of total EU semiconductor manufacturing capacity compared to other regions, the EU has set the ambitious political ambition that by 2030 the production of cutting-edge and sustainable semiconductors in Europe including processors is at least 20% of world production in value (meaning manufacturing capacities below 5nm nodes aiming at 2nm and 10 times more energy efficient than today).

The EU represents around 15% of the world's GDP[80] and its output in this key sector should at the very least reflect this position. It is well positioned in a number of areas that should experience significant growth in the coming years, and where micro-electronics will play a crucial part in market development (e.g., security and privacy, sensing, power electronics, Internet of Things, organic-printable electronics and photonics).

- *What are the baselines and current trends?*

The European Semiconductor Industry Association states that the EU's share in world wafer fab capacity increased in the 1995-2005 time frame and then decreased in the next decade[81].

The market for semiconductors is expected to grow substantially in the next 10 years. Analysts expect a market of roughly a USD 1 trillion by 2030 (see projection below).
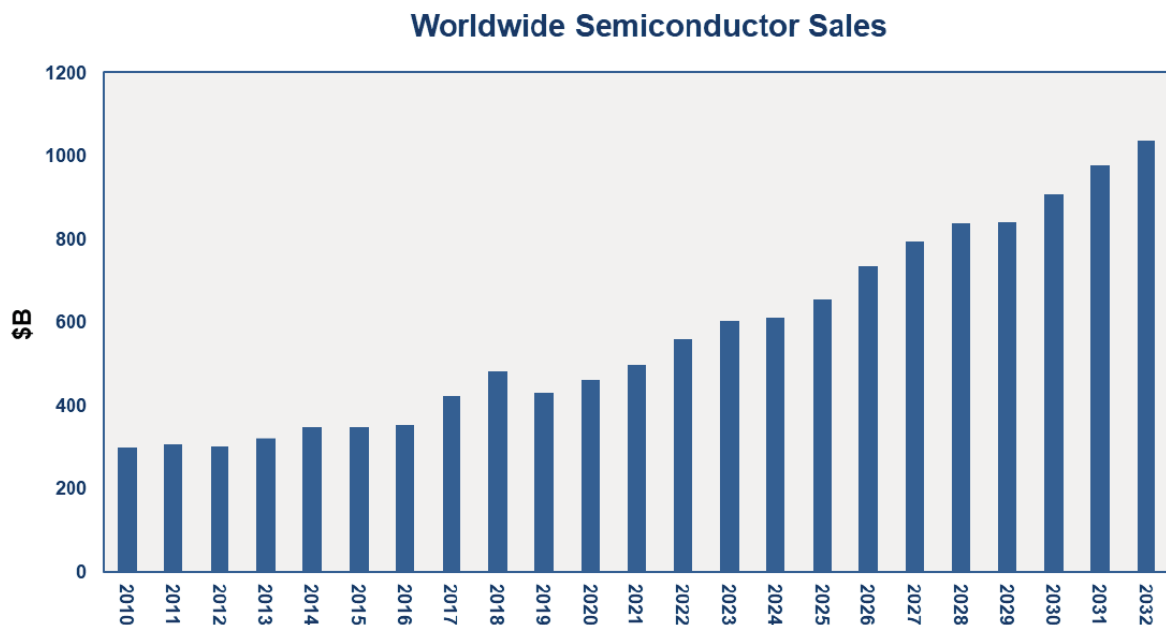
Figure 11: Worldwide semiconductor sales in billion USD, 2010-2032

Source: VLSI Research[82]

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[80] https://www.statista.com/statistics/253512/share-of-the-eu-in-the-inflation-adjusted-global-gross-domestic-product/
[81] https://www.eusemiconductors.eu/sites/default/files/ESIA_PR_WWCapacity_2021.pdf

As of May 2021, the EU share of the worldwide semiconductor market is 8.7%[83], representing roughly USD 45 billion on an annual basis. Taking into account the projected market size of USD 1 trillion by 2030, the EU would have to multiply its annual sales by a factor of 4-5 to achieve 20% in value of the world market by 2030. The below projection assumes investments in semiconductors manufacturing by EU actors to ramp up in the coming years, leading to an increasing EU market share by the end of the decade.
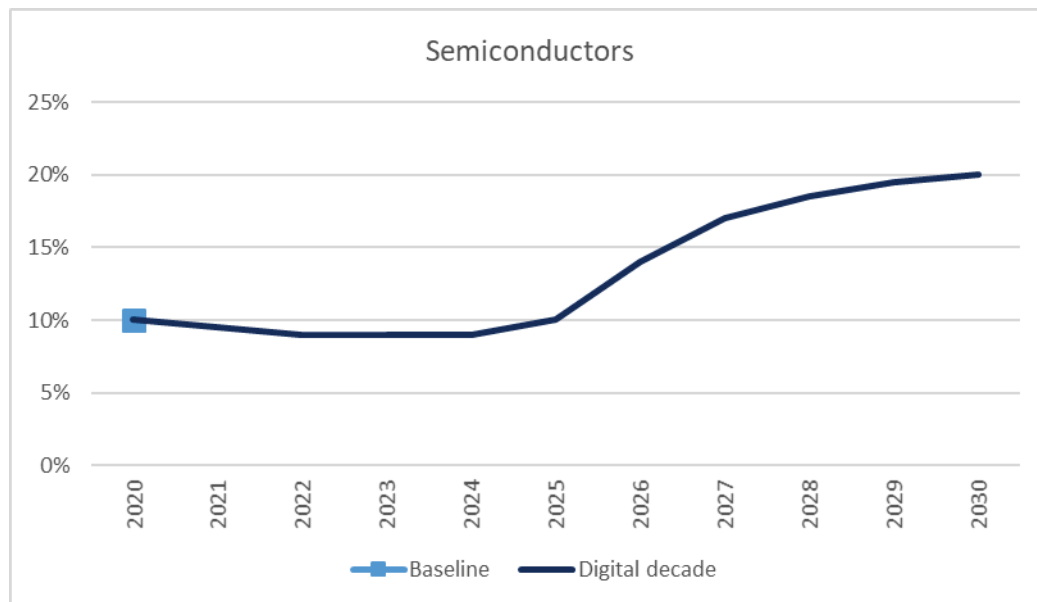
Figure 12: Percentage of semiconductor production of world market in value (EU projection to 2030)

Source: Commission services based on data from SIA/ESIA, World Semiconductor Trade Statistics (WSTS).

- *What is needed to achieve the target?*

Ongoing projects under the IPCEI on Microelectronics, approved in December 2018, have already played an important role in stimulating additional private investments in innovation and manufacturing in the EU, in particular for Automotive and IoT markets. Manufacturers of chips at leading-edge nodes (TSMC, Samsung, Intel) rely for their technology development on specific EUV photolithography machines produced by a unique global supplier, notably ASML (NL), which belongs to the European electronic ecosystem. Moreover, the ECSEL Joint Undertaking (JU) set up in 2014, which supported over 90 research projects, has been instrumental in advancing EUV technology towards 2nm[84]. As a follow-up to ECSEL JU, it has been proposed to develop the Key Digital Technologies Joint Undertaking (KDT JU) until 2027, with public support of up to EUR 3.6 billion shared equally between the Union and participating national authorities.

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[82] https://www.vlsiresearch.com/semiconductor-market-research-services
[83] https://www.eusemiconductors.eu/sites/default/files/ESIA_WSTS_PR_2105.pdf
[84] https://www.ecsel.eu/projects/pin3s

The Commission launched the Alliance on Processors and Semiconductor technologies in July 2021[85]. The Alliance brings together key actors to design and produce microelectronics chips and will identify current gaps in the production of microchips and the technology developments needed. The Alliance will also act as a sounding board to create synergies among related R&D and deployment initiatives.

Twenty-two Member States have already signed a declaration (of 7 December 2020)[86] expressing their interest to work together in order to bolster Europe's electronics and embedded systems value chain with a strong focus on processors and semiconductor chips. The declararion, among other things, calls for the mobilisation of industrial stakeholders through a future industrial alliance. Moreover, it calls for the design of a multi-country and inclusive European Flagship Project through the development of a proposal for an Important Project of Common European Interest (IPCEI).

A second IPCEI on processors and semiconductor technologies would stimulate the design and manufacturing capacities of European semiconductor companies. It could take a two-pronged approach with efforts to (1) develop digital logic chips, such as low-power processors, which would *inter alia* address the large market sectors where the EU has very limited presence today such as computing and communications, and (2) further reinforce the EU's position in market segments where it needs to maintain current strengths, such as automotive and industrial manufacturing.

In addition, as proposed during the consultation process, Member States can put in place a number of reforms and investments:

- National policies to stimulate domestic chip design capabilities and to attract foreign design companies would support demand creation for advanced EU semiconductor manufacturing capacities.

- National policies to leverage trusted electronics including, as necessary, standards, certification and common requirements for secure chips, iincluding security requirements and related performance-based specifications in public tenders (e.g., for communications networks or data infrastructures), could serve as a means to create markets for semiconductor products.

- Lastly, stronger foreign direct investment policy instruments dealing with attempts by companies from other parts of the world to acquire EU semiconductor companies would help keep intellectual property in Europe.

3.3.3. Edge/cloud

- *Target:* "**10,000 climate-neutral[87] highly secure edge nodes** are deployed in the EU, distributed in a way that will guarantee access to data services with low latency (few milliseconds) wherever businesses are located**"**

- *Baseline (2020):* 0

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[85] https://digital-strategy.ec.europa.eu/en/policies/alliance-processors-and-semiconductor-technologies
[86] https://ec.europa.eu/digital-single-market/en/news/joint-declaration-processors-and-semiconductor-technologies
[87] https://digital-strategy.ec.europa.eu/en/policies/green-cloud

- *Source:* Annual study on edge deployment under CEF2 (as of 2022); European industrial technology roadmap for the next generation cloud-edge offering of 7 May 2021[88]

- *What is the rationale for the set target value?*

Globally and in Europe, the volume of generated data is greatly increasing and a growing proportion of data is being processed at the edge, moving from the traditional centralised model of data processing to a highly distributed one [89]. In this context, the edge market is maturing. There is currently no data available on edge deployment across Member States. Industry players are mainly in testing and piloting phase.

The target of 10 000 edge nodes has been chosen to ensure an **edge node density** that would allow for an optimal coverage across the EU territory, including in less populated areas[90]. It will also boost Europe's global leadership in this technology, while other parts in the world are moving quickly[91]. The target has been developed by following a similar model to mobile network deployment. It draws on the findings of the *European industrial technology roadmap for the next generation cloud-edge offering*[92] elaborated by 27 European digital industry representatives, including telecommunication, edge and cloud providers. The *European technology roadmap* estimates that by 2030, 300 Near Edge nodes and 14.000 Far Edge nodes (including 9 000 near premise nodes) could be deployed.

The target is closely related to the objective of the **European strategy for data[93]** that aims to equip Europe with trusted, secure, interoperable and resource-efficient cloud to edge services and infrastructure. Contrary to the cloud computing market, there is currently no dominant player or market for edge nodes. Europe has key industrial strengths to build upon, and an accelerated deployment programme for edge nodes will also put Europe ahead of other regions in this new type of data processing that will become mainstream[94].

The achievement of the target is expected to deliver a sufficient density of edge nodes across the European territory to provide the **processing capacity and low latency** required to enable the most innovative use cases (few milliseconds). It will support the achievement of a cloud-edge continuum, enabling a seamless experience for users across EU territory.

An increased density of central-cloud and edge facilities is required for the deployment of innovative middleware and cloud to edge services, which will be supported by EU programmes like the **Digital Europe Programme**. Applications that were inviable or impractical to deploy on the cloud because of low latency requirements (e.g., connected mobility), high bandwidth requirements coupled with the need to process high volumes of

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[88] *European industrial technology roadmap for the next generation cloud-edge offering*, 7 May 2021, available at: https://ec.europa.eu/newsroom/repository/document/2021-18/European_CloudEdge_Technology_Investment_Roadmap_for_publication_pMdz85DSw6nqPppq8hE9S9RbB8_76223.pdf

[89] European Commission, SWD(2021) 352 final *Strategic dependencies and capacities*

[90] In practice, it can be expected that in rural areas there will be little investments, while in industrial areas and commercial areas, there will be a way higher density (hundreds of edge nodes).

[91] Gorkem Yigit, *Edge computing: operator strategies, use cases and implementation*, July 2020.

[92] *European industrial technology roadmap for the next generation cloud-edge offering*, 7 May 2021

[93] https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1593073685620&uri=CELEX:52020DC0066

[94] European Commission, SWD(2021) 352 final *Strategic dependencies and capacities;* IDC (2019), The Technology Impacts of Edge Computing in Europe

data (e.g., video analytics) or data sovereignty and security requirements (e.g., decentralised processing of sensitive personal data) will be enabled by edge computing.

Furthermore, cutting-edge **climate-neutral, highly energy-efficient and sustainable** edge nodes will deliver the efficient infrastructures for data storage and processing and position Europe as a leader on the path towards reaching **climate-neutral data centres by 2030**[95]. The increased number of edge nodes will inevitably increase energy consumption: By 2025, edge data centres are expected to account for 12% of the energy consumption of data centres in the EU28[96]. On the other hand, the distributed nature of edge cloud infrastructure can enable a smarter distribution of data across the network, and hence lead to energy savings compared to other alternatives.

A key challenge for the achievement of the target will be to define and monitor the deployment of different types of edge nodes so as to adequately answer to users' needs in terms of the **processing capacity** and **latency** across EU territory. According to the *European industrial technology roadmap*[97], the total of required edge node capacity (near and far edge) would represent around 550 MW for the whole of the EU and deliver a latency of less than 5 milliseconds anywhere in the Union by 2025[98]. These objectives can be achieved by deploying a capillary network of 'public edge data centres' across the territory of the EU, which will combine the benefits of proximity and ultralow latency of on-premise IT-systems with the flexibility and scalability of public cloud. This opens the door to much higher efficiency in terms of energy and resource consumption, and will unlock a myriad of use cases, e.g., related to the Internet of Things, digitisation of industry and Augmented Reality, also in regions of the EU that were previously unable to benefit from these technologies.

- *What are the baselines and current trends?*

The estimated target considers the rollout of **Near Edge**[99] and **Far Edge**[100] nodes, as well as **on premise or near premise and cell site edge nodes**[101]. This is to take into account the fact that the deployment of edge nodes can follow different models. The edge rollout that uses the telco network for edge connectivity will move from the Near Edge to the Far Edge in a **Cloud to Edge approach**. Alternatively, other edge providers may start with an on-premise (private) or near-premise edge rollout, following **an Edge to Cloud rollout approach**, starting very close to the customer[102].

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[95] European Commission, SWD(2020) 67 final, *Shaping Europe's digital future.*

[96] *Energy-efficient Cloud Computing Technologies and Policies for an Eco-friendly Cloud Market* (2020): https://digital-strategy.ec.europa.eu/en/library/energy-efficient-cloud-computing-technologies-and-policies-eco-friendly-cloud-market

[97] *European industrial technology roadmap for the next generation cloud-edge offering*, 7 May 2021, https://ec.europa.eu/newsroom/repository/document/2021-18/European_CloudEdge_Technology_Investment_Roadmap_for_publication_pMdz85DSw6nqPppq8hE9S9RbB8_76223.pdf

[98] It will also require cloud data centre capacity of 350 MW by 2025.

[99] Several hundred km from device

[100] Less than 100km from the device; a subset might be near-premise (less than 50 km) to cover hotspots

[101] Close to the device (0-5 km)

[102] *European industrial technology roadmap for the next generation cloud-edge offering*, 7 May 2021, https://ec.europa.eu/newsroom/repository/document/2021-18/European_CloudEdge_Technology_Investment_Roadmap_for_publication_pMdz85DSw6nqPppq8hE9S9RbB8_76223.pdf
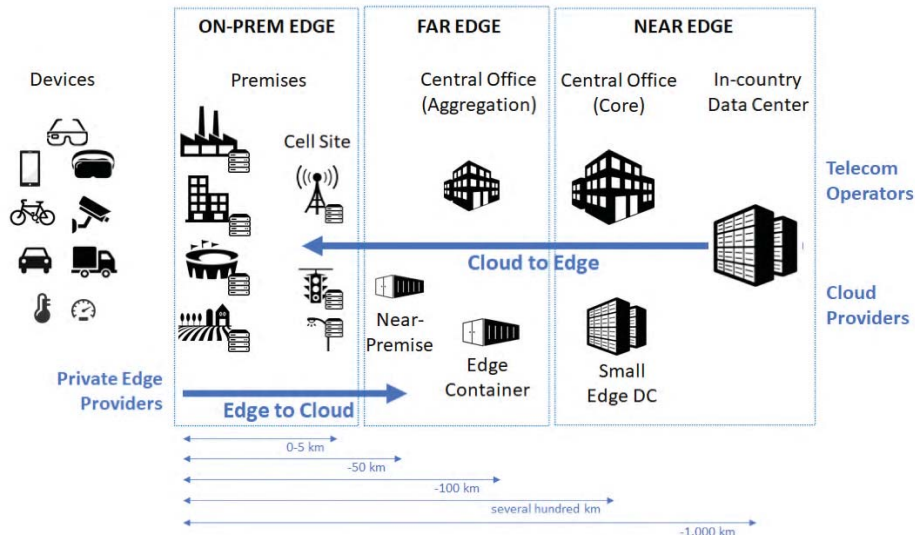
Figure 13: Different types of edge technology deployment and distance of edge data processing capacities from the end-user

Source: European industrial technology roadmap for the next generation cloud-edge offering, 7 May 2021.

The **density of edge nodes across the EU territory** will depend on several factors, such as the level of technology maturity, the amount of public support, and the market reaction to the first deployment of edge nodes.

Part of the deployment of edge nodes will be market driven, boosted by the development of the Internet of Things[103], Artificial intelligence, enterprise and consumer use cases as well as 5G roll-out[104]. Globally, edge infrastructure spending on compute and storage is expected to grow at a five-year Compound Annual Growth Rate of 18.9% to reach USD 33.3 billion by 2024[105]. In a first stage, the deployment of near edge and on premise nodes could be sufficient to meet the demand.

Under a *Digital Decade* scenario, it is foreseen that, in addition to the market demand, the deployment of edge nodes will be boosted by key measures enabling for most innovative use cases across sectors and the EU territory. In addition to near edge (every 200-300 km) and on-premise nodes, additional investment will enable a higher density of nodes and boost the deployment of far edge nodes. In a few years, an exponential raise of nodes, stimulated by demand and joint public-private investments, is expected.

The *Digital Decade* scenario would require public funding, especially for those types of edge nodes that are mostly supply-driven (near and far edge). The most realistic and still ambitious investment scenario is a 50:50 private-public investment ratio over time, which could translate into a higher public ratio in the first years of deployment to pre-empt market demand,

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[103] IDC estimates that the overall number of "connected" IoT devices worldwide will increase to over 35.2 billion by 2023 and will reach almost 42 billion by 2025. See: IDC (2020), *Worldwide Edge Compute and Storage Infrastructure Forecast, 2020–2024: Service Expansion Despite COVID-19*

[104] Gorkem Yigit, *Edge computing: operator strategies, use cases and implementation*, July 2020

[105] IDC (2020), *Worldwide Edge Compute and Storage Infrastructure Forecast, 2020–2024: Service Expansion Despite COVID-19*

decreasing over time. This assumption builds on the *European technology roadmap* that foresees a 30:70 private-public ratio during the first two years (and three first years for far edge), and a 50:50 private-public ratio onwards.

The trend described below is based on first industry projections and mainly takes into account available data on the evolution of near and far edge nodes[106].

It is expected that the number of edge nodes will grow slowly in the next few years, taking into account the time for deployment. Vertical use cases still need to reach maturity and overcome hurdles such as the complexity of deployment in heterogeneous applications. Furthermore, while 5G rollouts are moving forward, they are following a staged approach that could take several years before deploying a high density of edge nodes[107].

Once the market will reach maturity, an exponential growth is expected, boosted by demand and joint public-private investment, before reaching market saturation.
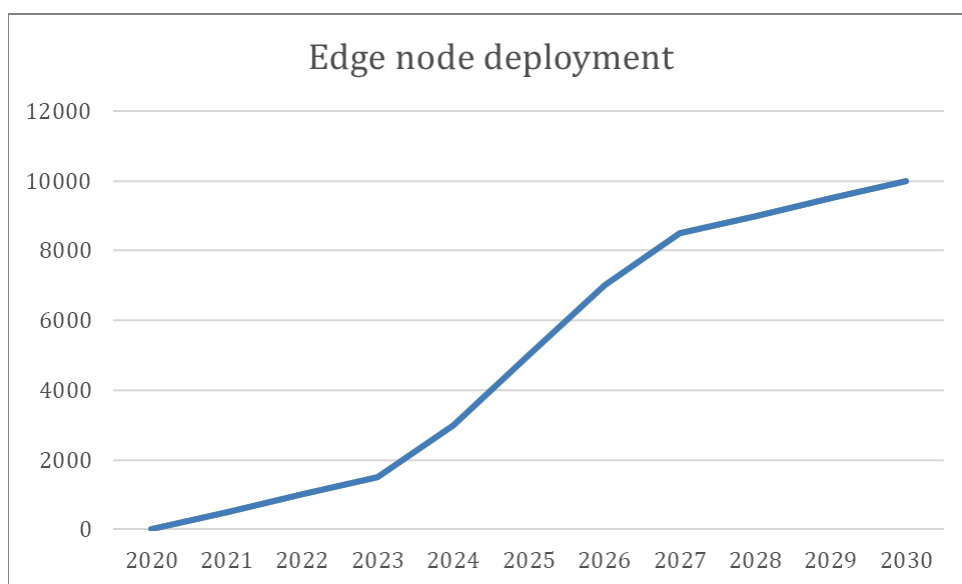
Figure 14: Number of deployed edge nodes (EU projection to 2030)

Source: Commission services.

- *What is needed to achieve the target?*

There is broad consensus among stakeholders that in order to achieve the target, a joint effort of EU, national and private investment will be required. According to first estimates, the total investment amount would need to reach at least 6 billion Euros by 2025 (without connectivity)[108]. In line with the Member States Declaration on European Cloud[109], the public sector should lead by example using innovation procurement investments to reinforce the European development and early adoption of climate-neutral secure edge nodes. An

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[106] *European industrial technology roadmap for the next generation cloud-edge offering* (2021)
[107] IDC (2020), Ibid.
[108] First industry estimates.
[109] *Building the next generation cloud for businesses and the public sector in the EU*: https://digital-strategy.ec.europa.eu/en/news/towards-next-generation-cloud-europe

investment channel for the deployment of edge nodes will be the national funding stemming from **the national RRPs** (Next GenerationEU), as well as possibly European Structural and Investment Funds.

The **European Alliance for Industrial Data, Edge and Cloud**, announced in the updated EU industrial strategy[110] and launched on 19 July 2021[111], will leverage investment synergies for joint development and deployment of the next generation of European cloud and edge technologies. First, by contributing to stimulate strategic partnerships between different players of the edge and cloud ecosystem (business match-making), the Alliance can help to boost investments in edge nodes. Second, by establishing sectorial working groups dedicated to cloud and edge deployment, including for sector-specific use cases (e.g., for the defence sector), the Alliance will assist in identifying concrete investment areas matching the needs of key European user industries and the public sector. Third, the Alliance can create synergies with other national or industrial initiatives in the area of cloud and edge, such as the private initiative Gaia-X[112], ensuring that its work will be connected to global market developments.

In the European strategy for data[113], the Commission announced the development of an **EU Cloud Rulebook**. The EU Cloud Rulebook will compile all existing binding and non-binding rules, codes of conduct, certification schemes and standards applicable to cloud and edge services. It will ensure that the next-generation European disruptive and distributed computing technologies will comply with key European rules, norms and standards. Furthermore, the EU Cloud Rulebook will be translated into common European standards and requirements for **the public procurement** of data processing services. This policy action should facilitate procurement of trustworthy cloud and edge services by EU, national, regional and local authorities for improving the delivery of public services to EU citizens and businesses.

Eleven Member States are currently working, as part of the **"European Common Data Infrastructure and Services" Multi-Country Project,** on delivering the next generation cloud and edge infrastructure and services, which may take the form of an Important Project of Common European Interest (IPCEI)[114]. Such an IPCEI could eventually support some of the first industrial development of next generation climate-neutral and highly secure edge nodes. It could also help to support a higher cloud and edge uptake among companies and public entities as positive externalities.

Furthermore, edge nodes will be stimulated by measures to support the deployment of specific use cases, such as 5G for vertical industry applications. In the context of the Multi-Country Project "Pan-European deployment of 5G corridors and Connected and Automated Mobility", the EU programme **Connecting Europe Facility 2** and the **RRF** will co-finance edge nodes as part of the 5G infrastructure. It is currently difficult to estimate precisely how many edge nodes could be deployed as part of this MCP, as it will depend on the chosen approach by

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[110] Communication from the Commission, *Updating the 2020 New Industrial Strategy: Building a stronger Single Market for Europe's recovery*, 5.5.2021, COM(2021) 350 final

[111] https://digital-strategy.ec.europa.eu/en/policies/cloud-alliance

[112] https://www.gaia-x.eu/.The Gaia-X initiative aims at building a federated data infrastructure on the basis of interoperability. The European Commission has no formal relationship with the Gaia-X initiative.

[113] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions *A European strategy for data*, COM(2020) 66 final

[114] https://www.bmwi.de/Redaktion/EN/Artikel/Industry/ipcei-cis.html

industry[115]. Depending on the chosen scenario ("cloud to edge" or "edge to cloud"), the deployment could range from one edge node every 200-300 km to every 50-60 km, and reach a total varying between 100 and 1000 nodes (along highways) across the EU by 2030.

The **European Alliance for Industrial Data, Edge and Cloud** should help to ensure consistency across the different funding instruments and investment tools mentioned above, and avoid a fragmented approach in different Member States. To bring this into practice, the Alliance will gather a wide range of stakeholders relevant to the data processing value chain to leverage investment synergies, for instance by developing detailed strategic technology and investment roadmaps on cloud and edge.

3.3.4. Quantum computing

- *Target:* "By 2025, Europe will have its **first computer with quantum acceleration** paving the way for Europe to **be at the cutting edge of quantum capabilities** by 2030."

- *Baseline (2020):* 0

- *Source:* Monitoring carried out by the Quantum Technologies Flagship's Strategic Advisory Board

- *What is the rationale for the set target value?*

During the Digital Decade, a whole generation of new quantum technologies will emerge, with a far-reaching impact on many activities of Europe's economy and society. The first devices, in the form of experimental physical platforms or advanced simulators, are already in use, and researchers are now starting to build pilot quantum computers to act as accelerators interconnected with supercomputers, forming "hybrid" machines that blend the best of quantum and classical computing technologies. Throughout the consultation process, experts highlighted the importance of the quantum computing target for facilitating unprecedented developments and findings in complex fields of research (e.g., climate change, health, brain science, biology, sustainable energy, materials, etc.) and industrial development (e.g., simulation sciences, data analytics, AI, digital twins, etc.).

Based on the progress made so far, a fully programmable machine of this kind should be available in Europe by 2025, capable of simulating problems with an accuracy and/or complexity beyond the capabilities of classical computers. Several EU start-ups and SMEs, some of them beneficiaries of Horizon 2020 projects under the first phase of the Quantum Technologies Flagship[116], are already offering first prototypes of functional quantum computers capable of solving specific problems. They are investing in the further maturing of those quantum computers, with the support of European and national funding programmes, but also first investments from private donors, aiming for the commercialisation of quantum computers showing quantum advantage (i.e., the ability to solve problems that a classical computer cannot realistically solve).

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[115] There are two possible trends in the industry on the deployment model for 5G corridors: either to have the edge nodes as close as possible to the road premises to satisfy the short latency criteria, or maximize efficiencies by not going too close to the premises. See also: https://bscw.5g-ppp.eu/pub/bscw.cgi/d397473/EdgeComputingFor5GNetworks.pdf
[116] https://ec.europa.eu/commission/presscorner/detail/en/IP_18_6205

*   *What are the baselines and current trends?*

European quantum computing research already has an excellent track record. In less than three years, the work of the Quantum Technologies Flagship has led to advances in quantum computing towards higher levels of technology-readiness, enabling researchers to start building experimental machines and addressing optimisation problems[117]. Across Europe, but also world-wide, large and small businesses are showing increasing interest in quantum technologies, and are experimenting with first practical use cases, while venture capitalists are also increasingly investing in the technology.

Quantum is also a key area for start-up and SME growth, and currently the EU hosts over 50 quantum start-ups. This number is likely to increase significantly in the coming years, with several Member States putting in place extensive support programmes for start-ups in the domain. These activities will help Europe's nascent quantum computing industry further develop its technological and engineering capabilities and build a full software and applications ecosystem, most probably providing multiple quantum computing accelerator technologies in Europe by 2025.

It is then expected that ongoing European but also worldwide efforts would make it possible to achieve, around the end of this decade, free-standing quantum computers showing quantum advantage with real-world applications[118]. Such computers are expected to comprise of a full stack, highly connected, high fidelity quantum computing engine of at least one thousand physical qubits, exhibiting scalable performance and the capability to out-perform classical computers on relevant real-world use-cases,. This will provide quantum advantage in several fields such as molecular biology, logistics, new materials discovery, process optimisation, machine learning, finance and inventory management.

*   *What is needed to achieve the target?*

The Quantum Technologies Flagship was launched in 2018 under Horizon 2020, and it receives continued support under Horizon Europe to reach its overarching goal of enabling the transformation of European research into commercial applications that would make full use of the disruptive potential of quantum. The Flagship is a central element of the Commission's ambitions to foster a world-leading quantum ecosystem in Europe, covering quantum computing and simulation but also quantum sensing and quantum communication.

The first European experimental quantum computing platforms (based on superconducting qubits, trapped ions qubits, and semiconductors-based qubits) resulting from the Flagship, are becoming ready for concept validation and trial applications[119]. The latter is already happening, as the EuroHPC Joint Undertaking[120] has launched in 2020 the installation in a supercomputing centre of a quantum simulator, which should be accessible to users for

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[117] https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=70073
[118] https://digital-strategy.ec.europa.eu/en/news/new-strategic-research-agenda-quantum-technologies
[119] See https://qt.eu/about-quantum-flagship/projects/?areas%5B%5D=computing for a full list of these projects and details about them.
[120] The EuroHPC Joint Undertaking (. https://eurohpc-ju.europa.eu/, https://digital-strategy.ec.europa.eu/en/policies/high-performance-computing-joint-undertaking) was created with the goal of enabling the EU and participating countries to pool their resources in order to deployworld-class high performance computing, quantum computing and data infrastructure in Europe. Its budget for the period 2021-2033 is in the order of € EUR 7 billion. In July 2021, an updated Regulation on the Joint Undertaking covering its mission and budget for 2021-2033 was adopted (Regulation (EU) 2021/1173).

experimental pilots in 2022-2023. In addition, it is expected that in 2021 and 2022, the EuroHPC Joint Undertaking will launch dedicated calls for the development and deployment of advanced quantum computers that will be integrated into high-performance supercomputers. This will allow European players to further mature the systems, test them under real-life conditions, and make them available to a growing number of scientific, industrial and public-sector users.

In addition, European industry has recently launched the Quantum Industry Consortium to foster the interests of Europe's industrial players in quantum.[121]

Joint action, investment and coordination at European and national level will be needed to achieve these goals as well as co-investment by Member States and matching investments in large-scale national and regional R&I activities. Several Member States have already in place ambitious national quantum programs, with similar goals – examples include Germany, France, the Netherlands, Austria, and Denmark, among others.

Public procurements of innovative quantum computing technology at national level, including through the Resilience and Recovery Facility (RRF) and the EuroHPC Joint Undertaking are expected to contribute to having in the Union, around the end of this decade, a first prototype of free-standing quantum computer showing quantum advantage.

Investments in quantum research and infrastructure must be complemented by initiatives in skills and training (supported by the Digital Europe programme) to ensure that Europe's workforce is able to meet the challenges of the quantum revolution.

3.4. Digital transformation of business

3.4.1. Take up of digital technologies

- *Target:* **"75% of European enterprises** have taken up: Cloud computing services, Big data, and Artificial Intelligence"

- *Source:* Eurostat, IPSOS

3.4.1.1. Cloud computing services

- Target: **75% of European enterprises** have taken up Cloud computing services

- *Baseline (2020):* 26% for medium-high sophistication cloud services ("advanced")

- *Source:* Eurostat

- *What is the rationale for the set target value?*

In 2020, 26% of EU companies used advanced cloud services[122]. The take-up of advanced cloud services for large enterprises (48%) is well above that of SMEs (25%). Reaching 75%

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[121] https://qt.eu/about-quantum-flagship/the-quantum-flagship-community/quic/
[122] I.e., hosting of the enterprise's database, accounting software applications, Customer Relations Management software and computing power.

adoption of advanced cloud services by businesses across sectors will enable the EU to match the growth in cloud uptake with its global trade partners, in particular the US.

Different surveys suggest that the uptake of (all) cloud services is rising fast in the US and could reach 60 to 80% in 2022[123]. Some surveys suggest that the figure could be close to 100% for medium and large companies in the US[124], with more than half of these companies operating on the cloud. According to the IDC Cloud Pulse, 58% of large companies worldwide have deployed production applications in a cloud setting[125]. In the US, the trend is also shifting for small and medium enterprises, where the uptake has been historically low, announcing a rapid growth well beyond 50%[126].

In the aftermath of the COVID-19 crisis, a high adoption rate of basic and advanced cloud services will continue to be essential for the resilience and competitiveness of European businesses driving agility and innovation.

- *What are the baselines and current trends?*

The economic imperative for the adoption of cloud solutions will continue to grow worldwide in the next years[127]. According to Deloitte (2020), revenue growth will remain at or above 2019 levels for 2021 through 2025[128]. The rapid advance in technologies such as 5G, Internet of Things (IoT), big data analytics, machine learning and artificial intelligence (AI) will call for the deployment of cloud and edge solutions across sectors and workloads.

Taking as a baseline the conservative figure of 26% of adoption rate of advanced cloud services, even if the high growth rate in 2020 would continue linearly until 2030, cloud adoption by businesses would remain significantly below the projected cloud adoption of main EU trading partners[129]. To reach 75% of cloud adoption, it is assumed that there will be an average annual growth rate of at least 11.4% (for advanced cloud services) over the period from 2020 to 2030 and that the projected growth path will follow that of a standard S-curve for technology diffusion. After initially progressing more slowly up to 2020, the take up is expected to accelerate over the period from 2021 to 2024 as more firms adopt cloud solutions, before gradually decelerating until 2030 as higher rates of diffusion are reached.

Currently, cloud and edge penetration remains unevenly distributed in Europe compared to other economies in the world and rises slowly due to the lack of a cloud offering adapted to sector specific needs. In particular, sectors such as manufacturing, mobility, energy, healthcare, public administration, and aerospace require highly tailored services due to their need to process highly sensitive data in strict compliance with sectoral legislation. Today, for

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[123] https://www.infoworld.com/article/3561329/the-state-of-cloud-computing-in-2020.html ;
https://www.oreilly.com/radar/cloud-adoption-in-2020/
[124] Deloitte, *Data modernization and the cloud*, 2019
[125] *IDC Cloud Pulse: Worldwide Enterprise Cloud Management Survey Insights*, August 2020, By: Mary Johnston Turner, Research Vice President, Future of Digital Infrastructure, Michelle Bailey, Sean Riley
[126] IDC, *U.S. Small and Medium-Sized Business: The State of Cloud Adoption*, 2020
[127] Deloitte, *The cloud migration forecast: Cloudy with a chance of clouds*, 2020
[128] Deloitte, *The cloud migration forecast: Cloudy with a chance of clouds*, 2020
[129] Deloitte, *Europe's Digital Decade and the RRF Gap Analysis* (2021): The study predicts that it would reach 40% in 2030 with a linear growth.

regulatory reasons, companies from specific sectors might refrain to put certain workloads to the cloud[130].

As of 2020, cloud adoption in the EU is the highest in Finland, Sweden and Denmark, where the majority of enterprises rely on such services, and the lowest in Poland, Romania and Bulgaria .
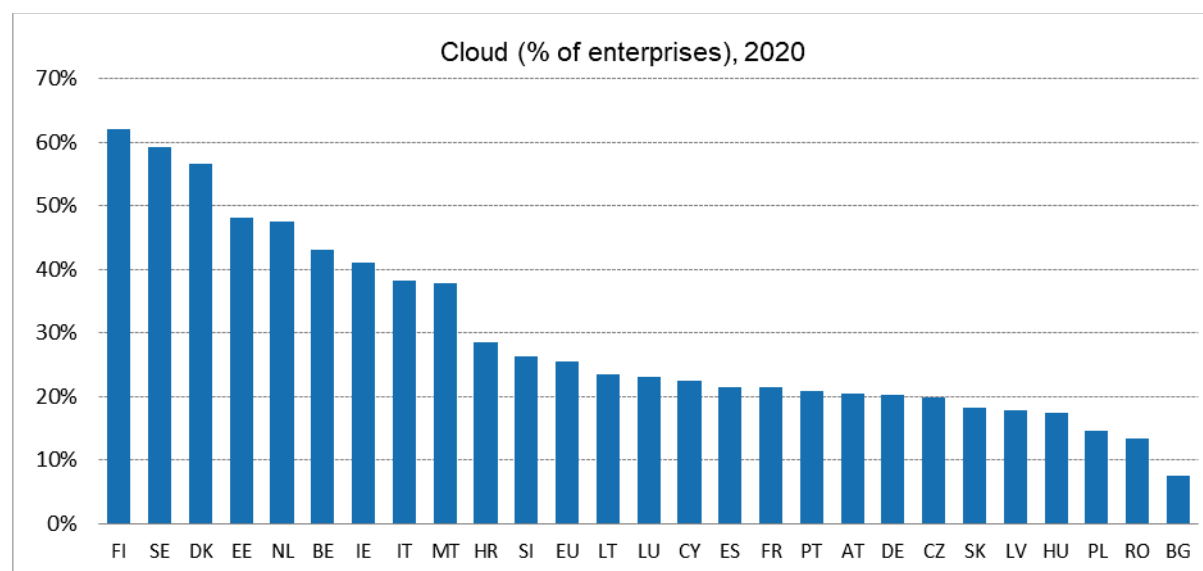
Figure 15: Cloud uptake (% of enterprises) by Member State, 2030

Source: Eurostat, Community survey on ICT usage and e-commerce in enterprises. Data for Greece is not available.

Under a *Business as usual* scenario, the uptake of cloud solutions will continue to be driven by sectors that are already most advanced in their digital transformation and satisfied with existing one-size-fits-all cloud offering of hyperscalers[131]. The market will become saturated, while many European firms will limit their adoption of such services, hampering their long-term competitiveness.

Under the *Digital Decade* scenario, European industry across sectors will find solutions to meet sectoral and security needs. A key differentiator will be the availability of an offering that meets the requirements for processing sensitive personal data or highly sensitive business and public sector data, guaranteeing high compliance with sectoral legislation.

The below projection assumes an S-curve, built on historical data, which is widely used to describe technology life cycles.

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[130] Deloitte, *Data modernization and the cloud*, (2019)

[131] The top four global leaders on the public cloud infrastructure market – often referred to as hyperscalers – are Amazon Web Services (AWS), Microsoft Azure, Google Cloud and Alibaba Cloud. They will account for over 80% of global revenues in 2021 according to Gartner: https://www.gartner.com/en/newsroom/press-releases/2020-08-10-gartner-says-worldwide-iaas-public-cloudservices-market-grew-37-point-3-percent-in-2019
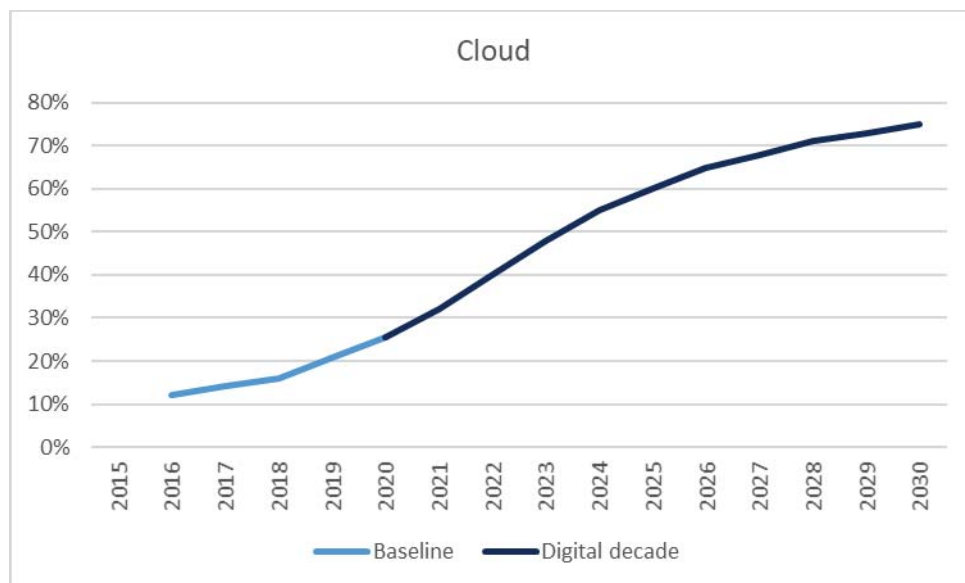
Figure 16: Percentage of European enterprises using cloud computing services (EU projection to 2030)

Source: Commission services based on data from Eurostat.

- *What is needed to achieve the target?*

Boosting cloud uptake will depend on both supply-side and demand-side measures. On the supply side, the EU will make funding available to boost public-private investments in a **next generation cloud and edge offering** meeting industry and public sector needs through targeted EU programmes (DEP, CEF2, HE).

In July 2021, the Commission kick-started the **European Alliance for Industrial Data, Edge and Cloud**[132]. This Alliance, bringing together key European stakeholders from industry and the public sector, will leverage investment synergies at European and national level (e.g., RRF Scale-Up Flagship[133]) as well as investments planned by EU industrial actors, including between industrial actors themselves. For instance, by developing strategic technology and investment roadmaps on cloud and edge, the Alliance can provide expertise to ensure that European public and/or private investments in cloud and edge will proceed in a strategic and streamlined manner to foster trusted EU cloud and edge capacities adapted to the needs of EU businesses and the public sector.

The **"European Common Data Infrastructure and Service" Multi-Country Project**, of which one part may take the form of a possible Important Project of Common European Interest (IPCEI) on Next Generation Cloud and Edge Infrastructure and Services[134], will contribute to support a higher cloud and edge uptake among companies and public entities as positive externalities by delivering a trusted EU cloud offering. Strategic linkages might be created with other EU initiatives, such as the 5G Infrastructure Public-Private Partnership

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[132] https://digital-strategy.ec.europa.eu/en/policies/cloud-alliance

[133] *Example of component of reforms and investments – Digital components and cloud capabilities*:
https://ec.europa.eu/info/files/examples-component-reforms-and-investment-scale_en

[134] See official website of the on-going IPCEI on Next Generation Cloud Infrastructure and Services:
https://www.bmwi.de/Redaktion/EN/Artikel/Industry/ipcei-cis.html

(5G-PPP) and the Joint Undertaking on Smart Networks and Services towards 6G (SNS JU), to build the next generation data processing infrastructure.

On the demand side, the **Digital Europe Programme** will provide support to businesses for the take up of advanced digital technologies such as cloud, in particular through the network of European Digital Innovation Hubs (see Section 3.4.2) . Furthermore, as announced in the European strategy for data, the Commission also intends to enhance legal certainty for the use of cloud services in compliance with key EU rules and norms[135]. In particular, the Commission intends to publish an **EU Cloud Rulebook** (Q2, 2022), which will serve as a reference for services offered on the future **EU online cloud marketplace** fit for the needs of businesses, including SMEs and start-ups, and the public sector (Q4, 2022). The Commission also intends to boost the uptake of cloud services in the public sector by facilitating the development of common European specifications for the **public procurement** of data processing services.

In order to accelerate the adoption rate of advanced cloud services, additional supply-side and demand-side measures could be required at national level, in particular targeting SMEs. An investment channel for accelerating the digital transformation of SMEs through cloud adoption will be the funding stemming from **the national RRPs** (Next GenerationEU), for instance to provide both technical and financial assistance to support the cloudification of internal IT systems and processes[136].

3.4.1.2. Big data

- *Target: **75% of European enterprises** have taken up Big data*

- *Baseline (2020):* 14%

- *Source:* Eurostat

- *What is the rationale for the set target value?*

The possibility of extracting information from data through advanced data analytics technique will be essential for the competitiveness of Europe's economy. Reaching 75% adoption of advanced big data analytics by businesses across sectors will enable European companies to match the growth in data uptake at global level and fully exploit the rich new ways to explore and interpret data using Artificial Intelligence, Natural Language Processing and eXtended Reality technologies. In a recent study by McKinsey, 93% of surveyed EU executives believe that better access to data would be important to their organisation (with approximately 40% designating this as very important)[137]. Research by the Organization for Economic Cooperation and Development (OECD) suggests that companies that invest in data-driven

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[135] Examples of currently enforceable legal acts and binding requirements for cloud services are the General Data Protection Regulation, the Network Information System Security Directive. Examples of non-regulatory codes of conduct and certification schemes for cloud services are the SWIPO data portability Codes of Conduct, Cloud Infrastructure Service Providers in Europe and the EU Cloud Code of Conduct, as well as the future European Cybersecurity Certification for cloud services.

[136] *Example of component of reforms and investments – Digital components and cloud capabilities*: https://ec.europa.eu/info/sites/default/files/examples_of_component_of_reforms_and_investment_scale_up_en.pdf

[137] McKinsey. Shaping the digital transformation in Europe, September 2020.

innovation and data analytics exhibit faster productivity growth than those that do not by approximately 5% to 10%[138].

The combined efforts of the European data and AI strategies[139] to drastically increase the availability and take-up of data and AI resources, while providing the required level of trust and certainty to innovators, are expected to contribute to the growth of both Data and AI fields, which are very interdependent.

- *What are the baselines and current trends?*

Over the last four years, uptake has increased by an annual average of 9.3%. Application areas for big data and big data analytics can be found in all sectors, their take-up is a horizontal trend[140]. Demand for big data analytics can be expected to increase further as policy initiatives address issues that prevent companies from tapping into the value of data. The trend is towards big data technologies that are inherently safe, secure, resilient; support interoperability, privacy preservation, transparency, traceability, and low energy and resource footprints; and comply with various societal, legal and ethical requirements. This trend is informed by the more and more frequent use of data for the development of artificial intelligence solutions that affect practically all aspects of the professional and private life of citizens.

Looking at the Member States, enterprises in Malta, the Netherlands and Denmark have the highest adoption rates (above 25%), while Romania, Slovakia and Cyprus record the lowest figures (5-6%).

Big data (% of enterprises), 2020

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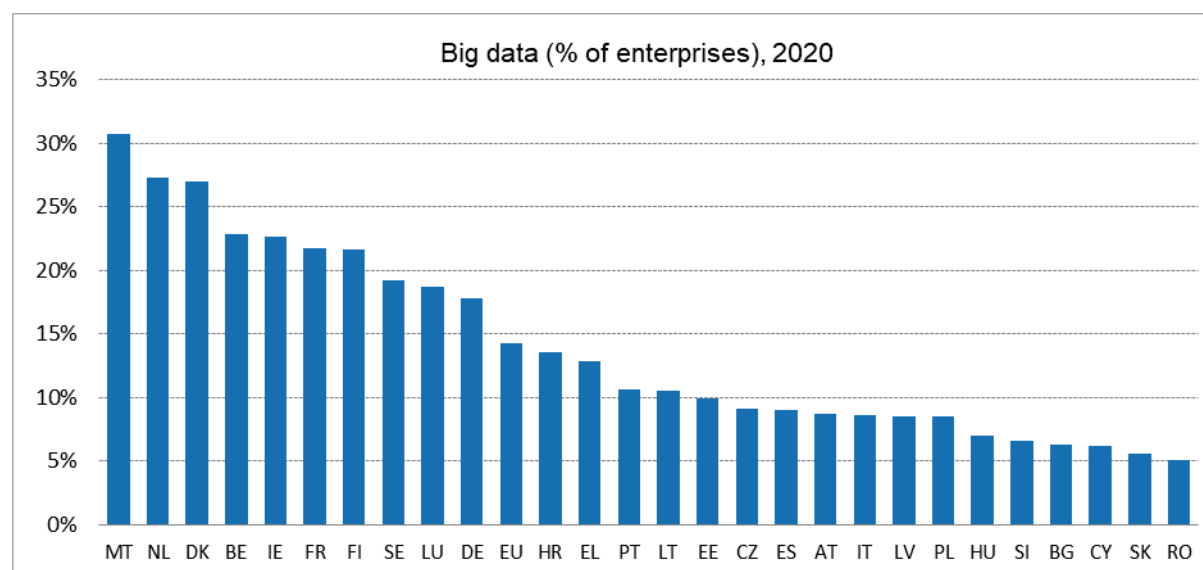
[138] OECD (2015). *Data-driven innovation: big data for growth and well-being*, OECD Publishing, Paris.
[139] Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions *Fostering a European approach to Artificial Intelligence*, COM(2021) 205 final, and Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions *A European strategy for data*, COM(2020) 66 final.
[140] European Commission, Business Innovation Observatory (2013). Big Data Analytics & Decision Making, Case study 8.

Figure 17: Big data uptake (% of enterprises) by Member State

Source: Eurostat, Community survey on ICT usage and e-commerce in enterprises.

In order to achieve the 2030 target, an average annual growth rate of 18% is assumed over the period from 2020 to 2030. The projected growth path is assumed to follow that of a standard S-curve for technology diffusion. After initially progressing more slowly up to 2020, take up is expected to accelerate significantly over the period from 2021 to 2024 as more firms adopt Big Data, before gradually decelerating over the period up to 2030 as higher rates of diffusion are reached and the target rate of 75% is approached.

The below projection assumes an S-curve, built on the historical data, which is widely used to describe technology life cycles.
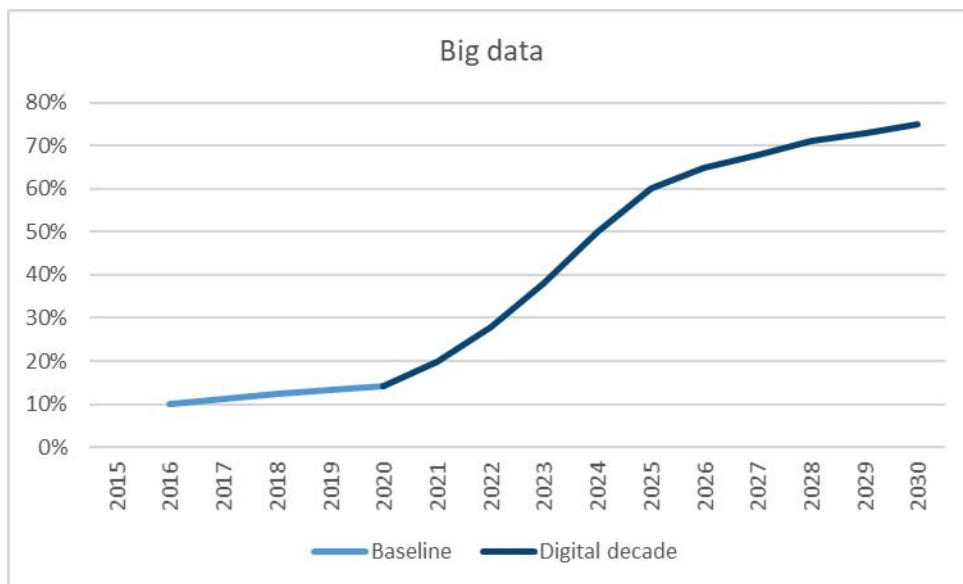
Figure 18: Percentage of European enterprises using big data (EU projection to 2030)

Source: Commission services based on data from Eurostat.

- *What is needed to achieve the target?*

Stakeholders across sectors emphasize the need for coordinated investment to create common European data spaces in strategic sectors. They expect these spaces to foster an ecosystem of companies, civil society and individuals that provides easy and secure access to shared data. Companies and others could then use this data to create new products and services, optimise supply chains and simplify admminisitration.

The Commission has announced in the Communication "A European Strategy for data"[141] a number of initiatives aiming at promoting the access and use of data. The Data Governance Act[142] and the upcoming Data Act will enhance trust and fairness, and encourage businesses to move to the data economy. Moreover, the network of European Digital Innovation Hubs

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[141] https://digital-strategy.ec.europa.eu/en/policies/strategy-data
[142] Proposal for a Regulation of the European Parliament and of the Council on European data governance (Data Governance Act) COM(2020) 767 final

(see Section 3.4.2) will play a role in meeting the target by supporting SMEs in using data to improve their business processes.

Furthermore, Member States will need to make complementary investments in data spaces and reforms to support and encourage the uptake of Big Data.

3.4.1.3. Artifical Intelligence

- *Target: **75% of European enterprises** have taken up Artificial Intelligence*

- *Baseline (2020): 25%*

- *Source: IPSOS[143]*

- *What is the rationale for the set target value?*

Artificial intelligence (AI) is an area of strategic importance in all domains, from precision farming in agriculture, more accurate medical diagnosis to safe autonomous driving and a key driver of economic development in Europe. However, in 2020, only 7% of enterprises in the EU [144] used AI applications. The successful uptake of AI technologies also has the potential to accelerate Europe's economic growth and global competitiveness[145]. AI systems and the new business models they enable are progressively developing to at-scale deployment.

The target for AI is to reach an uptake of AI technologies by 75% of businesses in the EU by 2030. This reflects the general purpose character of AI, which can be used across the entire economy and is accessible to SMEs as well as large companies. The current figure by IPSOS is a uptake of AI technologies of 25% (2020[146]). While the target is very ambitious, given also the low baseline, it can be achieved if overall economic growth is sufficiently strong and adequate policies are pursued, including after the end of the current policy cycle.

- *What are the baselines and current trends?*

2020 is the first year of available data for this indicator, therefore it is difficult to explain with certainty the trends. However, as with Cloud, AI can be assumed to have expanded rapidly over the last few years (as also confirmed by other data sources on the investments and uptake of AI technologies[147]). Additionally, since AI builds on other digital enablers such as Cloud and Big Data, it can leverage investments in those areas too.

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[143] The source for this indicator is currently IPSOS, but it will change to Eurostat starting 2022. This may have an effect on the methodology, the current indicator value and, therefore, the trajectory to the target value for 2030.

[144] Based on Eurostat figures https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20210413-1 (enterprise in this context if at least 10 people are employed)

[145] According to McKinsey, the cumulative additional GDP contribution of new digital technologies could amount to €2.2 trillion in the EU by 2030, a 14.1% increase from 2017, McKinsey, Shaping the Digital Transformation in Europe, 2020).

[146] European enterprise survey on the use of technologies based on artificial intelligence, IPSOS, 2020.

[147] Other indicators may serve to a limited extent as a proxy for the uptake of AI: notably, in the past 10 years, the rising number of AI patents and AI start-ups, and increased venture capital investment, also in specific sectors such as health or transport. These data have been analysed by the AI Watch, cf. JRC Science for Policy Brief "EU in the global Artificial Intelligence landscape", forthcoming. An analysis of AI uptake in the health

In 2020, AI adoption by enterprises stood at 25% in the EU, with national figures ranging between 14% in Ireland and 40% in Czechia.
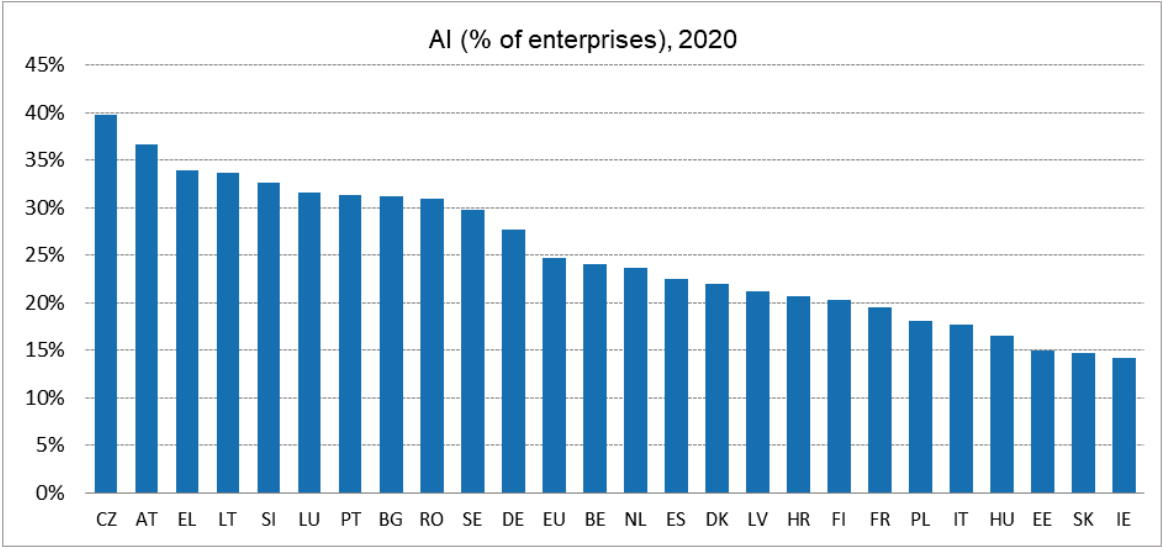
Figure 19: AI uptake (% of enterprises) by Member State, 2020

Source: IPSOS. Data for Cyprus and Malta is not available.

To reach the target would require an average annual growth rate of 11.7% between 2020 and 2030. Take up is expected to accelerate over the period from 2023 to 2026 as more firms adopt AI, before gradually decelerating over the period up to 2030 as higher rates of diffusion are reached. The set of measures being rolled out by the Commission, as stated in the Coordinated Plan on AI, is expected to support this growth acceleration. The projection assumes an S-curve, built on the historical data, which is widely used to describe technology life cycles.
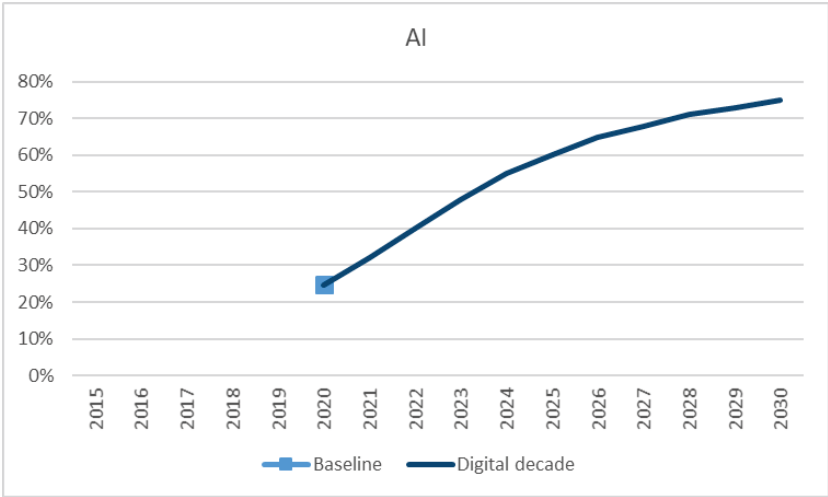
Figure 20: Percentage of European enterprises using AI (EU projection to 2030)

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care and mobility sectors can be found in "AI Watch: AI Uptake in Health and Healthcare", 2020, and "AI Watch: AI Uptake in Smart Mobility", forthcoming.

Source: Commission services based on data from IPSOS.

-   *What is needed to achieve the target?*

In 2018, the Commission together with the Member States adopted a Coordinated Plan on AI[148]. As a result of the actions agreed and facilitated by the Plan, most Member States have adopted national AI strategies and started to implement them. Investments in AI have increased and the EU has been able to mobilise a critical pool of resources to support the spread of AI in Europe. The Commission has published a review of the Coordinated Plan in 2021, putting forward a concrete set of joint actions for the European Commission and Member States on how to create EU global leadership on trustworthy AI[149]. To further support the uptake of AI in Europe and facilitate trust in AI technologies, the Commission has also proposed in April 2021 a risk-based horizontal legislation on AI, the Artificial Intelligence Act[150]. This proposal sets harmonised rules for the placing on the market, the putting into service and the use of artificial intelligence systems ('AI systems') in the Union, which are proportionate to the degree of risk AI systems are considered to present. The aim is to provide certainty for businesses while protecting the safety and fundamental rights of citizens and thus facilitate trust and wider uptake of AI technologies in the EU.

There is broad support across stakeholder groups for the initiative to regulate AI at EU level. Member States have welcomed the Commission's risk-based approach and see the proposal as an important step towards completing the single market. Business stakeholders agree that access to the digital single market is imperative for the digital transformation of businesses and call for the reinforcement, simplicity and the stability of framework conditions. Public administrations call for proper guidance for companies in the use of digital technologies and in the application of new regulations.

Through the Horizon Europe[151] and Digital Europe[152] Programmes, the European Commission will promote development and innovation in trustworthy AI and provide support to businesses for the take up of advanced digital technologies, specifically AI. The forthcoming actions are outlined in detail in the 2021 review of the Coordinated Plan[153]. For example, measures to promote a European Ecosystem of Excellence for AI include a new public-private partnership in AI, data and robotics[154] to drive and implement the R&I strategy, as well as to strengthen and link AI research excellence centres, aiming in particular to build

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[148] Annex to the Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions Fostering a European approach to Artificial Intelligence, COM (2021) 205 final.

[149] Annex to the Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions Fostering a European approach to Artificial Intelligence, COM (2021) 205 final.

[150] Proposal for a regulation laying down harmonised rules on artificial intelligence (Artificial Intelligence Act) and amending certain Union legislative acts, COM(2021) 206 final

[151] https://ec.europa.eu/info/research-and-innovation/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/cluster-4-digital-industry-and-space_en

[152] https://digital-strategy.ec.europa.eu/en/activities/digital-programme

[153] Sections 4 to 7 of the 2021 Review of the Coordinated Plan, specifically provide set of action related to promote ecosystem of excellence.

[154] European Public Private Partnership on Artificial Intelligence, Data and Robotics (ADRA), 2021. For an overview of the Partnership and more broadly funding and actions available under Cluster 4 of the Horizon Europe Programme, see e.g. Presentation Horizon Europe Info Day: Cluster 4: AI, Data and Robotics, July 21, 2021. https://ai-data-robotics-partnership.eu/)

bridges between stakeholders and increase the cooperation, integration and synergies between research teams and with industry.

The Commission is also setting up AI testing and experimentation facilities (TEFs), a highly specialised resource to be shared at the European level, to support bringing innovative solutions to market, with a focus on high-impact sectors such as health, manufacturing, smart cities/communities and agriculture. Additionally, the Commission is scaling up the European AI-on-demand platform, which aims to become the reference European marketplace for AI resources, which will provide easy and simple access to AI tools for local distribution by Digital Innovation Hubs or direct use by industry (especially SMEs) or the public sector.

The planned extension of the network of European Digital Innovation Hubs, with a minimum of one hub per Member State focused on AI, will provide support services to SMEs to enable the digitisation of their businesses through the adoption of AI technologies.

3.4.2. Digital "late adopters"

- *Target:* "**More than 90% of European SMEs** reach at least a basic level of digital intensity"

- *Baseline (2020):* 60%

- *Source:* Eurostat

- *What is the rationale for the set target value?*

The target is to reach 90% of SMEs in the EU with at least basic digital intensity by 2030. The pre-COVID current figure is 60% (2020) and studies show that there has been an acceleration of between 5 to 7 years[155]. Given this starting position and recent progress, a target of 90% by 2030 is ambitious, yet necessary given the increased policy focus on and support for the digitalisation of SMEs.

Stakeholders agree that the digital transformation of businesses, and SMEs in particular, will depend on their ability to adopt to new technologies rapidly and across the board. Business stakeholders emphasize that the biggest barriers and bottlenecks to achieve this target are a lack of resources and public funding, shortages in skilled labour, lack of infrastructure, lack of access to data for R&D, and the fragmentation of laws across the EU. Public Authority stakeholders point out that SMEs are struggling to implement digital solutions mostly due to a lack of knowledge and awareness of the possible benefits of digitalization.

The Digital Intensity Index (DII) measures the use of different digital technologies at enterprise level, and is based on the Community survey on ICT usage and e-commerce in enterprises carried out by Eurostat. The DII score (0-12) of an enterprise is determined by counting how many of the selected digital technologies it uses. The figure below presents the composition of the DII in 2020, and shows the difference in answers from SMEs and large companies. A basic level of digital intensity corresponds to a situation where an enterprise scores 4 or more.

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[155] Gartner, October 2020

	Large	SMEs
Enterprises where more than 50% of the persons employed used computers with access to the internet for business purposes	94%	76%
Employ ICT specialists	92%	76%
The maximum contracted download speed of the fastest fixed line internet connection is at least 30 Mb/s	78%	62%
Provide more than 20% of the employed persons with a portable device that allows internet connection via mobile telephone networks, for business purposes	56%	46%
Have a website	47%	39%
Website has at least one of : description of goods or services, price lists; possibility for visitors to customise or design online goods or services; tracking or status of orders placed; personalised content in the website for regular/ recurrent visitors	53%	32%
Use 3D printing	48%	25%
Buy medium-high CC services	76%	18%
eInvoices sent, suitable for automated processing	39%	17%
Use industrial or service robots	34%	14%
Enterprises with e-commerce sales of at least 1% turnover	28%	6%
Analyse big data internally from any data source or externally	17%	5%

Figure 21: Digital intensity by company size, 2020

Source: Eurostat, Community survey on ICT usage and e-commerce in enterprises.

- *What are the baselines and current trends?*

The starting position of the Digital Intensity Index for the EU as a whole is 60% (2020). For the projection of this index towards 2030 it is assumed that there will be an average annual growth rate of 4.1% over the period from 2020 to 2030 and that the projected growth path will follow that of a standard S-curve for technology diffusion.
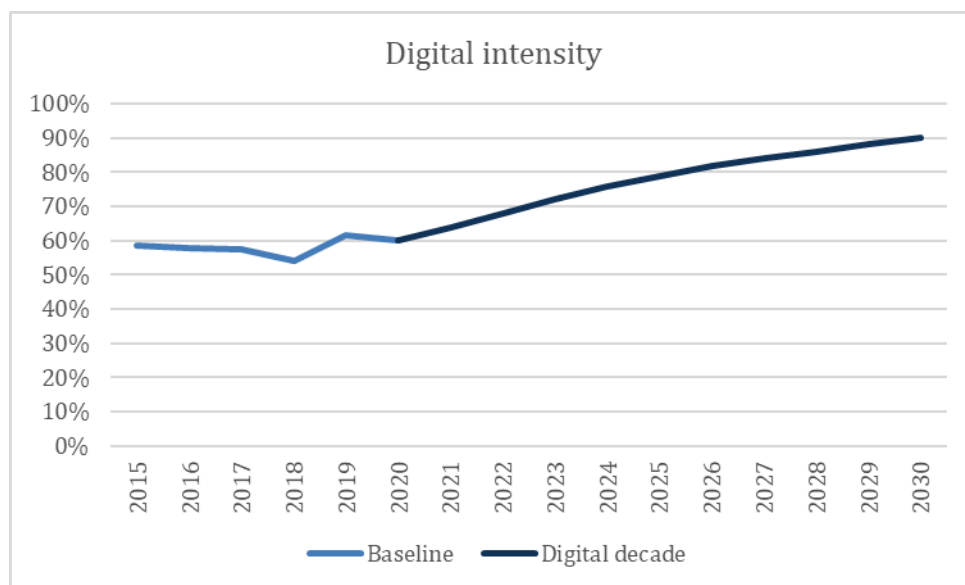
Figure 22: Percentage of SMEs with at least a basic level of digital intensity (EU projection to 2030)

Source: Commission services based on data from Eurostat.

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The above projection assumes a gradual transformation of SMEs, with a slightly decreasing growth rate over time. Indicator time consistency, notably in terms of composition of the Digital Intensity Index, is required to avoid seeing the uneven development observed in 2017-2020 due to the change of technologies measured[156].

While the projection shows the EU average, the level of digitalisation of SMEs remains uneven, depending on the location of the company and the sector of its activities. The figure below shows for each Member State its percentage of SMEs with at least a basic level of digital intensity in 2020. There are two Member States which have already almost reached the target of 90%, but there are also two that only have around 32% of SMEs with a basic digital intensity.
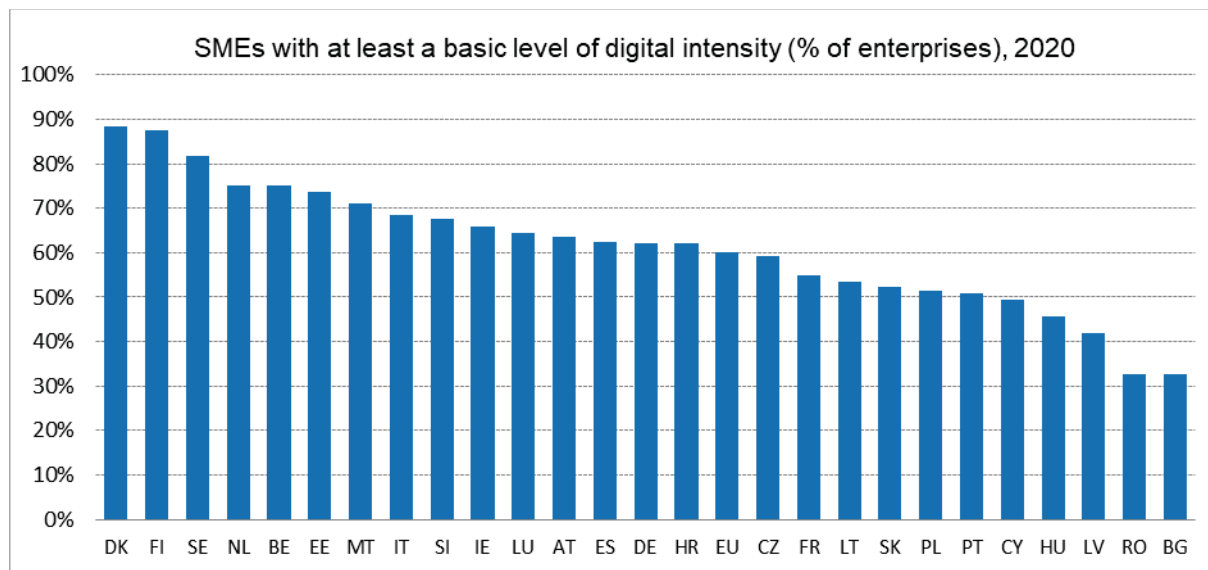
Figure 23: SMEs with at least a basic level of digital intensity (% of enterprises) by Member State, 2020

Source: Eurostat, Community survey on ICT usage and e-commerce in enterprises. Data for Greece is not available.

Moreover, there are disparities within countries, as companies in remote regions struggle even more than companies located in capitals. Reaching the targets of the Digital Decade will therefore require a differentiated national or regional approach. The Digital Intensity Score is currently not available at regional level, but would be useful for such a differentiated and localised approach. The European Commission is currently investigating whether and how this data gap could be filled.

There are also disparities between industrial ecosystems[157]. The below figure provides an overview of enterprises with at least a basic level of Digital Intensity Index by economic

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[156] Over the last years, the indicator has shown little progress, and even experienced a drop in some countries because the composition of the indicator has been regularly updated to include more recent technologies. Going forward it is necessary to benchmark the evolution of such an indicator against a similar composition of the technologies as much as possible, to avoid tracking progress towards a moving target.

[157] 'A New Industrial Strategy for Europe' identified 14 industrial ecosystems: Tourism, Creative&Cultural industries, Aerospace & Defence, Textiles, Electronics, Mobility-Automotive, Low carbon energy intensive industries, Renewable energy, Agri-food, Health, Digital, Construction, Retail, Proximity&Social economy.

sectors. This data is not available for SMEs only, and the NACE[158] groups do not correspond one-to-one to the 14 industrial ecosystems. Nevertheless, it can be derived from it that the Digital and Creative and Cultural industrial ecosystems is already close to the target of 90% (represented by the NACE groups "Publishing activities; films & television, sound & music publishing, broadcasting"; "Telecommunications"; "Computer programming, consultancy and related activities, information services"). Others, such as Construction and Retail (represented by the NACE group "Retail trade, except of motor vehicles and motorcycles") are at around 50%.

A differentiated approach for each industrial ecosystem is justified. Ecosystems with high numbers of SMEs, which have suffered the most from the COVID crisis, should be prioritised.
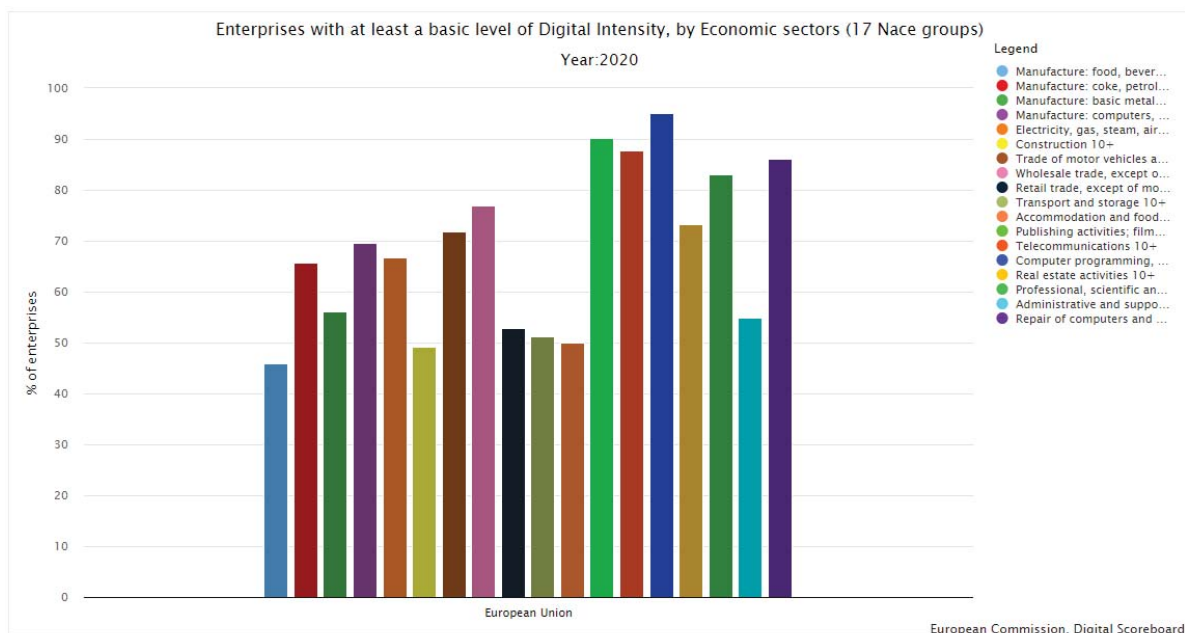
Figure 24: Enterprises with at least a basic level of digital intensity by economic sectors, 2020

Source: Eurostat , Community survey on ICT usage and e-commerce in enterprises.

- *What is needed to achieve the target?*

The Commission, together with Member States and regions, is deploying a network of European Digital Innovation Hubs (EDIHs), to foster the digital transformation of businesses through the Digital Europe Programme (DIGITAL). There will be one hub per region so that there is always one near every company. Every hub will give support to local companies, addressing their needs in the local language, taking into account the local economic context. At the same time, because of being part of a network, hubs can learn from each other how to effectively support companies. Moreover, if a local hub does not have the right competences to support a company, it will find another hub in the network that can provide the right support. Therefore, the network is combining the best of a local and EU-wide support. This

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[158] The Nomenclature of Economic Activities (NACE) designates the integrated classification system for products and economic activities.

will help to diminish geographical disparities and will give any company in Europe the best possible support to increase their digital intensity.

During the consultation process, stakeholders from business and government expressed strong support for expanding the network of EDIHs to reach the Digital Decade targets. Concrete proposals for EDIHs to support SMEs in their digitalization efforts included aggregating demand and organizing access to finance, pooling expertise and skills, and translating digital policies to reduce the regulatory burden and ensure compliance. Many emphasized the importance of a cross-sectorial approach, for example in the form of a digital volunteer mentoring programme in which larger companies support SMEs in developing the tools and skills they need to digitalize their business.

With about EUR 700 million over seven years, DIGITAL will not provide all the funds necessary to cover all regions in Europe and reach out to 90% of businesses. As such, many Member States have committed funds from the Recovery and Resilience Facility to support their hubs. Other European funds, such as cohesion funds, and national investments may also be used. Differences according to industrial ecosystems and economic sectors will be tackled through the renewed industrial strategy[159]. For each ecosystem pathways supporting the digital and green transition will be co-created by the Commission and relevant stakeholders. This should lead to specific actions and removal of barriers related to the uptake of digital technologies in each ecosystem, and therefore contribute to reaching the targets.

Member States and regions will need to make complementary reforms and investments to support and encourage the uptake of digital technologies broadly, e.g., by reducing administrative burden, providing tax breaks and other financial incentives, and creating dedicated funding schemes.

Lastly, achieving the targets does not only rely on direct measures to digitalise SMEs. It also relies on the availability of digital enablers such as connectivity, skills and education, and favourable regulatory frameworks.

3.4.3. Innovative businesses/scale-ups

- *Target:* "Europe will grow the pipeline of its innovative scale ups and improve their access to finance, leading to **doubling the number of unicorns**"[160]

- *Baseline (2021):* 122[161]

- *Source:* Dealroom

- *What is the rationale for the set target value?*

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[159] A new Industrial Strategy for a globally competitive, green and digital Europe

[160] By unicorns we understand here both: 1) realised unicorn, i.e. companies founded after 1990 that have had an IPO or trade sale above $1 billion and 2) unrealised unicorn, i.e. companies that have been valued at or over $1 billion in their last private venture funding round (meaning the valuation has not been confirmed in a secondary transaction). In 2019 there were 703 unicorns in the US and 206 in China (https://blog.dealroom.co/uk-unicorn-tech-update-for-london-tech-week/).

[161] Based on data from Dealroom.co (same data source for Atomico's well-regarded and widely cited Annual "State of European Tech" report).

There has been a growth in the number of EU unicorns over the last 20 years, especially in the last decade. The set target value would represent a major increase in the number of EU27 unicorns. It would be a powerful indicator that the EU delivers a better growth ecosystem for innovative start-ups, and thereby raise a new generation of European corporations competing globally.

- *What are the baselines and current trends?*

The average growth rate from 2016 to 2020 for late stage capital investments in Europe (i.e., investment rounds that are >USD 100m or > EUR 85m) was 15% per year[162]. Investment events of this scale are the ones that most coincide with a start-up moving into the 'unicorn' category. Our conservative assumption is that this growth of late funding in EU27 companies will increase from 2020 at a compounded 10% per annum. This will mean a doubling of late stage capital invested in EU27 by 2028. If this trend continues, at minimum a doubling of the number of EU27 unicorns in 2030 compared to the 2020 baseline of 122 can be expected.

The below projection assumes gradual developments with a stable growth until 2030.
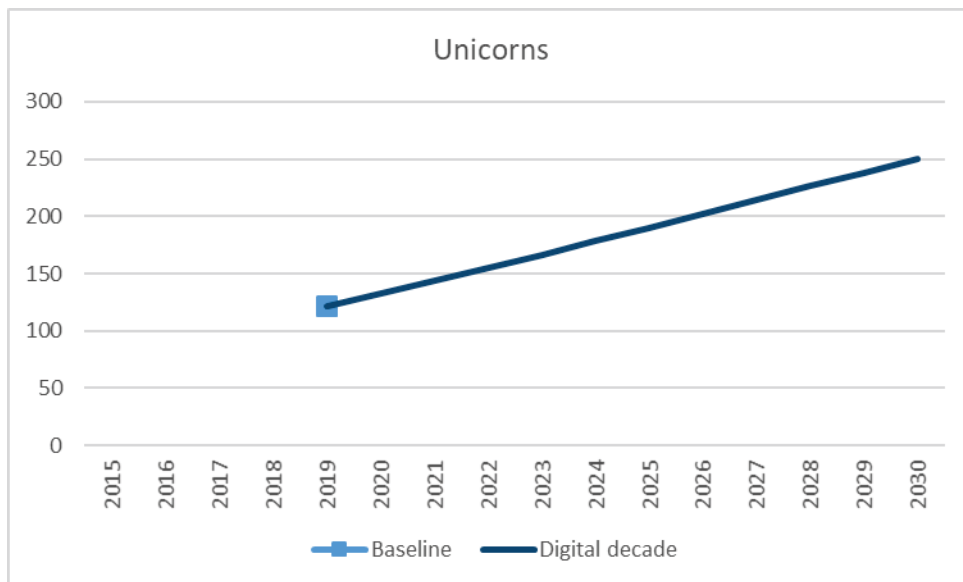
Figure 25: Number of unicorns (EU projection to 2030)

Source: Commission services based on data from Dealroom.

- *What is needed to achieve the target?*

Business stakeholders agree on the need for a stable, predictable, and supportive regulatory environment that allows companies to start up, scale, innovate, and compete across Europe. Many call for further actions to remove internal market barriers. Others would like to see more regulatory sandboxes to test new business models and ideas. Social partners call on the EU to facilitate the exchange of best practices at across sectors and Member States.

All EU Member States already strive to achieve the EU Start-up Nations Standard (EU SNS) by 2025. This initiative was launched by the Commission and the Portuguese Presidency of

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[162] Growth figures include UK.

the European Council at Digital Day 4 (19 March 2021)[163]. To date, 25 Member States have committed to it. The EU SNS mobilises Member States to take action under their national competencies to improve the framework conditions for start-ups in their country. 8 areas of action are identified (including access to finance, treatment of stock options, procurement from start-ups of innovations by public authorities, and access to talent) where best practices will be identified, shared and implemented by signatory countries.

As set out in the Capital Markets Union action plan[164] market-based financing is essential to sustain the recovery and the return to long-term growth and to finance the green and digital transitions of our economy. To make growth financing more accessible to European companies, the EU is developing several targeted financial instruments with other institutional actors, such as the European Investment Bank/European Investment Fund and the European Bank for Reconstruction and Development. The goal is to increase the capital available for EU start-ups active in strategic digital technologies. Such instruments, developed under the InvestEU programme, are building on the example of the Artificial Intelligence and Blockchain Fund[165]. The pilot scheme reached a total investment volume of EUR 1,2 billion in the market via private co-investment. Another example of such targeting, launched under InnovFin, the Digital Innovation and Scale up Initiative, enhances the access to equity finance for innovative start-ups in Central, Eastern and South-Eastern Europe[166]. These targeted actions are also flanked by EU programmes supporting start-ups and innovative SMEs directly or indirectly and SME friendly innovation procurements (such as through Horizon Europe, Digital Europe and LIFE).

The Commission needs to also support the launch of an EU27 network of Tech Diligence Centres to better valuate the technology behind innovations, and so enable more precise valuations of digital start-ups and prepare their investment readiness[167]. The tech due diligence services will deliver a benefit to spinoffs, start-ups and scale-ups by improving their access to finance. A pilot will be launched under Horizon Europe in late 2021.

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[163] https://ec.europa.eu/commission/presscorner/detail/en/ip_21_1186;
https://digital-strategy.ec.europa.eu/en/news/24-eu-member-states-commit-digital-day-take-action-support-growth-eu-startups
[164] Capital markets union 2020 action plan: A capital markets union for people and businesses | European Commission (europa.eu)
[165] https://ec.europa.eu/digital-single-market/en/news/eu-artificial-intelligence-and-blockchain-investment-fund-invest-100-million-euros-startups
[166] https://digital-strategy.ec.europa.eu/en/news/launch-digital-innovation-and-scale-initiative-central-eastern-and-south-eastern-europe
[167] https://digital-strategy.ec.europa.eu/en/news/24-eu-member-states-commit-digital-day-take-action-support-growth-eu-startups

3.5. Digitalisation of public services

3.5.1. Government as a platform

3.5.1.1. Online service provision

- *Target:* "**100% online provision of key public services** available for European citizens and businesses"[168]

- *Baseline (2020): 75/100 (citizens), 84/100 (businesses)*[169]

- *Source:* e-Government Benchmark[170]

- *What is the rationale for the set target value?*

The online availability of public services has been growing steadily over the last decade, accelerated by the COVID-19 pandemic during which digital interaction had to become the norm. A number of Member States are already close to the 100% target. However, progress is uneven across and within Member States. Services for citizens are less likely to be available online when compared to services for businesses. While the roll-out of basic digital public services is progressing steadily (e.g., access to online forms, online appointment booking, etc.), the availability of more advanced public services that make use of innovative digital technologies (e.g., AI, big data, robotics, etc.) still requires significant investment. This target aims to boost Member States' efforts in making *all* key public services available online while reinforcing also the adoption of innovative ICTs to provide digital public services with optimal quality and efficiency. Progress towards this target is contingent on the provision of secure and easy-to-use digital identity means (see 3.5.1.3).

According to public sector stakeholders, the digitalisation of public services is inhibited by a lack of interoperability, trust, and digital skills within and between public administrations. There is broad consensus that overcoming these barriers requires more public investment, more public-private cooperation and a more robust governance to steer EU and Member State action, especially in regards to cross-border access to digital public services.

- *What are the baselines and current trends?*

The average growth rate of the availability of basic online public services over the last 5 years is 2.4%. If this trend continues, in 2030 the score would increase to 95.5 out of 100. Investments in public procurement of innovative ICT-based solutions are at 4% of total public procurement across Europe, whereas a level of 10% is needed to reach full speed modernisation of public services[171].

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[168] "Key public services" are services related to the following "life events": Business start-up, Career, Studying, Family, Regular business operations, Moving, Transport, Starting a small claims procedure, Health (source: e-Government Benchmark).

[169] Data refers to a score (0-100).

[170] CAP gemini https://digital-strategy.ec.europa.eu/en/library/egovernment-benchmark-2020-egovernment-works-people

[171] Results of EU wide benchmarking of innovation procurement investments and policy frameworks across Europe | Shaping Europe's digital future (europa.eu): https://digital-strategy.ec.europa.eu/en/library/results-eu-wide-benchmarking-innovation-procurement-investments-and-policy-frameworks-across-europe

Looking at services for citizens, Malta, Estonia and Luxembourg preform best (90 or above out of 100), while Romania, Greece and Hungary are lagging behind (with scores below 55)
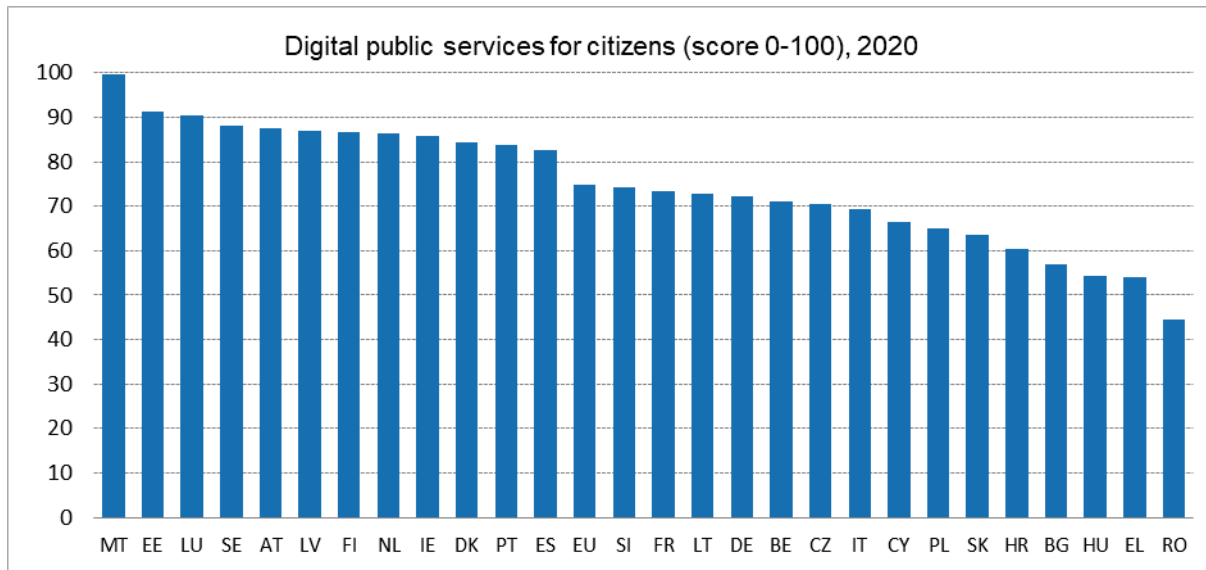
Figure 26: Digital public services for citizens (score 0-100) by Member State, 2020

Source: Capgemini, e-Government benchmark

Since past growth rates in the availability of basic online public services have been rather steady, for the projection a similarly linear growth of 2.9% instead of 2.4% is expected.

The below projection assumes a gradual development with a stable growth until 2030.
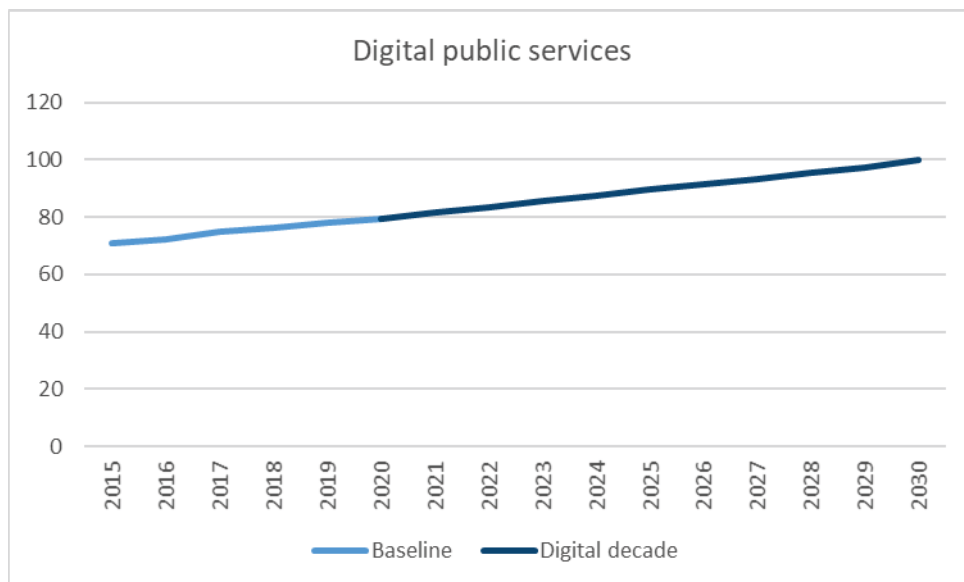
Figure 27: Score in online provision of key public services (EU projection to 2030)

Source: Commission services based on data from Capgemini.

- *What is needed to achieve the target?*

Respondents to the targeted consultation agree that overcoming existing administrative silos in the provision of public services will require strong political will and EU leadership. They see a role for the EU in ensuring the interoperability of digital technologies, including assistive technologies, through legislation and dedicated funding. Proposed actions include streamlining procedures, providing guidance, creating faster implementation processes, providing more efficient coordination of similar initiatives on EU level, strengthening the digital single market and cross-border services, and ensuring that public services have access to secure, interoperable, and trustworthy cloud services. Moreover, stakeholders from the business and education sector find that national public administrations should recruit more ICT professionals. They proposed to strengthen partnerships with academia and the private sector to benefit more from the young academics and entrepreneurs that are working in the GovTech industry.

To assist and guide those Member States in need of making greater leaps to reach the target, accompanying digital government and digital innovation procurement policies at all level of government as well as a strengthened EU Interoperability Strategy are needed, which would provide Member States with guidelines for the design, development and continuous enhancement of digital public services and facilitate the exchange of good practices between Member States.

The Single Digital Gateway Regulation[172] established a single digital gateway to provide access to information, to procedures and to assistance and problem-solving services. It already requires Member States to explain online how to carry out certain administrative procedures. By 2023 they must make it possible to actually carry out certain procedures online. The public face or 'front end' of the gateway is the Commission's online portal 'Your Europe'. It is through the Your Europe website that users access the information that the SDG regulation requires Member States to put online.

The recent Directive on the use of digital tools and processes in company law[173] requires Member States to make it possible to establish a company, register branches and file documents in the business registers fully online both domestically and cross-border. The Directive builds on the use of inter-connection of business registers (BRIS) which ensures that all EU business registers can communicate and exchange information cross-border in a safe and secure way, contributing thus to connected public administration and enhanced digital interactions between companies and Member State authorities and fosters public services to businesses. In addition, the Commission is preparing a new initiative on Upgrading digital company law, which would aim to further render company law procedures and tools digital proof to make more information about companies available on a cross-border basis and to enable the cross-border use of company data.

At national level, investments and reforms, could support the attainment of the target. Member States could notably adopt a digital innovation procurement policy and also follow an accompanying digital transformation policy to guide related existing investments and reforms.

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[172] Regulation (EU) 2018/1724 of the European Parliament and of the Council of 2 October 2018 establishing a single digital gateway to provide access to information, to procedures and to assistance and problem-solving services and amending Regulation (EU) No 1024/2012.
[173] Directive 2019/1151

Under the RRF, Member States will invest in the digitalisation of their public administrations to ensure that their digital public services are interoperable, available across borders, accessible, and user-friendly, and that their public administrations (re-)use data and novel technologies.

In particular, under the Flagship 'Modernise' of the RRF, Member States' plans, approved on 1 September 2021, will invest over EUR 40 billion in e-government, digital public services and local digital ecosystems[174]. The investments in digital public services under the RRF will help to achieve the targets. Additionally, Member States can receive support from the Technical Support Instrument in the digitalisation of their public administration. For 2022, DG REFORM has proactively proposed 13 Flagship technical support projects, which focus on areas of support largely needed across Member States. Digitalisation of the public sector is supported under the Flagship 'Development of resilient, innovative, and human-centric digital government services'. Moreover, Member States can benefit from ongoing digital government research projects under Horizon 2020 and foreseen research projects under Horizon Europe.

3.5.1.2. Access to medical records

- *Target:* **100% of European citizens have access** to medical records (electronic health-records, EHRs)

- *Baseline (2020):* Statistical data is not yet available but a majority of Member States have started to put in place mechanisms for citizen access to medical records

- *What is the rationale for the set target value?*

A target value of 100% of citizens with access to their medical records, means that citizens have the opportunity to access part of their Electronic Health Record such as patient summary or lab results of their electronic health records. As a first step, an indicator could be: the existence of a nationwide mechanism, for citizen access to health data, such as a patient portal, or a patient mobile app. Arriving at all Member States having a national mechanism in place for citizens should be achievable within 8 years, as already more than half of MS do have one in place. Such mechanisms could include the possibility for guardians to access medical records of their children/dependents or the possibility of authorizing trusted persons who can access medical records on behalf of the patients. Such mechanisms exist in some Member States, and these models practices could be scaled to other Member States still lacking the support for such cases. However, beyond the existence of a national mechanism (such as portal), additional measures should also be in place that enable certain categories of people (children, people with disabilities) to also access their data.

- *What are the baselines and current trends?*

As part of a recent survey, 16 Member States reported that they have a mechanism in place, such as an on-line portal, routinely used at national level, for providing citizen access to their

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[174] The calculations are based on the Recovery and Resilience Plans as approved on 1 September 2021 and on the basis on the methodology for digital tagging set out in Annex VI of the Recovery and Resilience Facility, which includes specific Intervention fields for e-government, digital public services and local digital ecosystems. These calculations provide a temporary view of the RRF and are without prejudice to the final figures that will only be available once the 27 plans have been adopted.

own health related data stored in an EHR system. Another six countries have ongoing pilot projects.[175]

The projected trajectory will be developed once statistical data is available.

- *What is needed to achieve the target?*

Respondents to the targeted consultation emphasize the importance of cooperation between Member States for improved interoperability and data exchange. They call on the EU to establish common criteria in order to guarantee the same level of accessibility and quality of services for citizens across Europe and to facilitate cross-border healthcare provision.

Actions at the European level have started to support the development of technical and semantic specifications for the interoperability (linking) of health data. While intended primarily to support the secure cross-border linkage of health data, such standards also have great utility within Member States where an individual's health data may be fragmented across different entities (e.g. primary clinic, local hospital, dentist, specialist clinic, etc.).

In 2018, the European Commission published a Communication on the digital transformation of health and care[176]. The Communication aims to empower citizens and to build a healthier society. One of the three priorities of the Communication is for citizens to have access to their health data, including across borders.

Enablers for citizen access to health data, and for other uses of health data, whether within health care systems or across borders, are common technical specifications for health data as well as appropriate trust frameworks for data protection, privacy and security (including e-ID systems).

To this end, the European Commission adopted a Recommendation on a European Electronic Health Record exchange format in 2019[177]. The Recommendation provides a set of principles that should govern access to and exchange of electronic health records; a set of existing common technical specifications for the cross-border exchange of this data in certain health information domains (patient summaries and e-prescriptions); and a process to advance the development of the exchange format to include other health domains (such as laboratory tests, medical images and hospital discharge reports). Work to develop the next set of technical specifications is underway with the Horizon funded project X-eHealth[178].

Other projects supported by the Commission, which have been instrumental to the development of common technical specifications, include Antilope[179], the Refined eHealth European Interoperability Framework[180], as well as ongoing projects, such as InteropEHRate[181] and Smart4Health[182].

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[175] Source: recently concluded survey of Member States, to be published shortly.
[176] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2018%3A233%3AFIN
[177] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019H0243&rid=2
[178] https://www.x-ehealth.eu/
[179] https://www.antilope-project.eu/front/index.html
[180] https://ec.europa.eu/health/sites/default/files/ehealth/docs/ev_20151123_co03_en.pdf
[181] www.interopehrate.eu
[182] www.smart4health.eu

The European Commission is currently working to create the European Health Data Space[183]. A common European Health Data Space is expected to promote better exchange and access to different types of health data (electronic health records, genomics data, data from patient registries, etc.), not only to support healthcare delivery (so-called primary use of data) but also for health research and health policy making purposes (so-called secondary use of data).

The My health @ EU infrastructure[184] is currently operational in eight Member States, with more joining in the coming years. Whilst currently the infrastructure is only supporting access to health data by health professionals, actions are taken in order to extend the functionality with the possibility for patients to access their own data and have it translated using code systems into another language.

In addition, as proposed also by participants of the consultation process, Member States can put in place a number of reforms and investments, such as:

- Strengthening capacity within health and care systems to securely digitise, store, process and use health records. This includes putting in place appropriate infrastructure, data protection and security aspects, as well as appropriate training for staff.

- Putting in place modalities that give citizens secure access to their health data. To do this, where they do not yet exist, Member States may need to strengthen the trust frameworks for security and access, among other things.

- Putting in place appropriate systems for health professional identification and authentication in EHR systems,

- Developing cybersecurity capacity such as encryption and a security-by-design approach to prevent cyber-attacks.

In addition, further measures may need to be taken across all Member States to ensure that *all* people, including people with disabilities, have access to their health data through established modalities.

3.5.1.3. e-ID adoption

- *Target:* 80% of citizens use a digital ID solution

- *Baseline (2020):* Currently no baseline for take-up of digital ID[185]

- *What is the rationale for the set target value?*

The ability to establish individual identity uniquely and accurately, to prove that a person is who she says she is, is becoming a critical enabler in an increasingly connected world. For simplicity reasons, users often resort to using the same password for many or all of their

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[183] https://ec.europa.eu/health/ehealth/dataspace_en
[184] https://ec.europa.eu/health/ehealth/electronic_crossborder_healthservices_en
[185] Art 48a of the draft Regulation for a European Digital Identity Framework proposed by the Commission on 3 June 2021(COM(2021)281 final) foresees data collection by Member States to measure this target. As regards availability, the current baseline for the percentage of key services that are e-ID enabled is 58% (services accessible domestically) and 9% (services accessible cross-border).

online accounts. This increases the risk of identity theft and leaked personal data. Others choose to authenticate using so-called 'social login', i.e. using their social media account (Facebook, Google, etc.) to log into other services, in which case it is difficult to control how their activities are being tracked and how their data is being used.

On 3 June 2021, the Commission adopted a Proposal for a Regulation of the European Parliament and of the Council amending Regulation (EU) No 910/2014 as regards establishing a framework for a European Digital Identity (hereinafter 'revised eIDAS Proposal')[186]. It will provide the framework conditions for boosting the development, roll-out and acceptance of digital identification schemes that work across Europe and are recognised by both public and private service providers. With this revised European legislation it will be possible to make safe and convenient digital identification means the standard form of authentication for accessing both public and private digital services.

Inversely, the take-up of digital identity solutions will also be heavily dependent on progress in regards to the availability of digital services, including public services (see point 3.5.1.1), which allow for authentication with such solutions.

- *What are the baselines and current trends?*

Currently, no baseline for this target is available. Article 48a of the revised eIDAS Proposal provides for reporting requirements that could provide relevant input for take-up data (e.g., Article 48a (2)(a) foresees that statistics collected shall include the number of natural and legal persons having a valid European Digital Identity Wallet).

In the European Digital Identity framework set forth in the revised eIDAS Proposal, the Commission proposes to make the *provision* of a European Digital Identity Wallet mandatory for all Member States. That would mean that every European citizen, resident and business will have the right to a European Digital identity Wallet, while of course it will be voluntary for them to use it. Hence, the supply of trusted and secure eID will increase.

The European Digital Identity Wallet will enable access to digital public services, as well as to digital private services, which by law or by contract require strong user authentication. Furthermore, very large online platforms (as defined in the DSA proposal) will be obliged to accept authentications using the European Digital Identity Wallet. Other private online services will be strongly encouraged to accept the use of the European Digital Identity Wallet. Hence, the number of use cases for trusted and secure eID will increase.

- *What is needed to achieve the target?*

Several consultation participants noted that current identity systems are complicated and have many external dependencies. They expect that a European solution could help to safeguard EU citizen's rights by facilitating access to online public services nationally and across borders while placing personal data under user control. In this context, public sector stakeholders emphasize the importance of building trust between public administrations, as well as between public administrations, people, and European industries that can supply the necessary ICT infrastructure and services.

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[186] Proposal for a Regulation amending Regulation (EU) No 910/2014 as regards establishing a framework for a European Digital Identity, COM(2021) 281 final

The revised eIDAS Proposal proposes a European Digital Identity framework to offer users self-determined personal digital wallets that allow for secure and easy access to public and private services under the users' full control.

Together with the Proposal, the Commission adopted a Commission Recommendation on a common Union Toolbox for a coordinated approach towards a European Digital Identity Framework[187] (hereinafter 'Toolbox Recommendation'). It sets out a process for close and structured cooperation between the Commission, the Member States and other relevant stakeholders. The toolbox should lead to a technical architecture and reference framework, a set of common standards and technical references as well as best practices and guidelines, as a basis for the implementation of the European Digital Identity framework.

This revision of the eIDAS regulation, resulting in the Commission's proposal for a European Digital Identity framework and the common toolbox for its implementation, will facilitate and speed up the development and usability of eID, thus helping Member States in attaining the target.

The Toolbox Recommendation calls on Member States to work together to develop and agree on a toolbox including a comprehensive technical architecture and reference framework, common standards, technical references and guidelines as well as best practices to support the implementation of the European Digital Identity framework, in close coordination with the Commission and, where relevant, other concerned public and private sector parties, by 30 September 2022.

In addition, as proposed also by participants of the consultation process, Member States can put in place a number of reforms and investments, such as:

- Cooperate proactively and lead parts of the technical work, including work on use cases, to ensure the success of the process and timely outcomes, in parallel with and in full respect of the legislative process for adoption of the revised eIDAS Proposal and in alignment with its outcome.

- Put in place any further administrative, financial and technical arrangements necessary to allow them to issue a European Digital Identity Wallet, and collect data on its take-up and use, within the legal deadline after the entry into force of the revised eIDAS Regulation.

Finally, a number of Member States have included investments and reforms to support the development and deployment of the European Digital Identity Wallet in their RRPs. This will also contribute to attaining the target.

4. GOVERNANCE: MONITORING AND COOPERATION MECHANISM

4.1. Guidance

In order to support the effective and timely implementation of the Policy Programme "Path to the Digital Decade", and to support Member States, and in cooperation with them, the

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[187] C(2021) 3968 final.

Commission, shortly after the entry into force of the Policy Programme, will provide guidance on different issues related to the monitoring and cooperation mechanism.

The guidance will include the assumed path per target until 2030 taken by the Union ("projected trajectories"[188]) elaborated in close cooperation with the Member States as well as support for the Member States in their elaboration of the corresponding national trajectories, where this is possible considering the relevant target.

The guidance will also define a system of traffic lights: a reporting system by which the colors of the traffic light (green, yellow and red) indicate whether the actual trends monitored at Union level are on track to achieve the target of a given key performance indicator compared to the projected trend. The analysis will compare actual against projected trends at EU level, as well as the individual performance of Member States, taking into account their different starting points and specialization, spillover effects on the internal market, and possibly also global benchmarks.

The Commission will also provide guidance to support Member States in preparing their digital decade strategic roadmaps. Article 7 of the Policy Programme already provides some categories of information that Member States need to include in their national roadmaps (see also 4.2). The aim of the guidance, beside the identification of the complete set of information, will be to structure their content, including possibly also through a template, to facilitate the drafting, the assessment by the Commission and the comparison among Member States.

The national strategic roadmaps will include the national trajectories for those targets for which the measurement at the level of a single Member State is feasible. Indeed, the projected national trajectories should be limited to relevant targets for which baseline data and methodologies for data measurement are available or will be available in the near future. Therefore, in its guidance on the preparation of national trajectories, the Commission will also include guidance on the criteria and methodologies to translate at national level the Union level trajectories and will take into account the role of specific national circumstances, e.g., that Member States have different capacities to put in place policies, measures and actions contributing to the achievement of Union targets.

4.2.   National Digital Decade Strategic Roadmaps

Within six months after the entry into force of the Decision establishing the Policy Programme "Path to the Digital Decade", and on the basis of the guidance issued by the Commission, Member States will submit to the Commission national **Digital Decade strategic roadmaps** for reaching the digital targets by 2030. The Member States will outline in their roadmaps :

- the main implemented, adopted and planned policies, measures and actions contributing to the objectives and the digital targets set in Articles 2 and 4 of the Decision;

- national projected trajectories contributing to relevant digital targets measurable at national level;

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[188] See definition in the proposal for a Decision of the European Parliament and of the Council establishing the Policy Programme "Path to the Digital Decade".

- the impact expected to be made on each digital target as a result of the implemented, adopted or planned policies, measures and actions;

- the timing for implementation of the adopted and planned policies, measures and actions as well as the estimate of the timing when those policies, measures and actions are expected to produce an impact on the achievement of the digital targets.

The policies, measures and actions to be described in the national strategic roadmaps are those which relate to the achievement of the objectives and the digital targets, and for which, at the date of submission of the national Digital Decade strategic roadmaps or of the adjustment of those roadmaps, one or more of the condition below applies:

- directly applicable Union or national laws are in force;

- one or more commitments to adopt policies, measures or actions have been undertaken;

- financial resources have been allocated, and human resources have been mobilised;

- radio spectrum resources have been or are committed to be allocated or assigned by the relevant national authorities;

- they constitute other important enablers related to objectives and digital targets.

The strategic roadmaps may also include a proposal for Multi-Country Projects. The Policy Programme "Path to the Digital Decade" establishes clear links with the European Semester process. In this regard, digital decade strategic roadmaps should take into consideration the latest country-specific recommendations issued in the context of the European Semester.

The strategic roadmaps will cover the entire Digital Decade period up to 2030. If needed, in order to take into account the findings of a particular annual Report on the "State of the Digital Decade", including the policies, measures and actions that the Commission may recommend to one or more Member States, Member States should **adjust their strategic roadmaps**, propose new or amend existing policies, measures and actions, to foster progress in the areas concerned by the digital targets.

National digital decade strategic roadmaps (Article 7)

Figure 28: National Digital Decade *strategic roadmaps (Article 7)*

4.3.   Annual monitoring and cooperation mechanism between the Commission and the Member States

The proposed Policy Programme establishes a **monitoring** and **cooperation mechanism** between the Commission and the Member States. The cooperation will aim to ensure that the Digital Decade objectives and targets are achieved through a combination of Union initiatives and relevant national policies, taking into account the cross-national dimensions of digital policies and Union-wide targets, in particular the development of the internal market.

4.3.1. Monitoring of progress

As described in more detail in section 3.1, in order to measure progress of the Union towards the objectives and targets set out in the Policy Programme, the Commission will use a number of analytical tools in order to monitor indicators, in particular the **enhanced Digital Economy and Society Index (DESI)** including an in-depth analysis of the digital trends and developments, as well as corresponding reports on the implementation of digital principles and reports on strategic dependencies.

There is broad consensus among stakeholders that a robust monitoring system is crucial to accelerate the digital transformation in Europe. Respondents to the targeted consultation consider measuring progress of the EU against the 2030 targets to be the most important function of the monitoring system (ranked extremely or very relevant by 83,1%), followed by comparing digitalisation trends at EU and Member State level with other global players (76,1%), following digitalisation trends at EU and Member State level (74.3%), and assessing areas with insufficient development at Member State level (73.2%). More than half of respondents also consider it important to showcase best practices from Member States (57,1%) and ensure a broader knowledge of the EU's digital policies across Europe for citizens, Member States, and other stakeholders (50%), hinting at the importance of publishing the monitoring results in an annual report. Several stakeholders emphasised that the monitoring should be part of a collaborative process.

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Finally, Member States will have to provide to the Commission in a timely manner the **necessary statistics and data** for the effective monitoring of the digital transition and the targets. This shall include relevant information on the availability and accessibility of spectrum. Should relevant statistics and data not be available from Eurostat, from Member States or existing studies, the Commission will perform its own data collection to monitor the progress of the Union against the objectives and targets.

4.3.2. The report on the "State of the Digital Decade"

The European Commission will submit to the European Parliament and the Council an annual report on the "State of the Digital Decade" (RSDD).

The report, which will include the DESI, will constitute an overview and analysis of the digital transformation of the Union and an **evaluation of the progress towards the digital targets**. Specifically, it will detail the degree of EU progress in relation to the projected trajectories for each target and include an assessment of the efforts necessary to reach each target. Moreover, it will assess as the more general state of compliance with the objectives set in the Policy Programme "Path to the Digital Decade". The Commission's evaluation will be based on its monitoring of the progress towards the objectives and targets, as outlined above.

The report on the "State of the Digital Decade" will also include (where relevant) **recommended policies, measures and actions to be taken at Union and Member State level** and joint commitments.

In particular, **the report will**:

- identify the areas where further action is needed;

- analyse investment gaps in capacities and raise awareness about the Union's digital strategic dependencies and actions needed to increase its digital sovereignty;

- include an assessment of the implementation of relevant regulatory proposals, as well as of the actions undertaken at Union and Member States level, including joint commitments undertaken in the context of the monitoring and cooperation mechanism;

- include recommended policies, measures and actions to be taken by Member States in areas where significant gaps have been identified or where progress is still insufficient to achieve the digital targets;

- inform on progress made by the Union and the Member States, in particular with reference to the extent to which Member States took the recommended policies, measures or actions made by the Commission and the recommendations under Article 9 of the Decision into account.

In particular, the recommended policies, measures or actions may address:

- the level of ambition of contributions and initiative proposed by Member States, with a view to collectively achieving the Union objectives and targets;

- policies, measures and actions at Member State-level and Union-level and other policies and measures of potential cross-border relevance;

- any additional policies, measures or action that might be required in the adjustments of Member States' digital decade strategic roadmaps;

- interactions between and consistency of existing and planned policies.

The report will also present the state of compliance with the digital principles and the outcome of an annual **Eurobarometer** exercise, which will be launched following the adoption of the **Declaration of Digital Principles for an EU Digital Citizenship**. The Eurobarometer will be specifically dedicated to monitoring the perception of Europeans regarding the respect of the principles enshrined in the Declaration and to what extent EU citizens feel that the digitisation of our society is serving them.

Stakeholders support the proposed scope of the report on the "State of the Digital Decade". A vast majority of respondents to the targeted consultation considers it to be extremely or very relevant that the report presents progress towards the 2030 targets at EU level (83,5%), and that it identifies deviations from the 2030 targets and digital principles at national level (69, 7%). Many also consider it to be extremely or very relevant that the report follows the implementation of digital principles (64,2%) and feeds it into the implementation of the Recovery and Resilience Facility (59,1). Over half of surveyed stakeholders would like the report to assess the general state of compliance with digital policies (59,1%), track common cross-border projects and investments (51,1%), and propose recommended actions including joint commitments to be discussed with Member States and the European Parliament (52,3%).

4.3.3. Collaboration mechanism

The monitoring and cooperation mechanism aims at creating a collaborative and constructive environment for Member States and the Commission to work closely together through an iterative process to find synergies, exchange good practices and share efforts to make progress towards the achievement of the Digital Decade objectives and targets.

Cooperation between the Commission and the Member States will be open, effective and transparent through an appropriate structure set up by the Commission, as provided in Article 10. Such structure will also serve as a forum for peer review between Member States. Moreover, to ensure transparency and public participation, the Commission and Member States will also engage with all interested stakeholders (including at national, regional and local level and with social partners, citizens and civil society).

Member States and the Commission will closely cooperate to identify ways to address **deficiencies in areas where progress is insufficient** to achieve one or more digital targets or where significant gaps and shortages have been identified based on the results of the latest report on the "State of the Digital Decade" and the most recent data available. In this context, the Decision establishing the Policy Programme "Path to the Digital Decade" requires Member States to present the policies and measures they have planned, adopted or implemented.

As part of the cooperative dialogue, and based on Member States' preliminary observations to be submitted indicatively two months after the publication of the report, the Commission and the Member States will also examine how recommended policies, measures and actions included in **the previous year's report** have been implemented by Member States collectively and individually. Such assessment will comprise the effects produced by the actions and measures adopted by the Member States and/or the estimated time when such effects are likely to be produced. On the basis of these discussions, the Commission and the Member States will also assess the need to introduce additional measures or actions, adjusting or complementing the measures and actions already in place. If a Member State considers that

no action is required and that its national roadmap does not require updating, it shall provide its reasons in writing.

At any point of the annual cooperation, the Commission and one or more Member States will be able to undertake **joint commitments**, consult with other Member States on policy, measures or actions or establish Multi-Country Projects. The joint commitments and other measures will be undertaken with a view to progressing towards achieving the digital targets, in alignment with the trajectories referred to in the report on the "State of the Digital Decade". In view of the publication of the report on the "State of the Digital Decade", the Commission will inform Member States in due time about the recommended policies, measures and actions it intends to include in the report.

The Commission and individual Member States will be able to request **a meeting between the Commission and Member States.** Such a meeting will be held in particular in the case where a Member State proposes to undertake a new Multi-Country Project or a joint action requiring the participation of other Member States. The Member States concerned or the Commission will also be able to request the launch of a peer review process, whereby other Member States' experts may comment on the suitability of the policies, measures and actions proposed by a given Member State to contribute effectively to achieving the Digital Decade objectives and targets. The outcome of the peer review process may be included in the following report on the "State of the Digital Decade".

The cooperative process between the Commission and the Member States will be as open and transparent as possible. The discussions in the context of the monitoring and cooperation mechanism will seek to ensure that the policies, measures and actions proposed at Union and Member State level contribute effectively to reach Union targets while efficiently and proportionally sharing efforts among Member States.

4.3.4. Recommendations

The Policy Programme "Path to the Digital Decade" provides that the Commission may adopt recommendations urging Member States to adjust their strategic roadmaps by taking into account Commission's recommended policies, measures and actions included in a report on the "State of the Digital Decade" (Article 9). This instrument is needed, in particular, in order to ensure that the recommended actions and the initiatives discussed and agreed through the collaborative process are implemented timely and effectively.

In particular, the Commission may adopt such a recommendation if a Member State fails to adjust its national roadmap in order to take into account the Commission recommended policies, measures or actions included in the report on the "State of the Digital Decade", or it does not provide sufficient reasons for failing to do so. Such recommendation will include a specific analysis of how the Member State's failure could impact the achievement of the objectives and digital targets of the Policy Programme "Path to the Digital Decade".

The Member State addressee of such a recommendation will be required to take it into utmost account and adjust accordingly its strategic roadmap within three months. In case the Member State concerned considers that it should not adjust the Digital Decade strategic roadmap in accordance with the recommendation or a substantial part thereof, it will have to provide a justification in writing and make it public within three months.

The recommendations will be complementary to the latest country-specific recommendations issued in the context of the European Semester. The Commission will inform the European Parliament and the Council of any recommendation adopted under Article 9.

If the Commission concludes that national measures are insufficient and put at risk the timely achievement of the objectives and digital targets set in the Decision, the Commission may consider, where relevant and if appropriate, propose measures and exercise its powers under the Treaties in order to ensure the collective achievement of those objectives and targets.

Finally, in case a Member State continuously deviates from the national projected trajectory for several years, or alternatively does not intend to adopt corrective action based on a previous Commission recommendation, the Commission may initiate a targeted dialogue with the Member State in question and inform the European Parliament and Council thereof.
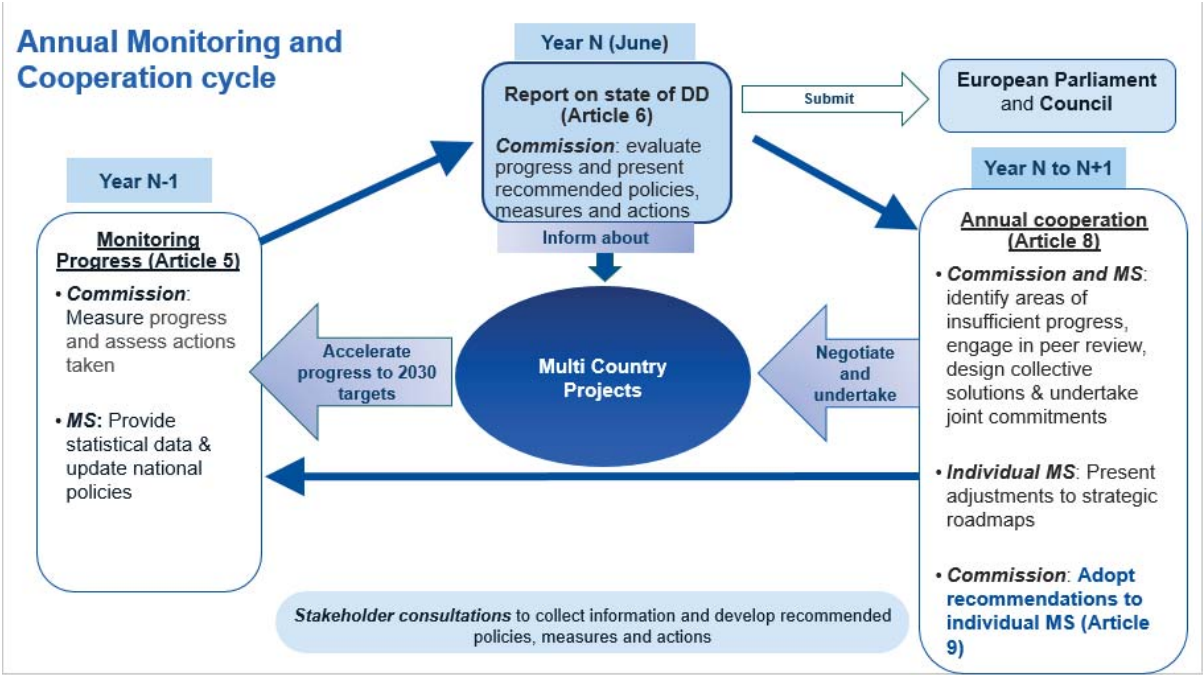
Figure 29: Annual Monitoring and Cooperation cycle
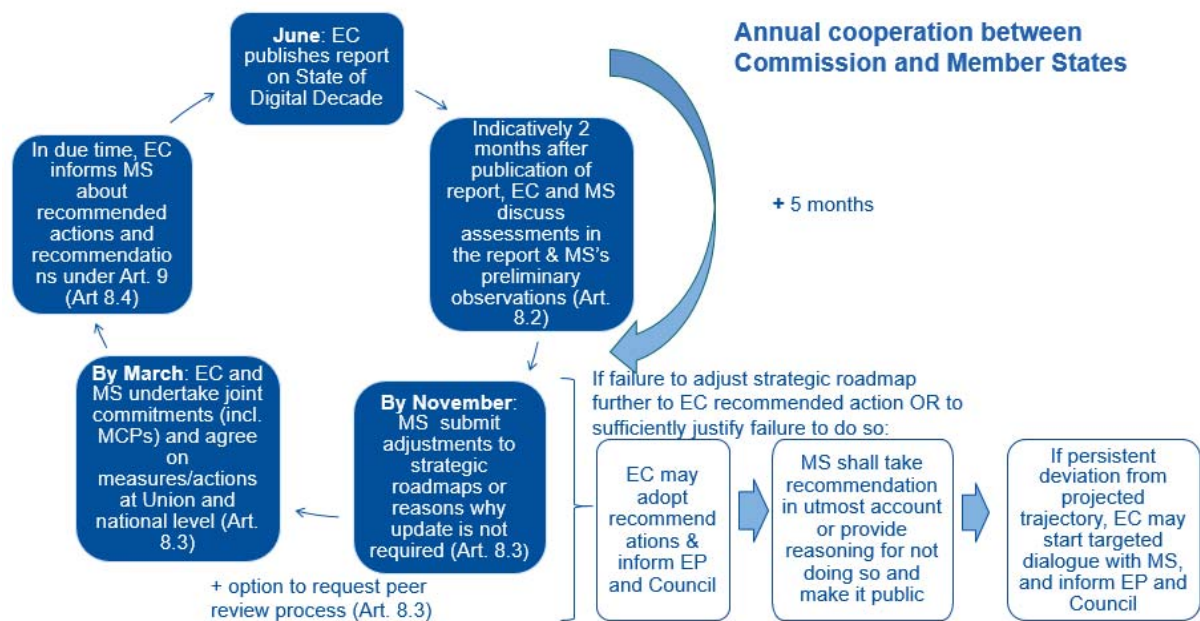
Figure 30: Annual cooperation between Commission and Member States

5. MULTI-COUNTRY PROJECTS

One of the instruments to achieve the targets of the Digital Compass is to deliver significant investments supporting its four cardinal points. Since this scale of the ambition can very often not be achieved by one country alone, the Commission has put forward the proposal of Multi-Country Projects as a response to challenges of the Digital Decade.

Multi-Country Projects (MCPs) are large scale projects facilitating the achievement of the targets for digital transformation of the Union and industrial recovery. They typically involve at least three Member States and include the Union's and Member States' financing.

A large majority of respondents to the targeted consultation strongly agrees or agrees that in some critical areas the EU needs to build up its digital capacities (90.1%), that there is a need to find solutions to accelerate and facilitate common digital projects (90%), and that such projects cannot be operated by Member States alone and should benefit from common action at EU level (81.2%). Consequently, they find that the most important objectives of Multi-Country Projects (ranking 1 and 2 out of 5) are to accelerate the digital transition (91.3%), accelerate the green transition (87%), and address strategic dependencies to achieve EU digital sovereignty (65.2%).

There are currently ten MCPs envisaged and we expect more to be launched throughout the decade.

5.1. Identifying Multi-Country Projects

The Union is working towards the capacity to develop and deploy cutting-edge digital technologies at sufficient scale, to ensure that citizens and businesses are fully empowered to benefit from the digital transition. Resilient, secure, and trustworthy infrastructures and technologies are indispensable to ensure respect of European rules and values. Today, digital

technologies are mostly developed outside Europe. While a strong single market, open competition and trade policy are critical assets for Europe's economic success, a massive scale-up of investments is also necessary.

By channelling coordinated investments between the EU, Member States and private stakeholders, Multi-Country Projects should be designed to deliver the following general benefits for the for citizens and businesses in all Union Member States:

- enable big projects that one single Member State could not deploy on its own;

- improve the cooperation of the Union and of the Member States on the digital transformation;

- reinforce the Union's technology excellence and industrial competitiveness in critical technologies, digital products, services and infrastructures;

- address strategic dependencies and vulnerabilities of the Union along the digital supply chains;

- pool resources to achieve economies of scale and increase impact;

- reduce digital divides between Member States, and widen the diffusion and best use of digital solutions;

- support an interconnected, interoperable and secure Digital Single Market;

- build ecosystems of excellence important enough to attract and retain talent;

- and implement flagship initiatives for which cooperation among Member States is important.

To deliver these benefits, the Commission and Member States should identify situations where MCPs represent an effective solution to issues identified in the in the report on the "State of the Digital Decade". Engagement with Member States has shown the opportunity for the Commission to coordinate such projects, and experience has been gathered in areas such as High-Performance Computing. During the discussions with Member States in the preparation of their RRPs, the Commission has underlined the opportunity of joint investments in a selected number of MCPs. These were identified on the basis of the preparatory analysis for the work programmes of Digital Europe, the Connecting Europe Facility, Horizon Europe and the Media Programme. The updated industrial strategy and the analysis of strategic dependencies also provided useful input. As a result, a number of projects were put forward in the Digital Compass Communication:

- *European Common Data Infrastructure and Services*: The purpose of this project is to deliver the next generation of common and multi-purpose federated, secure and energy efficient cloud-edge infrastructure, smart services and interoperable middleware platforms and to support the deployment of common European data spaces.

- Endow the EU with the *next generation of low power trusted processors*: The purpose of the project is to equip the EU with capabilities in electronics design and deployment of the next generation of trusted processors and other electronic components needed to power its critical digital infrastructure, AI systems and communication networks.

- Deploying *Pan-European 5G corridors*: The purpose of the project is a Pan-European deployment of 5G corridors along TEN-T networks in the interest of Single Market and cohesion.

- *Acquiring supercomputers and quantum computers*. The purpose of the project is to jointly invest with the Member States in acquiring and operating high performance computing power and connecting it with the EuroHPC extreme-bandwidth communication network.

- Developing and deploying an *ultra-secure quantum and space-based communication infrastructures*: The purpose of the project is to deploy and operationalise an ultra-secure quantum communication infrastructure (QCI) spanning the whole EU. It would significantly increase the security of communication and storage of sensitive data assets all over the EU, including of critical infrastructures.

- Deploying a *network of Security Operations Centres*. The purpose of the project is to build up a 'cybersecurity shield' for the EU, which would be able to detect signs of a cyberattack early enough to enable proactive action, enhancing joint risk preparedness and response speed at national and EU level.

- *European Digital Innovation Hubs*: The purpose of the project is to support the digitisation of European Industry through completing an EU-wide network of European Digital Innovation Hubs.

- *Connected Public Administration*: The purpose of the project is to make digital public services safely and easily accessible, while preserving privacy and reducing the administrative burden on citizens and businesses.

- *High-tech partnerships for digital skills and specialised education*: The purpose of the project is to make the EU the best in the world for nurturing and attracting advanced digital talents and skills whilst fostering an ecosystem that will help drive innovation and digital breakthroughs. Higher education institutions, businesses and research centres will form consortia to devise and implement common education programmes in specific advanced digital domains, building on the expertise of each partner.

- *European Blockchain Services Infrastructure*: The purpose of the project is to bring significant benefits to EU citizens, enterprises and authorities by supporting cross-border and local applications enabling, for instance, that citizens can digitally identify themselves and share accredited credentials (e.g., diplomas or life-long learning certificates for university/job applications) without a burdensome verification process.

Investment gaps in the areas targeted by these projects have been estimated and published in May 2020 in the staff working document[189] accompanying the Communication on the Recovery Plan[190]. The proposed projects intend to fill the gaps and considerably develop EU's capacities and technological sovereignty in these areas.

All projects included in the initial list of MCPs were deemed high-priority (ranked 1 or 2 out of 5) by more than half of participants in the targeted consultation. Many respondents

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[189] SWD(2020) 98 *Identifying Europe's recovery needs,* Table 2 on p 18
[190] COM(2020) 456 *Europe's moment: Repair and Prepare for the Next Generation*

assigned the same high rank to several of the proposed areas, pointing out that all of them would benefit from a strongly European approach.

The experience gathered over the last years in setting up large scale digital projects involving the EU, Member States and stakeholders, and in particular the discussions in the context of the RRPs, have shown that time, resources and efficiency gains would be made by having a more streamlined mechanism with Member States to identify and commit to the necessary projects in the future.

The Policy Programme "Path to the Digital Decade" proposes to establish, together with this initial list of MCPs, such a coordination mechanism to identify and launch additional Multi-Country Projects on the basis of the analysis performed in the report on the "State of the Digital Decade" and in discussion with Member States. For this purpose, it is proposed to update the list of MCPs through the annual report on the "State of the Digital Decade", providing the necessary flexibility to account for developments and identified gaps in Europe's digital transformation.

5.2. Implementing Multi-Country Projects

Once a project has been identified, a critical issue has to do with implementation. Experience has revealed a need to further strengthen synergies to use EU and national funding as well as private investment for the purposes of deploying and operating infrastructures and services of common interest, for building digital capacities and to achieve critical mass of funding.

The Commission has identified and applied a series of implementation instruments that may be available for the purpose of implementing Multi-Country Projects.

Joint Undertakings: Article 187 of the Treaty on the Functioning of the European Union (TFEU) specifies that the EU may set up joint undertakings (JUs) or any other structure necessary for the efficient execution of EU research, technological development and demonstration programmes. Article 187 TFEU has been used under FP7 and Horizon 2020 to set up, in particular, public-private partnership bodies in order to integrate industrial research in specific areas. The members of these JUs are typically the European Union (represented by the European Commission) and industry-led associations as well as other partners. JUs adopt their own research agenda and award funding mainly on the basis of open calls for proposals.

European Research Infrastructure Consortia (ERICs): The ERIC is a specific legal form that facilitates the joint establishment and operation (by Member States) of research infrastructures with European interest on a non-economic basis. The ERIC becomes a legal entity from the date the Commission decision setting up the ERIC takes effect. An ERIC offers a legal capacity recognised as an international body or organisation in all EU countries, flexibility to adapt specific requirements of each infrastructure and exemption from VAT (to the discretion of the host country).

Projects of common interest (such as the trans-European energy infrastructure): The TEN-E guidelines regulation defines the criteria for projects of common interest. The Commission then adopts by way of delegated acts the Union list of projects of common interest. Such projects are cross-border and involve at least two Member States. Projects of common interest may benefit from accelerated planning and permit granting, a single national authority for obtaining permits, improved regulatory conditions, lower administrative costs,

increased public participation via consultations, and increased visibility to investors. They may benefit from CEF funding.

Non-profit associations: The GÉANT Association is an existing example of a non-profit organisation financed with H2020 grant which federates services, interconnects and acts on behalf of its national research and education network (NREN) members. NRENs are at the same time partners and users of GÉANT services. The GÉANT Vereinigung is registered in the Netherlands and operates with a branch in the UK.

Important Projects of Common European Interest (IPCEI): The IPCEI is a compatibility basis under State aid rules. Where private initiatives supporting breakthrough innovation fail to materialise because of the significant risks such projects entail, the IPCEI State aid Communication enables Member States to jointly fill the gap to overcome these market failures, while ensuring that the EU economy at large benefits and limiting potential distortions to competition. The IPCEI criteria[191] do not prevent a mix of national, private and centrally-managed EU funds. Therefore the IPCEI offers a mechanism to coordinate investments between Member States, businesses, research and technological organisations and proves to be a useful as an instrument to implement some of the Multi-Country Projects.

Working with an existing agency, such as EU-Lisa: Executive agencies can be tasked to invest and coordinate specific projects. For instance, EU-Lisa (established by Regulation (EU) 2018/1726) is the European Union Regulatory Agency (with legal, administrative and financial autonomy) for the long-term solutions for Operational Management of Large-Scale IT Systems in the Area of Freedom, Security and Justice. The Agency is entrusted with the preparation, development and operational management of a number of IT systems defined in the regulation.

European Economic Interest Grouping (EEIG): EEIG (established by Regulation No 2137/85) is a legal instrument set up to for cross-border cooperation within the EU. It can be formed by companies or firms, or individuals who carry out industrial, commercial or agricultural activities (at least 2 members from different EU countries). EEIG is a lighter form of cooperation, which facilitates or develops the economic activities of its members by pooling resources, activities or skills.

Considering the above implementation mechanisms, the following table describes how they can be used to implement the initial list of MCPs described in the previous section. The table also presents the Member States that have foreseen to invest in these MCPs by using national Recovery and Resilience Funds (RRF).

Multi-Country Project	Member States investing RRF funds into the MCP	Implementation instrument for the MCP
European Common Data Infrastructure and Services	For the MCP part on data processing infrastructure and	IPCEI on Next Generation Cloud Infrastructure and

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[191] Communication from the Commission — Criteria for the analysis of the compatibility with the internal market of State aid to promote the execution of important projects of common European interest, OJ C 188, 20.6.2014, p. 4.

The purpose of the project is to deliver the next generation common and multi-purpose federated cloud to edge infrastructure and smart services, and to support the deployment of common European data spaces.	services, RRF commitments by seven Member States[192]. In addition, BE, LU, NL, HU are involved in the MCP part on data processing capacities based on national funding.	Services For common European data spaces: Digital Europe Programme; and EDIC in the future.
Endow the EU with the next generation of low power trusted processors The purpose of the project is to equip the EU with capabilities in electronics design and deployment of the next generation of trusted processors and other electronic components needed to power its critical digital infrastructure, AI systems and communication networks.	RRF commitments by ten Member States[193].	IPCEI on Microelectronics focusing on processors and connectivity, complemented by other instruments, particularly the Key Digital Technologies Joint Undertaking
Developing Pan-European deployment of 5G corridors The purpose of the project is a Pan-European deployment of 5G corridors along TEN-T networks in the interest of Single Market and cohesion.	RRF commitments by eight Member States[194].	Large-scale testing using Horizon 2020 funding and large-scale deployment under CEF Digital
Acquiring supercomputers and quantum computers, connected with the EuroHPC. The purpose of the project is to jointly invest in acquiring and operating high performance computing power and connecting it with the EuroHPC extreme-bandwidth communication network.	RRF commitments by nine Member States[195].	EuroHPC Joint Undertaking
Developing and deploying an ultra-secure quantum and space-based	RRF commitments by four Member States[196].	Digital Europe Programme, CEF Digital and ISA funding, overall governance arrangements still

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[192] Best estimates based on the DE, ES, FR, IT, LV plans. Further amounts proposed from Member States for which the adoption of the plans are still pending. Possibly subject to further changes.

[193] Best estimates based on the AT, DE, CZ, ES, FR, IT, SI, BE plans. Further amounts proposed from Member States for which the adoption of the plans are still pending. Possibly subject to further changes.

[194] Best estimates based on the CZ, ES, IT, LV, EL, LT plans. Further amounts proposed from Member States for which the adoption of the plans are still pending. Possibly subject to further changes.

[195] Best estimates based on the CZ, SK, ES, DE, IT, EL, AT. Further amounts proposed from Member States for which the adoption of the plans are still pending. Possibly subject to further changes.

[196] SK, EL, ES, LU

communication infrastructure The purpose of the project is to deploy and operationalise a ultra-secure quantum communication infrastructure (QCI) spanning the whole EU. It significantly increase the security of communication and storage of sensitive data assets all over the EU, including of critical infrastructures.		under discussion, including the synergies with DEFIS Secure Connectivity Initiative.
Deploying a network of Security Operations Centres. The purpose of the project is to build up a 'cybersecurity shield' for the EU, able to detect signs of a cyberattack early enough and to enable proactive action, for enhanced joint risk preparedness and response at national and EU level.	RRF commitments by four Member States[197].	Digital Europe Programme
European Digital Innovation Hubs The purpose of the project is to support the digitisation of European Industry through completing an EU-wide network of European Digital Innovation Hubs.	RRF commitments by nine Member States[198]. Other MSs intend to invest as well, outside RRF.	Digital Europe Programme
Connected Public Administration The purpose of the project is to make digital public services safely and easily accessible, while preserving privacy at a minimum of administrative burden on citizens and businesses.	Member States investing from outside RRF	Digital Europe Programme
High-tech partnerships for digital skills and specialised education . The purpose of the project is to make the EU the best in the world for nurturing and attracting advanced digital talents and skills whilst fostering an ecosystem that will help drive innovation and digital	RRF commitment by one Member State[199].	Digital Europe Programme

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[197] EL, ES, IT and a Member State for which the adoption of the plan is still pending.
[198] Best estimate based on the HR, IT, IE, SK, PT, LV, ES, CZ plans. Further amounts proposed by a Member State for which the adoption of the plan is still pending. Possibly subject to further changes.
[199] IT

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breakthroughs. Higher education institutions, businesses and research centres will form consortia to devise and implement common education programmes in specific advanced digital domains, building on the expertise of each partner.		
European Blockchain Services Infrastructure

The purpose of the project is to bring significant benefits to EU citizens, enterprises and authorities by supporting cross-border and local applications enabling, for instance, that citizens can digitally identify themselves and share accredited credentials (diploma or a life-long learning certificate, for university/job applications) without a burdensome verification process. | RRF commitments by two Member States[200]. The Blockchain partnership however brings together all EU MS. | CEF Telecom and Digital Europe Programme as a start, EDIC in the future. |

Figure 28: Initial list of MCPs with corresponding implementation instrument and participating Member States

5.3. Need for a new instrument for implementing some Multi-Country Projects

In order to be efficient and fit for the purpose of accelerating the process to set up some of the above or future MCPs, a new instrument for deploying and operating multi-country projects is needed. It requires a number of combined features as described in the Communication. Concretely, it will need to be set up swiftly and flexibly, while making sure projects remain open to all interested Member States, and the Commission should be involved to ensure openness and coordination of that instrument with Union law, EU policies and priorities, notably competition and State aid rules, and coordination with EU investment programmes.

Respondents to the targeted consultation agree that the possibility to set up projects swiftly and flexibly is the most important feature of an instrument facilitating the implementation of MCPs (ranked 1 out of 5 by 67.9% of respondents). Many emphasized the importance of reducing administrative burdens and supporting flexibility to facilitate the pooling of EU and national funding, cross-border investments, and co-investment models with private stakeholders. Some requested the European Commission to create a "toolbox" including the above-mentioned features to accelerate Multi-Country Projects.

The table below provides an overview of the gap analysis performed to validate whether existing instruments would be sufficient to meet these objectives. It highlights that shortcomings can be identified for all of the existing mechanisms. The existing mechanisms could be used in certain circumstances. These would include for example the IPCEI to

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[200] CZ and a Member State for which the adoption of the plan is still pending.

implement Next Generation Cloud Infrastructure and Services, or the IPCEI on Microelectronics through which the endowment of the EU with the next generation of low power trusted processors will be implemented. These two projects managed to gather a significant amount of support from the Member States through the RRP adoption process. On the other hand, designing a new implementation mechanism for certain projects is necessary and justified too, especially for cases such as the European Blockchain Service infrastructure, for which the features missing in the existing instruments are vital to proceed with further deployment.

Key requirements for instruments to implement the MCPs	EU body – JU / CCCN	EU body – executive agency	ERIC	PCI	Non-profit	IPCEI	EEIG
Scalability							
a) Rapid set up	No	No	Yes	?	Yes	No	No
b) Legal status/personality	Yes	Yes	Yes	No	Yes	No	Yes
c) Liability (GDPR and consumer protection)	Yes	Yes	Yes	No	Yes	No	Yes
d) Variable geometry	Yes	No	Yes	Yes	Yes	Yes	No
e) Private members	Yes	No	No	Yes	Yes	Yes	Yes
f) Commission in governance	Yes	Yes	No	No	No	?	No
g) Independent from research activities	No / Yes	Yes	No	Yes	Yes	Yes	Yes
Combination of funding – single set of rules	No	No	No	No	No	Yes	No

Red: Feature not present

Yellow: The presence of the feature depending on the circumstances

Green: Feature present

Figure 29: Key features of existing implementation instruments for MCPs

The Policy Programme proposes therefore that a mechanism is designed based on a cooperation between the Commission and the Member States, that would involve identifying Member States interested in participating in MCPs with financial or non-financial commitments; as well as an analysis of the available implementation instruments followed by an advice on the choice of the optimal instrument for a given MCP, prepared by the Commission

Then, if no suitable existing implementation instrument is identified for a given MCP, it is proposed that a flexible and easily implementable legal framework should be created under the Policy Programme for setting up consortia by Member States interested in the participation. This legal framework is inspired by the provisions on European Research Infrastructure Consortia (ERICs) regulation, which has proven successful in the implementation of many research projects. The 21 existing ERICs have applied for and

received Horizon 2020 grants[201]. In contrast to ERIC, the new instrument would be open to areas outside research and be equipped with the necessary additional features outlined in the Chapter 5 of the proposed decision establishing the Policy Programme "Path to the Digital Decade".

This new instrument, the **European Digital Infrastructure Consortium** (EDIC), would address the need for a number of combined implementation features of Multi-Country Projects as described in the Communication.

EDIC will therefore complement existing implementation instruments for Multi-Country Projects to be considered in discussions with Member States. Examples of MCPs that could rely on the existing instruments would be the Processors and Semi-conductor chips and the part on data processing infrastructure and services of the European Common Data Infrastructure and Services, where the implementation is foreseen under an IPCEI structure, and for which the preparations are already ongoing. EDIC is not envisaged to replace such existing implementation instruments, but to offer Member States another, fast, efficient and easily implementable mechanism.

It is expected that EDIC will be widely used for new Multi-Country Projects identified in accordance with this decision beyond the initial list provided in Annex II, especially because of the speed of establishment and other efficiencies offered by EDIC. Future EDICs will be able to apply to calls for proposals in the context of EU funding programmes.

5.4. Case-studies for the new EDIC

In addition to a gap analysis, the Commission analysed concrete case studies to assess the need for a new instrument as EDIC. Two cases of MCPs are presented here: i) European Blockchain Service Infrastructure and ii) European Common Data Infrastructure and Services.

European Blockchain Service Infrastructure

Blockchain technology allows people and organisations who may not know or trust each other to collectively agree on and permanently record information without a third-party authority. By creating trust in data in ways that were not possible before, blockchain has the potential to revolutionise how information is shared and transactions are carried out online.

The European Blockchain Service Infrastructure (EBSI) is a unique pan-European project that brings together all EU Member States and other (EEA) countries in the European Blockchain Partnership with the Commission's support. With development phase (2018-2019) concluded, the EBSI has now moved to deployment and operation of a pan-European blockchain-based infrastructure.

Since 2018, the EBSI has fully functioning governance[202] to collectively take decisions on both the policy and operational levels. A network is now ready for exploiting the EBSI Core

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[201] The 21 ERICs have received a total of 212 H2020 grants, both from the research infrastructures part and from other parts of the programme. The list of ERICs is available here: ERIC Landscape | European Commission (europa.eu)

[202] The European Blockchain Partnership (EBP) decides every year what are the use cases to address as the priority for EBSI. Member States coordinate the work on use cases; EBP endorses all key decisions for EBSI;

Services (blockchain, APIs) in a pre-production phase. It relies on the deployment of more than 35 nodes covering at least 23 Member States (other Member States are currently onboarding), and to pilot in real settings first use cases of the European Blockchain Partnership (EU Self Sovereign Identity Use Case, Diploma Use Case, Document Traceability Use Case, while a fourth use case concerning VAT IoSS Case is under development) for non-commercial purposes.

The EBSI has been funded by CEF Telecom (for development phase) and from 2021/22 onwards will be funded by the Digital Europe Programme. The core service platform currently in place for EBSI is procured with DG DIGIT. The potential beneficiaries from Member States can apply to calls for grants in order to receive funding for deployment at national level. Member States can contribute funds to create additional capacity for national or regional use cases. The service for users is free of charge, considered public good, and at the disposal to large variety of actors.

In order to ensure the long term sustainability of the EBSI, the current "consortium structure" of EU Commission and 29 Member States of the European Blockchain Partnership must be managed through a legal vehicle that can conclude legal relationships and manage regulatory questions on behalf of the consortium. The legal vehicle should involve the EU Commission as well as the members of the European Blockchain Partnership in its governance structure. This transfer into a legal vehicle may also allow to safeguard potential investments of EU Member States under the RRF. The added value of the new instrument for such a legal vehicle, in the form of EDIC, would stem from the creation of a specific legal entity for EBSI, whose governance coud be customised to the needs of the project, in particular:

- Scalability – very limited now, as the Digital Europe funding is not sufficient to reach the necessary scale;

- Liability – at the moment the Commission is liable for any potential issues (GDPR, consumer protection) ;

- Long term operation –the operation is dependent on funding from the Commission, subject to biennial Digital Europe WP adoption;

- Legal personality and the possibility to procure and operate infrastructure;

- Agility – depending on related conditions, the creation of a new legal entity can provide for more agility, considering that EC services mainly focus on policy and that EC rules and procedures can often be too constraining for the future development, deployment, support and maintenance of such an infrastructure.

European Common Data Infrastructure and Services

In the European strategy for data, the Commission announced a *High Impact Project on European Data Spaces and federated cloud infrastructures and services*. A key asset of the project is that it provides an integrated strategy for European investments in the data economy by interlinking its two constituent elements: on the one hand, innovative data ecosystems and,

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EBP participates with experts in technical and design discussions on EBSI; MS contribute to the infrastructure through the provision of national nodes. Regular EBP quarterly meetings have been organised since mid-2018 and meetings with EBP co-chairs, convenors of technical group and use cases and the EC are held twice a month.

on the other hand, the necessary data processing infrastructure and services. Both will be part of the MCP in European Common Data Infrastructure and Services.

Respondents to the targeted consultation identify European Common Data Infrastructure and Services as the most important area for Multi-Country Projects (ranked 1 or 2 out of 5 by 90.6%), stressing that the EU needs to look at digital technologies not just to improve operations or efficiency, but also to connect ecosystem actors in a broader data economy, with advanced data-driven services and business models. The MCP will realise these two elements by focusing on four key actions: Firstly, it will support the deployment of common European data spaces. Secondly, it will renew and expand distributed data processing infrastructure and service foundations across Europe, by developing and deploying real-time (very low latency) edge capabilities and smart data processing services. Thirdly, it will foster the design of secure, low power and interoperable middleware platforms for multiple sectoral uses; and fourthly, it will invest in becoming the global leader in transversal domains to create the next generation of data processing solutions that are by design secure, climate-neutral and interoperable.

The implementation of this MCP is expected to require a combination of two instruments: the IPCEI to implement Next Generation Cloud Infrastructure and Services and an EDIC to implement the common European data spaces:

1. Implementation of the Next Generation Cloud Infrastructure and Services via an IPCEI

The infrastructure and services for data processing (e.g., cloud and edge computing) could be implemented through an IPCEI on Next Generation Cloud Infrastructure and Services[203]. This IPCEI would aim to deliver the next generation common federated cloud to edge infrastructure and smart services and would include, among others, several relevant use cases[204]. It would directly contribute to transforming/reforming the data processing sector by making it more diversified, low power, ultra-secure, interoperable and distributed to efficiently respond to the real time and data security needs of EU businesses, citizens and the public sector.

The Commission advanced common infrastructure for data storage and processing, to be set up in line with European values and rules, will respond to the needs of the public and private sectors, including SMEs. It will support a resilient and sustainable digital transition by developing and deploying a distributed, secure, energy efficient and interoperable cloud-edge continuum accessible across the entire EU. Such a continuum will be equipped with ultra-secure and low power data hosting and processing services and innovative data exchange services via the cloud. These innovative services of secure storage and data exchange provide a technical infrastructure for the deployment of the common European data spaces.

2. Implementation of the common European data spaces via an EDIC

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[203] See official website of the on-going IPCEI on Next Generation Cloud Infrastructure and Services: https://www.bmwi.de/Redaktion/EN/Artikel/Industry/ipcei-cis.html

[204] See *IPCEI on Next Generation Cloud Infrastructure and Services (IPCEI-CIS) Working Paper - Value Chain Description*, 1 July 2021: https://www.bmwi.de/Redaktion/EN/Downloads/I/ipcei-cis-value-chain-description.pdf?__blob=publicationFile&v=2

The data spaces will bring together data infrastructures and governance structures in order to facilitate data pooling and data sharing, a pre-condition for wider availability of data across the European economy. Given the enormous potential in data sharing within and between sectors, the Commission will co-invest in common European data spaces in strategic economic areas and areas of public interest. The Digital Europe programme will be instrumental to the deployment of such common European data spaces. Their implementation will take place in two phases:

- In the first phase, common support actions will lay the basis for the development of each of the data spaces through community building and preparatory work on interoperability and governance. A Data Spaces Support Centre will be created that will define the blueprint architecture and data infrastructure requirements for the data spaces in cooperation with the relevant stakeholders. In parallel, the data processing infrastructure that can be used across the different data-spaces will be developed.

- In the second phase, the Commission will support the deployment of the actual European data spaces, which should connect to the work done in the other part of the MCP on European Common Data Infrastructure and Services, relating to data processing infrastructure and services.

Currently a number of Member States are already investing in and deploying national data spaces. Therefore, in order to make data spaces scale across the EU, funding from the Digital Europe Programme will need to be combined with other public funding sources for data spaces at the European and national level (CEF2, regional funds, etc.) as well as with private investments. To structure and coordinate these investments, and building on the actions funded by the Digital Europe Programme, an EDIC would have the following advantages:

- Coordination and push for "EU-wide accessible" data spaces (based on the developed data processing infrastructure and services).

- Combined funding (e.g., through joint procurements) to reach a sufficient scale of investments to allow the deployment of data spaces at European level, guaranteeing impact and sustainability of the action; and to finance a technical infrastructure offering additional services (such as ad hoc data analytics and metadata, generation tools for public sector organisations that would like to move their data on the next generation cloud infrastructure).

- Strengthened role of the Member States under a governance structure for funding the deployment of data spaces, as this is to be provided by the EDIC.

To guarantee an integrated approach between all objectives of the MCP, the Data Spaces Support Centre[205] and the European Alliance for Industrial Data, Edge and Cloud[206] will help to ensure that EU funding in standard data processing capacities matches the needs of common European data spaces.

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[205] This is one of the actions foreseen for funding under the Digital Europe programme work programme 2021-2022.
[206] See European Commission website: https://digital-strategy.ec.europa.eu/en/policies/cloud-alliance

These two initial examples demonstrate the opportunity of EDIC for concrete Multi-Country Projects and highlight that its features would offer possibilities currently not covered by existing tools.

6. SPECTRUM AS AN ESSENTIAL ENABLER TO REACH DIGITAL TARGETS

Radio spectrum is an essential connectivity resource, without which the connectivity goals under the 2030 Digital Decade cannot be achieved. Radio spectrum is also a scarce resource that needs to be managed effectively and efficiently to meet the requirements of a variety of stakeholders. As stressed by the Commission's 2030 Digital Compass Communication, the timely availability of radio spectrum will be essential for the deployment of wireless fixed, mobile terrestrial and satellite communications through very high capacity networks and the achievement of the new 2030 targets on connectivity. This requires transparency, predictability and legal certainty to maximise investments, as well as sufficient flexibility to allow for innovation and efficient use of the spectrum. The experiences in Europe concerning the late deployment of 4G due to late spectrum authorisations need to be avoided in the future.

Access to radio spectrum requires both spectrum allocation under harmonised technical conditions on the basis of the Radio Spectrum Decision and timely spectrum assignment under appropriate procedures and conditions. While the assignment of spectrum is managed at national level, it has to be implemented in line with the European Electronic Communications Code and should benefit from the best practices identified in the Connectivity Toolbox[207].

The Radio Spectrum Policy Programme (RSPP)[208] of 2012 has set the framework of regulatory principles and strategic orientations on spectrum management as well as an initial set of spectrum related actions on spectrum harmonisation and assignment for 4G. Further, recent work of and public consultation by the Radio Spectrum Policy Group (RSPG), recommend a number of important initiatives on advanced connectivity, innovative wireless services, environmental needs and the deployment of new technology in the spectrum management process (including for spectrum sharing) in various sectors, including electronic communications and broadcasting, space, transport or unmanned aviation systems[209].

Additionally, the RSPG has launched the process of peer review forums under Article 35 of the Electronic Communications Code whereby its (voluntary) use by four Member States in

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[207] https://digital-strategy.ec.europa.eu/en/news/connectivity-toolbox-member-states-agree-best-practices-boost-timely-deployment-5g-and-fibre
[208] Decision No 243/2012/EU of the European Parliament and of the Council of 14 March 2012 establishing a multiannual radio spectrum policy programme, OJ L 81, 21. 3. 20122, p. 7
[209] Recent work of and public consultation by the Radio Spectrum Policy Group (RSPG), include:
-   the development of a 5G spectrum roadmap (3 Opinions, i.e. RSPG16-032, RSPG18-005 and RSPG19-007) which paved the way for the availability of 5G-ready frequency bands in support of 5G deployment as set out in the 5G Action plan and in meeting the EU's Gigabit connectivity targets by 2025.
-   the opinion on a future radio spectrum policy programme (RSPG21-033), which suggests key intervention areas where additional support measures can be deployed to increase the efficiency and effectiveness of the spectrum management process.
-   the Opinion on spectrum sharing – pioneer initiatives and bands (RSPG21-022)
-   the Opinion on additional spectrum needs (RSPG21-024)
-   the draft Opinion (RSPG21-027) and a report on the "role of radio spectrum policy to help combat climate change" (RSPG21-026).

the first six months of its implementation in the context of their national selection processes demonstrated the effectiveness of the process. In parallel, the peer review forums revealed the potential to lead national assignment processes to greater levels of efficiency notably through the deployment of additional support measures focusing on more systematic collection and cross-fertilisation of knowledge and experiences among national authorities that can be used both by Member State authorities when designing their selection processes and/or by prospective spectrum users.

The new framework and developments under the 2030 Digital Decade notably call for even greater flexibility and faster adaptation of spectrum management to the emerging connectivity needs and requirements, such as for environmental protection and sustainability within the Green Deal. This implies the more efficient assignment of spectrum at national level (in particular, where most of the delays have been observed so far, e.g. in the assignment of the 5G pioneer bands) and the faster adoption of new technology and innovative regulatory options for spectrum management such as on shared spectrum use. While it is hard to predict spectrum needs in the longer term due to rapid technological developments and constantly evolving needs, particularly under the fast evolving digital and green transformation process, early and flexibly adaptable information about future spectrum availability would increase legal certainty and investment predictability.

Since spectrum is essential to achieve the digital targets, and in particular a secure, performant and sustainable digital infrastructure, Member States should report on their adopted and future policies and measures regarding the availability and possibility to use radio spectrum for existing users and prospective investors and operators. Without prejudice to the possibility for the Commission to propose new strategic spectrum policy orientations or mechanisms under Article 4 (4) of Directive (EU) 2018/1972 of the European Parliament and of the Council[210], appropriate guidance could be provided by the Commission in that regard in order to meet the general objectives and digital targets.

Examples of such guidance may include (but not be limited to) practical spectrum roadmap elements for priority actions in relation to initiatives on enhanced radio spectrum coordination and/or mechanisms (such as setting up a database) with an aim to assist the cooperation between national authorities, inform existing and prospective spectrum users about the national spectrum authorisation processes, and monitor the availability and accessibility of spectrum in the Member States. Any recommended actions from the Commission should take utmost account of any relevant RSPG opinions.

The targeted consultation included questions, among others, pertaining to the above guidance-examples. Most respondents to the targeted consultation believe that an evolving spectrum roadmap would increase the efficiency and effectiveness of spectrum management (78,6%). A vast majority of respondents considers a voluntary mechanism to assist national authorities in the spectrum authorisation process to be beneficial for timely spectrum availability and usage (82,4%). The RSPG had in this context provided an opinion[211] in which it welcomes the measures and provides suggestions on their implementation.

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[210] Directive (EU) 2018/1972 of the European Parliament and of the Council of 11 December 2018 establishing the European Electronic Communications Code (OJ L 321, 17.12.2018, p. 36).
[211] https://rspg-spectrum.eu/wp-content/uploads/2021/06/RSPG21-033final-RSPG_Opinion_on_RSPP.pdf

ANNEX 1: CONSULTATION

1. Overview of consultation activities and participants

The preparation of the Commission's proposal was informed by the views and input from a wide range of stakeholders collected through a series of consultation activities between March and August 2021. The main objective of these activities was to help to prepare a legislative policy proposal based on the Digital Compass Communication and pave the way for a smooth and effective achievement of the enshrined objectives.

The consultation activities targeted stakeholders in the Member States, EU institutions, the business community, civil society, academia, and other economic and social partner organisations operating on local, regional, national, and international levels and encompassed the following:

1) A consultation on the Roadmap for the Digital Compass Policy Programme, open on the Commission's 'Have your say' platform from 24 June 2021 to 22 July 2021.

2) A targeted consultation in the form of a questionnaire published on EU survey to collect feedback on the key elements of the Digital Compass, open from 22 June to 3 August 2021. Awareness of the targeted consultation was raised through several outreach activities, including email invitations to policy stakeholders, features on the homepage of the digital strategy website and in the Commission's weekly Shaping Europe's Digital Future Newsletter as well as posts on DG CNECT's social media channels and in the Digital Compass Community on Futurium. Notably, the Digital Compass Community on Futurium raised awareness and disseminated information to up to 128 members, of which 34 are associated with academic/research institution, 29 with a company, 26 with a public authority (including EU institutions), 16 with a non-governmental organisation (NGO), 10 with a business association, 1 with a trade association and 12 are without organisational affiliation.

3) Events, discussions and exchanges with stakeholders, including institutional partners, prior to the written consultation process.

Disclaimer: the views summarized are not the views of the European Commission but of the stakeholders that participated in this open public consultation. It cannot in any circumstances be regarded as the official position of the Commission or its services.

2. Results of consultation on roadmap

The Commission received 15 contributions from different types of stakeholders: non-governmental organisations (4), business associations (2), public authorities (2), business organisations (2), an EU citizen (1), an academic institution (1) and other (3). All of the replies originated from the EU: Belgium (6), Spain (3), Germany (2), Netherlands (1), Greece (1), France (1), Finland (1).

2.1 General Comments

Stakeholders are overall supportive of the Commission's initiative and its intention to operationalise the EU's digital ambition into a concrete monitoring and reporting mechanism.

The Open Future Foundation (OFF) feels, however, that **a stronger presence of the civil society and the non-profit sector** is needed for the Programme to succeed. The OFF emphasises that, as a principle, the European Union should adopt the Quadruple Helix model, according to which government, industry, academia and civil participants are treated as equal stakeholders. Moreover, the OFF believes that a strong, shared vision that guides this coordinated effort is as important as governance mechanisms outlined in the Roadmap; a European Digital Public Space, promoting more sovereign societies and individuals through the democratisation of access, transparency and accountability would be one such vision.

While the Free Knowledge Advocacy Group (FKAG) is supportive of establishing a common framework for implementation of the digital targets across the EU, FKAG fears that the Programme may not bring its intended results unless more attention is devoted to the **implementation of related legislative acts or proposals in the area of digital.** FKAG mentions in particular the Copyright Directive[212], the Terrorist Content Regulation[213] and proposals on the Digital Services Act[214] and the Digital Markets Act[215].

The Global Institute for Structure Relevance, Anonymity and Decentralisation (GISAD) proposes that **citizens' rights** should be at the centre of any legislative initiative in the area of digital, including the Digital Compass Policy Programme. GISAD mentions a range of rights which should be taken into account in the process of digital transformation, such as control over one's creative works online, choice over location of data storage, digital access to public services and equal participation in autonomous road transport.

The Flemish Public Administration (FPA) supports the rights approach proposed by the Digital Compass. However, FPA asks for attention to be paid to the **proper guidance for companies** and other users about **digital technologies** such as artificial intelligence and data-driven application in the integration of these new regulations. In addition, the FPA notes that a lot of preparatory work is already being carried out for such a rights approach, not in the least with the Council of Europe in the Ad Hoc Committee on Artificial Intelligence (CAHAI) which is focusing on regulation on Artificial Intelligence. The FPA therefore asks that maximum use be made of that work and that duplication and overlap be avoided. The FPA also notes that the pursuit of digital sovereignty should be accompanied by **coherence in EU policies** – digital sovereignty, as the FPA understands it, pertains to the development of the EU's own capacities and the reduction of our deficiencies, not to protectionism. For this reason, when entering into international digital partnerships, special attention needs to be paid to openness.

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[212] Directive (EU) 2019/790 of the European Parliament and of the Council of 17 April 2019 on copyright and related rights in the Digital Single Market and amending Directives 96/9/EC and 2001/29/EC, OJ L 130, 17.5.2019, p. 92–125.

[213] Regulation (EU) 2021/784 of the European Parliament and of the Council of 29 April 2021 on addressing the dissemination of terrorist content online, OJ L 172, 17.5.2021, p. 79–109.

[214] Proposal for a Regulation of the European Parliament and of the Council on a Single Market For Digital Services (Digital Services Act) and amending Directive 2000/31/EC, COM/2020/825 final.

[215] Proposal for a Regulation of the European Parliament and of the Council on contestable and fair markets in the digital sector (Digital Markets Act), COM/2020/842 final

The App Association (ACT) appreciates Commission commitment to focus on the delivery of Europe's common digital targets and to make Europe fit for the digital age.

The French Atomic Energy and Alternative Energies Commission (CEA) fully supports the Commission's vision for the Digital Decade Compass, which stems from European values and the conviction that the human being must remain at the center. Cooperation between the Commission and the Members States is of the essence to achieve concrete objectives, clearly defined for each of the four axes.

The Finnish IT Center for Science (CSC) reiterate the importance of the green and human-centric approach to the digital transformation: the digital and green transition must interplay as a twin challenge and opportunity in the proposed targets and tools. It recommends that the EU develops a **comprehensive Green ICT Strategy** aiming at minimising the carbon footprint and maximising the carbon handprint.

The European Disability Forum (EDF) welcomes the plan to formulate set of digital principles in the form of a joint inter-institutional solemn declaration of the European Commission, the European Parliament and the Council, based on a proposal from the European Commission. They call on the European Institutions to **ensure inclusive digital transition,** by committing to improving accessibility and **digital inclusion persons with disabilities in all areas of public and private life,** so that they equally benefit from EU action rather than be left behind due to the digital transformation. EDF suggest to establish an obligation for the European Commission and Member States to harmonize and mainstream accessibility and interoperability of digital technologies in the EU. It should also oblige the EU and Member State to **ensure digital participation of persons with disabilities beyond public services** which is the only area currently mentioned in the European Commission's Communication "2030 Digital Compass: the European way for the Digital Decade". Persons with disabilities have the right to participate freely and equally in all areas of digital public and private life, not only when it comes to accessing public services. It also advocate for including accessibility as funding criterion in all public funding, such as those under IPCEIs, Technical Support Instrument and the Digital Europe Programme. This will ensure that when EU funds are used, new technologies equally benefit persons with disabilities, rather than create further digital barriers for them.

The European Network of Social Integration Enterprise (ENSIE) welcomes the initiative of the European Commission aimed at establishing a robust framework to deliver on the vision set by the Communication on Europe's Digital Decade, but **calls on the European institutions to ensure inclusive digital transition, by committing to improve accessibility and digital inclusion disadvantaged groups** in all areas of public and private life, with a specific focus on work integration.

Be Global launched a project, called: "European platform for digitalisation, future of work, attraction of talent and diversity", which will focus on delivering solutions that will facilitate the achievement of the objectives of the Digital Compass and preserve European values: Human dignity, freedom, democracy, equality, the rule of law and human rights. It considers that the objectives of the Digital Compass should to pay **particular attention to reducing the digital divide, strengthening ethics, ensuring the digital inclusion of persons with disabilities, in all areas of public and private life**.

The OFF supports the stated goal of enhancing the DESI Index as pace of technological development means that statistical indicators should be constantly updated. However, the OFF believes that the monitoring system should include indicators that go beyond measuring growth (such as the targets defined under the four "cardinal points") and should include **measurement of more complex goals**, related to **achieving the twin transition** and related goals of sustainability and societal well-being, and mission-oriented indicators which would be devised to complement the more traditional quantitative measures. In particular, the OFF is of the view that the enhanced DESI should include indicators for measuring adherence to the Digital Principles.

The European Data Centre Association (EUDCA) emphasises the role of **the data centre industry** in providing connectivity and space for cloud and edge, and in reaching the corresponding 2030 targets.

ACT considers the Digital Economy and Society a useful tool, moreover suggests to conduct SME-focused studies to examine the impact the DCPP could have on them and to ensure it benefits all digital players in Europe.

CSC underlines that if the EU wants to reach its ambitious climate targets for 2030, **climate-neutrality must be a target for all digital infrastructures with vast energy consumption** (e.g. data centres), not just the upcoming edge nodes included in the suggested targets. This would also be in line with the Communication on Shaping Europe's Digital Future , where the climate-neutrality of data centres and telecommunication networks is explicitly mentioned. It adds that the whole lifecycle of the digital infrastructures must be in scope of a greener approach with tangible criteria and metrics such as carbon footprint, usage of renewable energy, free cooling, and re-use of waste heat.

CSC also considers that an increased **interoperability** is also crucial for the development of data economy and **must be addressed in the 2030 targets** from that perspective as well. In general, the Digital Compass policies must be more closely linked with the EU's data policies (such as the upcoming Data Governance Act), which in turn must be firmly rooted in MyData principles, FAIR principles and the European Interoperability Framework, where interoperability at all levels (legal, organisational, semantic and technical) is systematically addressed.

EDF ask to include **accessibility and disability-focused indicators** in the enhanced Digital Economy and Society Index (DESI) and in the regular annual reporting by the European Commission, i.e., in the European State of the Digital Decade Report – ESDDR.

ENSIE considers that the Digital Economy and Society Index (DESI) should foresee some **specific indicators for disadvantaged groups** in order to ensure a smooth and inclusive transition towards a digital economy and society by avoiding to leave anyone behind. These indicators should take into account the vulnerabilities of such people as well as the obstacles they face when approaching the labour market.

- *Digitally skilled population and highly skilled digital professionals*

Kaspersky considers that **cybersecurity** should be included under the umbrella of 'basic digital skills' (e.g. via dedicated IT and cybersecurity courses in school curricula at an early

age) and that a separate goal for a number of employed cybersecurity specialists should be added. Kaspersky also recommends referring to the number of students admitted to specifically cybersecurity-themed graduate programmes in Europe every year by 2030.

The FPA finds the term 'ICT specialists' in the target problematic as it does not appear to take into account the **regional specificities** – e.g., in the context of Flanders, the proposed target for ICT specialist means that the region would need to increase the number of ICT specialists by 146%. The FPA also points out that the **definition of 'basic digital skills' is unclear** and asks whether it relates only to practical skills or also to competences such as media literacy and digital responsibility.

EUDCA considers particularly important an inclusion of **skills-upgrading for existing employees,** retraining of people in sectors where labour demand declines, and activation of unemployed to fill all vacancies. EUDCA argues that a rise in labour productivity, by speeding up automation and digitalisation, is necessary to compensate for the demand for jobs.

CEA considers that to train qualified **professionals work-study training** has many advantages, particularly in reducing the gap between the supply of higher education and the demand of companies. Students receive practical training in the field with professionals and can combine theory and practice. **Research and technology organisations (RTOs) have a crucial role to play in training digital professionals with very high and specialized skills**. It is also important to encourage RTOs' engineers/researchers to be involved in professional training organisations, whether they are part of the public or private sector, especially for continuing education.

CSC underlines that end-users must play a key role in the design of the services, to ensure development of services that are responsive to users' needs. **Co-design and engagement of a broad range of user communities** is important. In addition, an **interoperability target** must be added to ensure that consumers can easily change digital service providers if they so wish.

Be Global has several proposals to foster the development of digital skills for all to **promote digital skills programmes according to different needs (**older people, entrepreneurs etc). It suggests to promote systems that favour "multimodality in education", ensuring academic auditing, taking into account the diversity of experiences and good practices arising from non-face-to-face education. In particular they call to enhance the incorporation into the European education system of strategic guidelines to raise awareness among girls, adolescents and women on the importance of STEM studies to foster their empowerment. Be global also encourages the design of a **collaborative intelligence programme** so that engineers and related professionals around the world can contribute their knowledge and position the European Union as **a hub for innovation and talent.** Be Global also suggests to promote tax incentives for European organisations to take an interest in developing remote working policies, teleworking and attracting the best talent.

- *Secure, performant and sustainable digital infrastructures*

Kaspersky argues that **cybersecurity-related considerations** should be included from the design phase, thereby eliminating the risk of entire classes of less sophisticated cyberattacks and minimising the overall risk of cyber incidents and related accidents.

Everbridge asks for a mandatory clause which introduces a **necessary link between 5G rollout and public warning**, in compliance with the European Electronic Communications Code[216], in particular Article 110 on critical communications systems, such as public warning, as an integral part of digital transformation.

The FPA also emphasises the **importance of digital solutions and infrastructures in social sectors**, especially medical services and education and highlights that strong public-private partnerships, complemented by academic and civil society stakeholders, can contribute to this.

Regarding semiconductors, the FPA notes that currently, there are three chipmakers that hold the majority of the market at global level (Intel, TSMC and Samsung). The FPA argues that the landscape should be diversified by investing more in European chipmakers but considers that a mere call for funding is insufficient **- specific guidelines on funding models and a distinction between the development of different types of chip** are needed to achieve the desired objective.

Concerning edge nodes, the FPA argues that the definition of edge nodes should also include **local digital equipment**. From an energy saving and privacy standpoint, the FPA believes that it is problematic to focus solely on the rollout of smaller distributed data centres as this goes against the trend of obtaining **more distributed technical solutions**, as also defined in the AI White Paper[217] under the term edge computing.

The FPA would like to see a **separate KPI regarding circularity** in order to stimulate the reduction of the ecological footprint of digital products by including eco-standards. In this context, the FPA proposes to include an extra target on "Green IT: reducing the footprints of IT & electronics".

CEA considers the European digital product passport system will be very useful to stimulate resource efficiency and empower consumers to make sustainable choices. According to CEA three categories of infrastructures or platforms are essential **for digital primacy**: 1) efficient and autonomous software development platforms and associated strategic tools, 2) data analysis platforms, and 3) digital twins that are multi-scale and multi-model simulation platforms -they live alongside and interact with real systems. It also underlines the importance, in terms of applications, of platforms for the exploration of new materials which are infrastructures of great utility for the prosperity of tomorrow's industry. **Experimental and test facilities (TEFs) are also essential.** It is of course useful to have this type of infrastructures close to innovation organisations. CEA in general considers crucial the existence of an intelligent distributed systems, hyper connectivity, networks and communications technologies, AI and decentralized, resilient, secure and frugal decision systems including the "green blockchain". CEA underlines **characteristics of future computing** to be considered: computer architectures, high performance computing, including quantum computing and other new paradigms, continuum from sensor computing to the cloud via the edge, micro and nano electronics, chips and embedded systems, optimization of energy and resource efficiency, software stack, or large-scale systems such as exascale supercomputers. They also underline the importance of **Cybersecurity:** including trusted hardware and software components and the development of system security technologies.

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[216] Directive (EU) 2018/1972 of the European Parliament and of the Council of 11 December 2018 establishing the European Electronic Communications Code (Recast), OJ L 321, 17.12.2018, p. 36–214.
[217] White Paper "On Artificial Intelligence - A European approach to excellence and trust", COM(2020) 65 final.

According to CSC the **rather narrow target of 10000 new edge nodes** must be complemented with or even replaced by a more comprehensive target for developing an interoperable ecosystem of edge computing capacities and more consolidated cloud and HPC infrastructures, allowing for data to be analysed and further utilised in the most appropriate environment, taking into account the needs of different beneficiaries. CSC also considers that the **target regarding quantum computing must be made more ambitious**, aiming not only at getting started with quantum but reaching technological leadership in emerging technologies. Different types of infrastructures (HPC, quantum, data, AI, connectivity networks etc.) must be developed in convergence and by using world-class technologies in order to allow European RDI to reach its full potential.

Be Global considers strategic **boosting the upgrading of telecommunications infrastructure in rural areas** and mapping from all EU countries and identify the urban, rural and remote areas that need more investment.

- *Digital transformation of businesses*

Kaspersky recommends setting an **ambitious and future-proof cybersecurity-related target** by 2030, e.g. goals for the percentage of the cybersecurity budget of the overall IT budget and adding cybersecurity to the goals of businesses overall (and for SMEs in particular) and for running cybersecurity trainings in large businesses and SMEs.

EUDCA's point of view is that the target of "at least 75% of European enterprises having taken up cloud computing services, big data, Artificial Intelligence" should also include **data center services (colocation)**, as they provide the platform for private cloud services.

The FPA proposes adding a specific KPI regarding the **large venture capital investments for digital technologies in Europe**; since the breakthrough and growth opportunities of a start-up and scale-up are based on these investments, the FPA considers it very important to pay special attention to this issue.

In general CEA considers that EU must intensify its efforts to support digital research and innovation across the entire value chain, from micro and nanoelectronics to algorithms and data, for end-user solutions. The objective is to keep EU industry and SMEs that provide digital technologies, products and solutions, as well as services, in the race. CEA suggest when considering **AI to focus in areas** such as 1) algorithmic development like image analysis, semantic analysis, signal processing), 2) frugal AI or green AI, 3) embedded AI with state-of-the-art AI hardware, including dedicated memories, 4) AI techniques in scientific simulation, and 5) trusted and ethical AI with a general focus on validation or certification. As regards data to **capitalize data located in the sensors, the edge, and the cloud** CEA considers very important: 1) data science for statistics and machine learning, 2) data analysis for dashboards and visualization methods, 3) data governance for the rules of use, in particular trust, ethics and confidentiality, and 4) data engineering for data migration to the cloud and quality assurance.

Be Global welcomes initiatives to enhance the creation of a dedicated support fund the digital transformation of organisations, targeting in particular SMEs, micro-SMEs and self-employed professionals. It also underlines the importance of fostering an innovative entrepreneurial ecosystem, that facilitates the creation and attraction of unicorn enterprises to the European Union.

- *Digitisation of public services*

Kaspersky supports an ambitious agenda for the protection of the evermore digitised public services of the Member States and of the EU. The company suggests that targets could be set for **increased investment in cybersecurity solutions and services** (e.g. in public procurement policies through setting budget thresholds dedicated to cybersecurity within new IT projects), for innovative cybersecurity training and gamification approaches for civil servants, as well as for minimum requirements towards information security management.

A Greek citizen suggests that digital ID solutions should be expanded **to include a wide range of information** such as owned tangible and intangible properties, biometric data or work experience.

The FPA would like to add a KPI on the extent to **which sustainable and circular criteria** are used in public procurement and the extent to which IT material is managed in a circular way.

Be Global suggests to strengthen 'Open Government' initiatives to increase transparency in public administration, incorporating technological innovation and open data, for public use and greater interaction between government and citizens also promoting the creation of a network of European public administrations to share best practices and implement relevant ones. It underlines the importance of promote gender mainstreaming and social equity in all digital public policies and developing inclusive digital public services for people with disabilities.

2.3 On Governance

The OFF believes that the Expert Group should be tasked also with **monitoring the adherence to the Digital Principles** that are part of the Digital Decade framework.

Everbridge supports the Commission's proposal for the creation of a stakeholders' forum and of an expert group, provided these include the **participation of critical communication providers both from the public and the private sector.**

ACT welcomes the Commission taking this next step of setting out a dedicated governance framework to organize the cooperation among European institutions and the Member States. **Existing structures, monitoring, reporting, should be aligned and established at the EU level**, therefore a structured cooperation and progress monitoring and reporting on the European level would add significant value to a common vision for a Europe fit for the digital age.

CEA welcomes that the Digital Compass policy programme puts in place a monitoring and reporting system and a mechanism for the Commission to engage with Member States in close collaboration and considers very important to establish a governance structure to achieve these objectives. However, it is equally **important to define these objectives in a very clear way on the four axes**, to make technological choices and to arbitrate between priorities as soon as possible.

2.4 On Multi-Country Projects

ACT considers positively the proposal for a Member State-specific incentive to work together and organise multi-country projects. It agrees with the Commission that such cooperation

would help to accelerate the build-up of digital capacities and large-scale technologies projects across the EU. The DCPP should set up this mechanism with the Commission in a coordinator role to ensure alignment with EU programmes, policies, priorities, and regulations as well as pooling of national and private financial resources.

CEA welcomes the mechanism to incentivize Member States to work together to carry projects to build Europe's digital capabilities in critical areas is paramount, especially during the period of the time period of the RRF for which a minimum of 20% will support the digital transition.

CSC warmly welcomes the plans to incentivise Multi-Country Projects for developing Europe's digital capacities in critical areas. Such projects must pool not only funding, but also human resources, and build on lessons learnt from previous and ongoing cross-border collaboration activities. One such activity to benchmark is the EuropHPC JU1.

2.5 On Stakeholder Consultation

ACT welcomes the Commission's extensive engagement of the public through several consultations, as well as the proposal of a high-level event, workshops, and citizens dialogues in the Member States. Such stakeholder engagement will ensure an inclusive policy programme and should be included in the proposed DCPP. Moreover encourages the Commission to establish an inclusive stakeholder forum that brings together technological as well as regulatory expertise and represents the interests of all actors in the digital economy across the EU Member States.

CSC also welcomes the idea to establish a stakeholder forum and/or an expert group to support the implementation of the Digital Compass policies. When inviting members to these bodies, due attention must be paid to openness, transparency and ensuring a diverse and balanced representation of public and private interests as well as civil society and various fields of academia. The mandate and responsibility of such bodies must be clearly communicated. **Stakeholders must be consulted not only on the implementation but also the design of the Digital Compass policies.** Therefore, the final approval of the vision and concrete targets for 2030 must not take place until the feedback on the various roadmaps is properly analysed.

EDF suggest to engage organisations of persons with disabilities, accessibility experts in the planned stakeholder forum, and possible expert group for implementation of the Digital Compass. It underlines that is often assumed by policymakers that new technologies can help fix social issues by default. However, technical engineers, ICT experts are not equipped with expertise on human rights, non-discrimination and social equality to bring positive social change on their own.

ENSIE flags the need to involve Work Integration Social Enterprises (WISEs) representatives into the stakeholder forum to be established in line with the Communication and composed of private and public actors, to ensure that the necessary measures are undertaken for an inclusive and equal access to digitalisation to all actors of the labour market, also the ones operating within the social economy and the work integration of disadvantaged people.

3. Results of targeted consultation

In total, 101 contributions were received, of which 61 were on behalf of a company or business association, 8 from citizens (all EU citizens), 9 on behalf of academic / research institutions and 12 from public authorities. 5 respondents were non-governmental organisations (Figure 1).
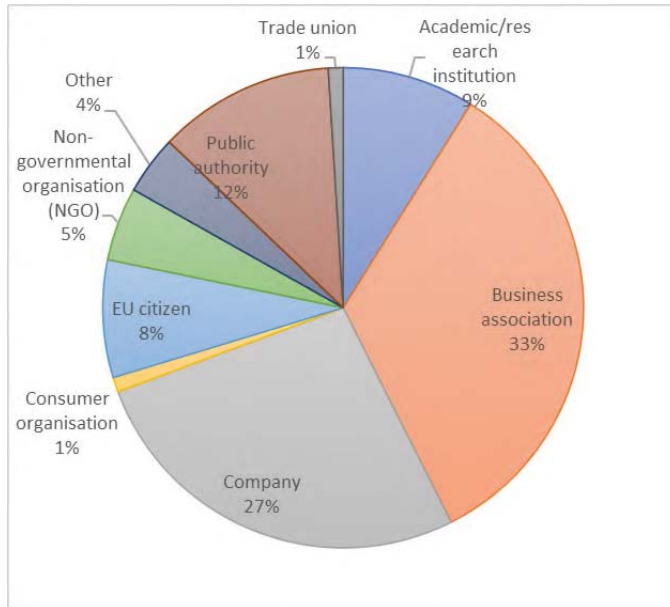
Figure 1 - Respondent as representative of:

Amongst the 101 contributions, 53.3% were micro, small and medium-sized organisations and 46.7% large organisations (Figure 3). 92 respondents indicated whether their organisation had a local (1.1%), regional (5.4%), national (32.6%) or international scope (60.9%) (Figure 2).
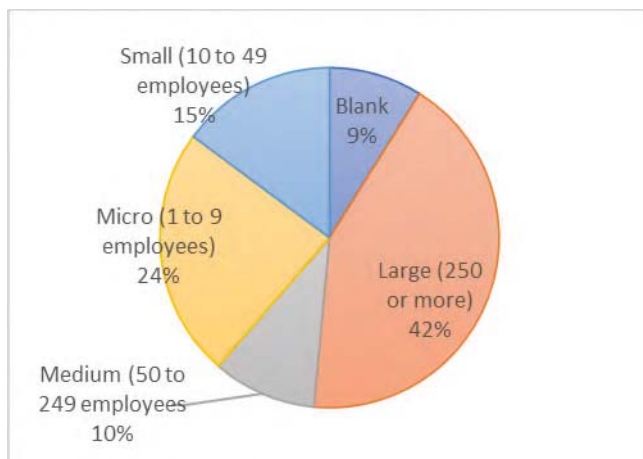
Figure 3 - Organisation size
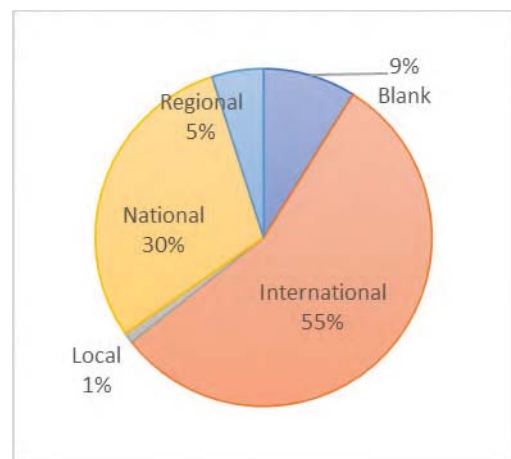
Figure 1 - Organisation scope

Overall, Figure 4 shows that 92.1% of the replies came from the EU-27 and 7.9% of the replies came from organisations with the origin in other countries, such as US, Ukraine and China.
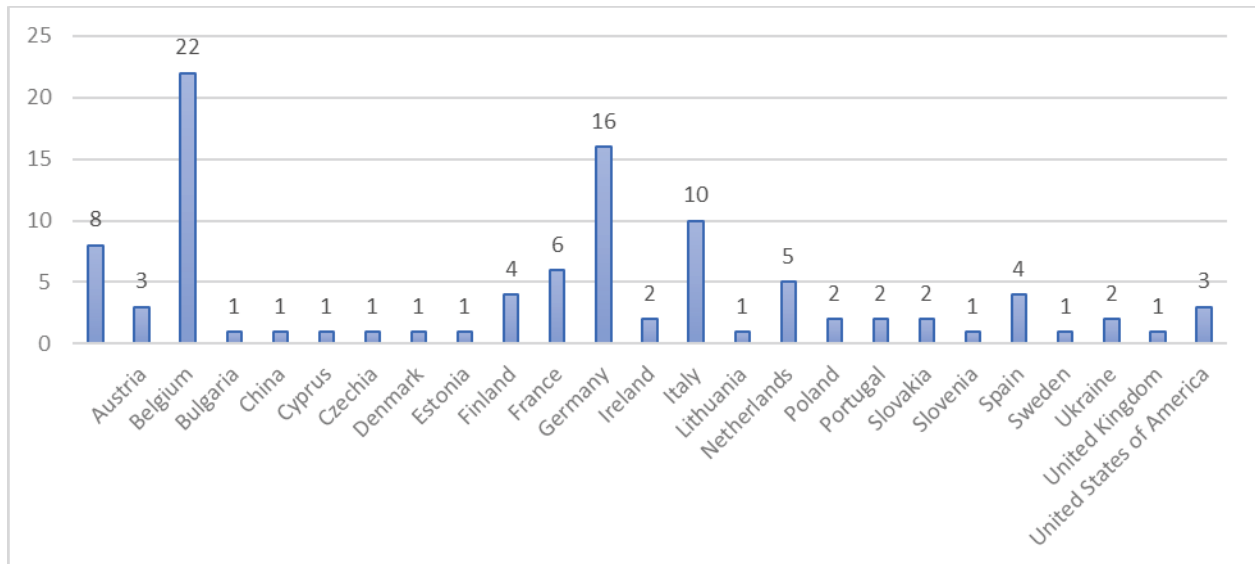
Figure 4 - Country of origin of organisation

Respondents could contribute to all or some of the 71 questions across four sections and had the possibility to submit position papers. Few respondents replied to all questions; hence the sample size varies between and within sections. For this reason, for each topic, the percentage indicated is always the share of the actual respondents to the specific section or question.

The questionnaire combined a mixture of 'closed' questions (where respondents chose from a pre-determined selection of answers) and 'open' questions (where they were free to write any response they chose). Closed questions with ranking options were set up as non-exclusive, so that a respondent could assign the same rank to several of the items. Open questions had a 500-character limit except the last, for which responses of 2 000 characters were allowed.

This report presents preliminary trends emerging from an initial analysis of closed questions to the targeted consultation, focusing on quantitative aspects. It is not representative of the breadth of feedback and input received through the extensive consultation process described above.

3.1 On Accelerating the Digital Transformation

This section features general questions about the need and vision for accelerating the EU's digital transformation in the context of the COVID-19 pandemic.

Most stakeholders strongly agree or agree that the COVID-19 pandemic emphasised the importance of ensuring that everyone in Europe fully benefits from the digital transformation (95.5%) and that it demonstrated a need to accelerate the pace of the digital transformation in Europe (95.5%). The pandemic exposed a digital divide between those businesses already able to leverage the full potential of the digital environment and those not yet fully digitalised (92%). Above that, 90.8% among the respondents strongly agree or agree that COVID-19 exposed a digital divide between people who can fully benefit from a digital space with a full range of services, and those who cannot. They strongly agree that the COVID-19 pandemic highlighted a need for a substantial increase of investments through all relevant EU funds and national spending to develop critical technologies (90.7%) and the need to increase the EU's role for coordinating the digitalisation efforts of Member States (78.8%). 75% of the respondents strongly agree or agree that the pandemic showed that achieving digital sovereignty by building our own technological capacities is crucial for strengthening the EU's

resilience. 63.2% of respondents agreed that the COVID-19 pandemic demonstrated a need to accelerate the pace of digital transformation in Europe, however, as shown below on individual level most respondents strongly agree or agree that COVID-19 has altered their organisation's need for and reliance on the following aspects:

- Reliance on secure, performant and sustainable digital infrastructures (89.7%)

- Reliance on digital public services (86.1%)

- Increased need for digital products, tools, and services (85.5%)

- Increased need for and reliance on a digitally skilled population (i.e., citizens with at least basic digital skills) (81.3%)

- Increased need for and reliance on highly skilled digital professionals (72%).

The respondents rank the following elements as most important (ranking 1 and 2 out of 5) for accelerating EU's digital transformation:

- Secure, performant and sustainable digital infrastructures (84.9%)

- A digitally skilled population and highly skilled digital professionals (82.6%)

- Digitalisation of public services (81.9%)

- Digital transformation of businesses (80.2%)

- A framework for accelerating the implementation of multi-country projects, i.e., projects that aim to mobilize and combine investments from the EU budget, Member States and the private sector to achieve digital goals (65%)

- An EU governance framework to enable close cooperation and coordination between the Commission and Member States, with the objective of adopting recommended actions including joint commitments (61.9%)

The following aspects are ranked as important (ranking 1 and 2 out of 5) and in need for progress for realising the EU's commitment to reduce greenhouse gas emissions by at least 55% by 2030:

- Digital transformation of businesses (84.6%)

- Secure, performant and sustainable digital infrastructures (82.3%)

- Digitalisation of public services (75.9%)

- A digitally skilled population and highly skilled digital professionals (64.5%)

3.2 On Reaching the 2030 Targets

The Digital Compass sets out targets along four cardinal points. Section II is divided into 4 subsections, each of which represents a cardinal point. The first two subsections focus on digital capacities in skills and infrastructures, and the other two focus on digital transformation of business and public services.

- *A digitally skilled population and highly skilled digital professionals*

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Just under half of 69 participants believe it will be challenging (ranking 4 and 5 out of 5) to guarantee that by the end of 2030, 80% of all adults have at least basic digital skills (49.2%). A majority agrees that it will be challenging to employ at least 20 million ICT specialists in the EU (65.7%), while 67.2% recognise that it will be challenging to achieve a convergence between the number of female and male ICT specialists by 2030.

Participants find that more public investment is the most important intervention needed to achieve the digital skills targets. From a list of six proposed interventions, over three quarters of 65 respondents (78.4%) rank more public investment as a top priority to ensure that 80% of adults are equipped with basic digital skills by 2030. This is followed by more public-private cooperation, which is identified as a top priority by 59.1% of respondents.

The table below shows the percentage of respondents who ranked each of the proposed interventions as 1st or 2nd most needed (out of 6) to achieve the digital skills targets. Participants could assign the same rank to several interventions per target.

Proposed interventions	Proposed targets		
	80% of all adults have at least basic digital skills	At least 20 million employed ICT specialists in the EU	Convergence between the number of female and male ICT specialists
N. of respondents	65	64	61
More public investment	78.4%	74.2%	67.2%
Stimulation of more private investment	50.8%	67.7%	49.2%
More public-private cooperation	59.1%	62.5%	47.5%
More robust governance to steer EU and Member State actions on digital	36.3%	41.3%	35.4%
Better implementation and enforcement of existing regulation	22.2%	24.6%	32.8%
Additional regulation to advance the Single Market	12.3%	19.4%	15%

- *Secure and performant sustainable digital infrastructures*

Out of 76 respondents a majority believed it would be challenging (rank 4 and 5 out of 5) to have all EU households covered by a gigabit network by 2030 (67.1%) as well as to have all populated EU areas covered by 5G (65%). Likewise, a majority of the respondents agreed that it would be challenging for Europe to have at least 20% of world production by value in cutting-edge and sustainable semiconductors, including processors (69.9%) as well as to

achieve that 10,000 climate neutral highly secure edge nodes are deployed in the EU (71.6%). Finally, most stakeholders found it challenging to achieve that Europe is at the cutting edge of quantum capabilities, with its first computer with quantum acceleration by 2025 (65%).

Participants find that the stimulation of more private investment is the most important intervention needed to achieve the digital infrastructure targets. For edge nodes and quantum computing, this is closely followed by more public-private cooperation (identified as a top priory by 69% and 73.2%, respectively) and more public investment (identified as a top priority by 67.2% and 70.9%, respectively).

The table below shows the percentage of respondents who ranked each of the proposed interventions as 1st or 2nd most needed (out of 6) to achieve the digital infrastructure targets. Participants could assign the same rank to several interventions per target.

Proposed interventions	Proposed targets				
	All EU households are covered by a gigabit network	All populated EU areas covered by 5G	The production of cutting-edge and sustainable semiconductors in Europe including processors is at least20% of world production in value	10,000 climate neutral highly secure edge nodes are deployed in the EU	Europe is at the cutting edge of quantum capabilities, with its first computer with quantum acceleration by 2025
N. of respondents	73	72	53	58	55
Stimulation of more private investment	74%	80.2%	84.9%	71.1%	74.5%
More public-private cooperation	69.8%	61.1%	65.4%	69%	73.2%
More public investment	65.8%	57%	59.6%	67.2%	70.9%
More robust governance to steer EU and Member State actions on digital	35.3%	37.7%	25%	37.9%	18.6%
Better implementation and enforcement of existing regulation	31.5%	28.6%	13.4%	19%	15.4%
Additional regulation to advance the Single Market	17.8%	12.9%	11.5%	19%	36.6%

Out of 77 respondents, a majority recognised the importance (ranking 1 out of 5) of coordinated action/EU guidance to harmonise spectrum management and availability (51.9%) and foster connectivity infrastructures (53.2%) for enabling the EU's digital transformation. Meanwhile, 46.7% recognised the importance of investing in the EU's joint infrastructures and capacities.

The following ranking displays 65 respondents' perception on the areas in which additional (new) 5G network deployment objectives at EU level would be most relevant (ranking 1 and 2 out of 5):

- Level of network security (79.3%)

- Level of service quality (57.9%)

- Contribution to green policy objectives (50.8%)

- Geographical availability of edge cloud capability (50%)

- Geographical coverage of 5G services beyond populated areas (48,8%)

- *Digital transformation of businesses*

The following displays the ranking of 58 respondents on how challenging (ranks 4 and 5 out of 5) it will be to achieve the proposed EU targets by 2030:

- 65.5% of respondents believe that it will be challenging to have 75% of European enterprises take up cloud computing services (2020: 26%), big data (2020: 14%), and Artificial Intelligence (2020: 25%).

- 41.1% of respondents believe that it will be challenging to achieve the target that more than 90% of European SMEs reach at least a basic level of digital intensity (2019: 60.6%).

- 44.5% of respondents think that it will be difficult to double the number of EU unicorns.

Participants find that the stimulation of more private investment is the most important intervention needed to accelerate the digital transformation of businesses. From a list of six proposed interventions, over four fifths of respondents rank this as a top priority for achieving the 2030 targets.

The table below shows the percentage of respondents who ranked each of the proposed interventions as 1st or 2nd most needed (out of 6) to achieve the targets related to the digital transformation of businesses. Participants could assign the same rank to several interventions per target.

Proposed interventions	Proposed targets		
	75% of European enterprises have taken up cloud computing services, big data and Artificial Intelligence	More than 90% of European SMEs reach at least a basic level of digital intensity	Double the number of EU unicorns

N. of respondents	57	52	52
Stimulation of more private investment	83.9%	80.8%	88.5%
More public-private cooperation	72%	75%	72.6%
More public investment	52.6%	42.3%	44.3%
More robust governance to steer EU and Member State actions on digital	42.9%	41.2%	28%
Better implementation and enforcement of existing regulation	37.5%	25.5%	21.5%
Additional regulation to advance the Single Market	21.8%	15.4%	20%

- *Digitalisation of public services*

The following displays the ranking (ranks 4 and 5 out of 5) of 62 respondents on how challenging it will be to achieve the proposed EU targets by 2030:

- 58.1% think that the target of 80% citizens using a digital ID solution, will be difficult to achieve.

- 51.6% believe that it will be challenging to achieve that all key public services for citizens (2020: 75%) and businesses (2020: 84%) are available online.

- 51.6% think that it will be difficult to achieve that all citizens have access to electronic medical records.

Adequate digital ID solutions are relevant for 73.3% of the respondents and enhanced cross-border access to electronic medical records for 46.3%.

Participants find that more public investment is most needed to accelerate the digitalisation of public services. From a list of six proposed interventions, 94,4% of 54 respondents rank this as a top priority to ensure that all key public services are available online by 2030.

The table below shows the percentage of respondents who ranked each of the proposed interventions as 1st or 2nd most needed (out of 6) to achieve the targets related to the digitalisation of public services. Participants could assign the same rank to several interventions per target.

Proposed interventions	**Proposed targets**		
	All key public services are available online	All citizens have access to electronic medical records	80% of citizens use a digital ID solution
N. of respondents	54	49	52

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More public investment	94.4%	77.6%	90.4%
More public-private cooperation	55.5%	58.3%	54.9%
More robust governance to steer EU and Member State actions on digital	52.7%	56.2%	55.1%
Additional regulation to advance the Single Market	40.7%	38.8%	46%
Better implementation and enforcement of existing regulation	37.1%	45.8%	40%
Stimulation of more private investment	32.7%	36.2%	38%

3.3 On Building a New Governance Framework

Among the respondents to the section on the New Governance framework (73), most see strong benefits in the proposed system. They find it extremely or very relevant that the framework supports the development and implementation of Multi-Country Projects (75.4%), that it sends a clear signal to market actors to incentivise private investments (73.6%), that it ensures the effective delivery of Digital Compass goals on EU level (70.9%), and that it stimulates cooperation between Member States (68.5%).

On the specific aspect of radio spectrum, which plays a key role as an enabling resource to reach many of the 2030 digital targets, 78.6% of respondents (out of 56) think that an evolving spectrum roadmap as a guiding but non-mandatory monitoring mechanism integrating input from a broad range of relevant stakeholders would increase the efficiency and effectiveness of spectrum management. Further, 82.4% (out of 51) considered that a voluntary mechanism to assist national authorities in the spectrum authorisation process would be beneficial for timely spectrum availability and usage.

- *Monitoring*

Regarding the proposed comprehensive monitoring system, 71 respondents considered that it would be extremely or very relevant that is focuses on:

- Measuring progress of the EU against the 2030 targets (83,1%)

- Following digitalisation trends at EU and Member State level, and comparing them with other global players (China, US) (76,1%)

- Following digitalisation trends at EU and Member State level (74.3%)

- Assessing areas with insufficient development at Member State level (e.g., due to insufficient investment and/or regulatory action) (73.2%)

- Showcasing best practices from Member States (57,1%)

- Ensuring a broader knowledge of the EU's digital policies across Europe for citizens, Member States, and other stakeholders (50%, with an additional 41.4% finding it only relevant, as opposed to extremely or very relevant)

- *Reporting*

Considering the proposed annual Report on the state of the Digital Decade, which will present progress and identify deviations from the digital decade targets through a score of 'traffic lights', among 67 respondents, it was considered extremely or very relevant that the focus/scope be on:

- Monitoring progress towards the 2030 targets at EU level (83.5%)

- Identifying deviations from the 2030 targets and digital principles at national level (69.7%)

- Monitoring implementation of digital principles (64.2%)

- Feeding the implementation of the Recovery and Resilience Facility (63.5%)

- Assessing general state of compliance with digital policies (59.1%)

- Tracking common cross-border projects /investments (51.5%)

- Proposing recommended actions including joint commitments to be discussed with Member States and the European Parliament (52.3%)

- Feeding the European Semester process (35%)

3.4 On Developing a Mechanism to Operate and Deploy Multi-Country Projects

The consultation also asked about the function, features and possible directions for Multi-County Projects, which will be key to scaling up the EU's digital capacities and strengthening critical infrastructures linked to EU's digital sovereignty. In this context, 90.1% of 69 respondents strongly agree or agree that in some critical digital areas, the EU needs to build up its digital capacities. 90% also strongly agree or agree that there is a need to find solutions to accelerate and facilitate common digital projects, and 81.2% that the scale of such projects cannot be operated by Member States alone and should benefit from common action at EU level.

The most important objectives of Multi-Country Projects (ranking 1 "most important" out of 5 "least important"), according to 70 respondents, were to accelerate the digital transition (68.6%), accelerate the green transition (56.5%), and address strategic dependencies to achieve EU digital sovereignty (45.6%).

All digital areas for Multi-Country Projects discussed with Member States under the Recovery and Resilience Facility were deemed high-priority (ranked 1 or 2 out of 5) by more than half of respondents (64). Many respondents assigned the same high rank to several areas, pointing out that "all of these areas can benefit from economies of scale and scope" and that "there is not one area that would not benefit from a strongly European approach":

- European Common Data Infrastructure and Services (90.6%)

- Pan-European deployment of 5G corridors (77.4%)

- Capabilities in electronics design and deployment of the next generation of low power trusted processors and other electronic components (76.2%)

- Developing and deploying an ultra-secure quantum communication infrastructure spanning the whole EU (75%)

- Connected Public Administrations (74.2%)

- Deploying a network of Security Operations Centres (74.1%)

- European Digital Innovation Hubs (72.6%)

- High tech partnerships for digital skills through Pact for Skills (67.2%)

- Acquisition of supercomputers and quantum computers (63.8%)

- European Blockchain Services Infrastructure (55.2%)

Regarding the features of an instrument facilitating the implementation of Multi-Country Projects which would be vital, 56 respondents found most important that (ranking 1 out of 5):

- Possibility to set up projects swiftly and flexibly (67.9%)

- Facilitate the pooling of EU and national funding (65.5%)

- Low administrative burden (64.3%)

- Create incentives to crowd in private investments (42.1%)

- Coordination with EU programmes and policies (38%)

- Legal capacity to procure and operate multi-country infrastructures and pan-European services of public interest (28.3%)

- Possibility to cover areas outside digital (e.g., green transition) (28%)

- Standard governance arrangements, including variable geometry with defined role of different actors (Member States, industry, Commission) (23.1%)

- Bottom-up approach to project pipeline, option for Member States to propose projects (19.6%)

- Legal personality to act as data controllers (6.7%)

- Legal personality to be liable for damages (4.3%)

- Top-down approach to project pipeline, Member States to agree to the list proposed by the Commission (4.1%)

4. Results of pre-consultation activities

The Commission gathered additional input through a series of events, discussions and exchanges prior to the launch of the online written consultation. This included:

- The Leading the Digital Decade Conference (LDD), a two-day online event co-organised by the European Commission and the Portuguese Presidency of the Council of the European Union on 1-2 June 2021, to engage in a broad debate with public and private sector stakeholders from Member States, as well as representatives of

European institutions, notably the European Parliament and European Investment Bank, in six plenary sessions covering the different elements of the Digital Compass.

- Targeted meetings at the inter-institutional level, including a policy debate in the Transport, Telecommunications and Energy Council (TTE) on 4 June 2021 to identify key actions necessary to achieve the 2030 targets; the 15th meeting of the Digital Single Market Strategic Group (DSM SG) on 24 June 2021 to gather Member States' views on the Commission proposal; study group meetings of the European Economic and Social Committee and European Committee of Regions; as well as individual meetings with Member State representatives and attachés.

- Position papers from Member States and the Austrian Federal Chamber of Labour (AK Europa) as well as opinions from the European Economic and Social Committee (EESC), the Radio Spectrum Policy Group (RSPG) and regional parliaments.

The main results of these pre-consultations are summarized below.

4.1 Support for Digital Compass

One of the main aims of the consultation activities was to receive views on the vision, targets, governance structure and mechanism for Multi-Country Projects outlined in the Digital Compass Communication. Overall, stakeholders from all relevant groups recognized the urgent need to accelerate the digital transformation in Europe through coordinated efforts and investments from the EU, Member States and the private sector. Many explicitly endorsed the Digital Compass policy programme as an appropriate tool to effectively and efficiently govern this transformation, and pledged their support to achieve the envisioned objectives, as exemplified in this statement from the Netherlands (at DSM SG): *"Putting the digital transition in the center of the European Union is really necessary at the moment and achieved by the Digital Compass."* Expert panelists at the Leading the Digital Decade conference backed the Commission's assessment of the current situation: *"Europe needs to scale in infrastructure, services and skills in order to become a more competitive economy and a more sustainable society"* (María Jesús Almazor, CEO of Cyber & Cloud at Telefónica). Business stakeholders agreed that the COVID-19 crisis has demonstrated the importance of digitalisation for the resilience of the EU economy. The European Economic and Social Committee (EESC) agrees in its opinion that *"the European Commission's Plan for the 2030 Digital Compass arrives at a critical moment for the Union and the entire world."*

a) Targets

During the policy debate in the Transport, Telecommunications and Energy Council (TTE), there was agreement that the Digital Compass targets are *"very rightly and well-chosen"* to address the structural shortages and gaps hampering the ability of EU citizens and businesses to take full advantage of the digital transition today. Several Member States explicitly emphasized their support for the *"ambitious and concrete"* targets (FI, IT, DE, LV, LT, CZ, NL, EE at TTE). Each was deemed important in its own right but achievable only as part of the holistic, coordinated approach envisioned by the Policy Programme "Path to the Digital Decade". Others combined support for the proposed targets with additional suggestions to expand or adjust the initial list of KPIs.

- *Digital skills*

The importance of a digitally skilled population and highly skilled digital professionals was universally acknowledged by stakeholders from all groups as a prerequisite for a successful digital transformation. Public sector stakeholders saw a role for themselves in democratizing digital skills, closing persistent gaps between rural and urban areas, education levels, and age groups, and achieving digital equity for all (Petra de Sutter, Vice-Prime Minister of Belgium; Malta Josianne Cutajar, Member of the European Parliament, at LDD). Several stakeholders from the business and education sectors stressed the importance of advanced digital skills for the creation of new innovative companies and unicorns in the EU (Alexandra Mechkova, CEO of Telerik Academy, at LDD).

- *Digital infrastructures*

Infrastructural services and technologies were identified as another key enabler for a successful European digital transformation. Experts validated the importance of the connectivity target (5G) for connecting services across sectoral and national boundaries, and of the quantum computing target for facilitating unprecedented developments and findings in complex fields of research (climate change; health; brain science; biology; sustainable energy; materials; etc.) and industrial development (simulation sciences; data analytics; AI; digital twins) (Thomas Lippert, Head of Supercomputing Centre at Forschungszentrum Jülich, at LDD). Industry stakeholders strongly supported the ambition to achieve digital sovereignty by expanding European production capacities through independent research and industry activities, especially regarding semiconductors (Lars Reger, CTO of NXP, at LDD). The importance of edge nodes was also stressed as a new paradigm, enabling the development of new algorithms (e.g. real-time use cases, AI, smart factories) and the deployment of data spaces (Sebastian Ritz, CEO of German Edge Cloud, and María Jesús Almazor, CEO Cyber & Cloud of Telefonica Tech, at LDD).

- *Digital transformation of businesses*

Regarding the digital transformation of businesses, stakeholders responded positively to the focus on SMEs and start-ups in the proposed targets, seeing them as crucial providers of resilience, flexibility and jobs in a healthy European economy. Many stressed that the digital take-up and intensity targets are closely tied to progress in the area of digital skills and infrastructures.

- *Digital public services*

Stakeholders from civil society and business supported the digitisation of public services as a way to better respond to the needs of citizens and companies. Public administrations identified Digital ID solutions, especially when linked across borders, as a main entry point to the widespread use of digital public services.

b) Governance

Opinions on how to achieve the proposed targets varied, but all stakeholders agreed that a successful digital transformation requires close cooperation between EU institutions, national authorities, and the private sector. One Member State emphasized the need to better align EU and national actions (HR at TTE). The governance framework envisaged in the Digital Compass Communication received broad support as a tool to facilitate such cooperation and alignment. Several stakeholders considered it to be both *"lean"* and *"robust"* by building on existing mechanisms and tools. The Commission received strong support for enhancing the

Digital Economy and Society Index (DESI) as a monitoring tool for the Digital Decade, with consistent (LT, CY, EE, NL, SI, PT at DSM SG) but adaptable indicators to facilitate comparisons across time, Member States, and on the international level (LU, FI, DK, DE at DSM SG). Belgium proposed to consider the digital barometers carried out at national/regional levels as a complementary source of information. The EESCC, in its opinion, emphasized the need to monitor European's perceptions of their physical and mental health and safety in the digital environment, as envisioned in the proposed monitoring of the implementation of Digital Principles.

Many Member States stressed that the monitoring, reporting and follow-up mechanism must allow for national approaches rather than imposing a one-size-fits-all approach to achieving the targets (DK, NL, MT at DSM SG). This is reflected in the Digital Compass policy programme, which provides for a cooperative dialogue to identify and undertake targeted actions that account for national specificities and needs.

c) Multi-Country Projects

The relevance of pooling resources and coordinating leadership to build capacity and invest sustainably in digital technology was confirmed by stakeholders from all relevant sectors: "In order to achieve the 2030 goals, it will be necessary to produce a coordinated investment effort to strengthen European technological and digital capacities and to respond to the needs highlighted by the crisis, such as the need to strengthen Europe's semi-conductor production capacities" (FR at DSM SG). Multi-Country Projects were recognized as an excellent mechanism to progress towards these goals in a coordinated way at the European level. Following stakeholder feedback, it will be crucial to ensure that Multi-Country Projects are inclusive and accessible to smaller Member States and SMEs in practice.

In the TTE policy discussions, Member States explicitly supported cooperation through multi-country projects (BG, BE, LV, HR, RO, CY, SK, EL, HU, IT), stressed the role of the Commission in helping Member States invest in multi-country projects (RO), and argued that a quick roll-out of multi-country projects would require understanding the different industrial models of Member States and using this as an advantage (IE).

The desire for a new mechanism to complement or combine existing instruments was expressed most explicitly by industry stakeholders: "*Light-touch approach or process improvements are not enough. There is a need to fully implement Industry 4.0 to unlock further data-driven business models and services. This is a very complex undertaking and requires massive investment*" (Infrastructure Pane at LDD). For example, panelists at the Leading the Digital Decade conference agreed that the mass production of semiconductors in Europe requires the involvement of many market players as well as a strong leadership from the EU. They advocated for an open-source hardware microcontroller/ microprocessor (RISC-V) ecosystem bringing together product offerings, industrial capacities and funding from private and public players. In its Position Paper, Belgium called for specific guidelines on funding models to increase the EU's share in the global production capacity of semiconductors. Besides semiconductor production, stakeholders repeatedly proposed (industrial) data spaces as a priority area for Multi-Country projects, stressing that the EU needs to look at digital technologies not just to improve operations or efficiency, but also to connect ecosystem actors in a broader data economy, with advanced data-driven services and business models (Infrastructure Panel, LDD).

d) Policy Enablers

The RSPG, in its separate opinion, agrees that radio spectrum is a key enabler of the 2030 Digital Decade targets and strongly supports the proposed development of roadmaps to enhance radio spectrum coordination at EU level as well as a support mechanism for spectrum awards.

4.2 Actions to reach targets

Throughout the consultation activities, stakeholders made numerous proposals for priority actions to undertake once the Policy Programme "Path to the Digital Decade" is established. They expressed political appetite for EU and national policies advanced within the framework of the annual governance cycle. They also expressed expectations to link the Policy Programme to recent EU proposals and existing initiatives, and to explain how these will help deliver on the targets. Moreover, the consultations provided useful input on leveraging contributions from the private sector. While proposed actions differed in detail, stakeholders agreed on the importance of creating synergies between national, public and private efforts under EU coordination/leadership, reiterating the core assumption of the Digital Compass Communication that a successful digital transformation must be based on joint commitments. For example, the EESCC, in its opinion, identified *"a need to boost existing public and private cooperation and create more synergies to secure a new Digital Deal based on a governance model that combines social, environmental and economic aspects, to achieve a long-term sustainable, fair, and inclusive digital transition."*

One theme cutting across cardinal points concerns actions to facilitate data sharing and interoperability across national and sectoral borders to progress on digital infrastructure, business and public services targets. This includes the implementation of data spaces (e.g., through MCPs), data standardization (under industrial/public sector leadership), and legal guidance on the sharing of data across the EU.

a) Digital skills

Proposals to progress towards the digital skills targets included initiatives to embed the responsible use of technology in school and university curricula: *"Universities and schools have the responsibility to raise the next generation of Europe's digital experts, but they must also learn to deploy these digital skills in a responsible way"* (Robert-Jan Smits, President of the Executive Board at Eindhoven University, at LDD).

Besides updating educational content to the digital era, the EESC identified the creation of public-private partnerships to implement new and accessible methodologies of education that provide the same opportunity for all as crucial for upskilling and reskilling. AK Europe, in its position paper, recommended to combine investments in the digital infrastructure of schools with free basic education courses for people with formally low qualifications to ensure that no one gets left behind. Moreover, the EESC proposed to promote powerful campaigns in Member States, starting in primary schools, to encourage young girls in scientific and technological disciplines. A broad social dialogue will be necessary to close the gender gap among ICT professionals.

b) Digital infrastructures

Removing existing barriers of the digital single market was identified as a key priority to achieve digital infrastructure targets by stakeholders from both the public and private sector. Many Member States advocated for a strong link with the Industrial Strategy and the Green

Deal. To meet the 5G target, business stakeholders proposed to accelerate Radio Access Network Sharing, i.e. facilitating the capability to share costly equipment with other operators. Furthermore, the EU should foster **open and interoperable solutions at infrastructure level**. To leverage the synergies between 5G networks and edge-cloud infrastructures,*"the EU can be a real trigger for seamless interoperability from one country to another"*, for instance by establishing common requirements for certification (Mari-Noëlle Jégo-Laveissière, Deputy CEO of Orange, at LDD).

The EESC, in its opinion, called for a more favourable regulatory framework that supports private investment in network infrastructure. Regarding the deployment of 5G, In its position paper, Belgium emphasized the need to adequately inform citizens about rollout plans and health impacts.
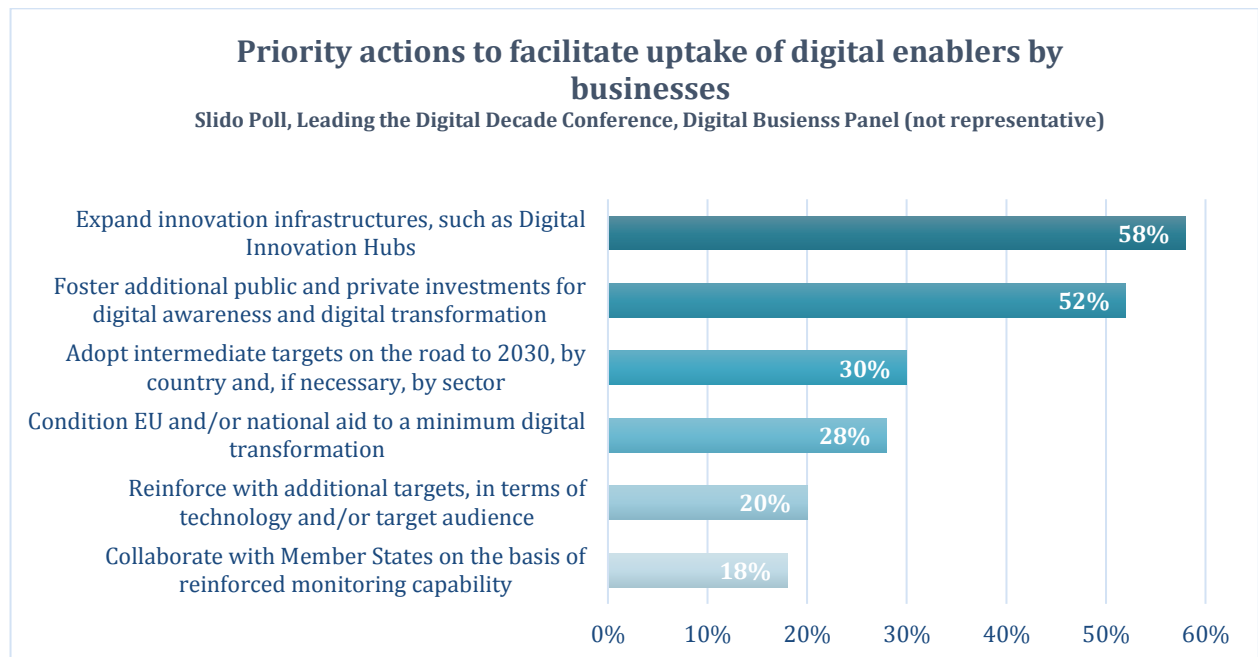
c) Digital businesses

Completing the single market, including for services, was also frequently mentioned in relation to the digital transformation of businesses (DK, EE, CY, SE, PT, LU at DSM SG). Business stakeholders called for "*reinforcement, simplicity and stability of framework conditions*" to facilitate access to the digital single market for SMEs in particular (Business Panel at LDD). Member States saw the Commission's 2021 AI regulation as setting a positive example. Businesses stakeholders wished for similar legal guidance on the sharing of data across the EU, but cautioned that regulations have to draw the right balance in protecting the EU economy and European values, and securing the right incentives to invest and develop EU digital businesses and platforms without stifling competitiveness. There should be no forced data sharing principles or overly constraining rules, including on data flows, that could put European companies at a disadvantage to their American or Chinese counterparts. A data regulatory framework with freely flowing data across the single market was welcomed, and the Data Governance Act was repeatedly elevated as a way to level the playing field in this regard.

Other proposed actions focused on fostering additional public and private investments to increase the digital awareness and transformation of businesses, e.g., through vouchers, loans and tax incentives. In this context, the EIB, at the Leading the Digital Decade Conference, stated that they could support the greater community of investors and innovators with its patient shareholders and higher risk bearing capacity. The EIB also plays a critical role for the digitalization of businesses by providing financial support in the form of capital and intermediate loans to commercial banks for distribution to SMEs. The EESC, in its opinion, highlighted the urgency of achieving a Capital Markets Union, which allows innovative companies to transfer savings between Member States in search of the best return.

Stakeholders described European Digital Innovation Hubs (EDIHs) as one particularly valuable, existing instrument to accelerate the digital transformation of businesses, and called to expand such efforts within the framework of the Digital Compass. EDIHs should focus on aggregating demand and organizing access to finance for SMEs; providing SMEs with the internal capacity, expertise and skills to digitalise and adopt leading digital innovations; and translating digital policies for SMEs to reduce the regulatory burden and ensure compliance. This would require following a cross-sectorial approach that brings together actors from various ecosystems, such as universities and big companies (BE, BG, IE, LV, HU; Leading the Digital Decade, Business Panel). For example, big companies could support SMEs in developing the tools and technology they need to digitalize their business through a digital volunteer mentoring programme.

AK Europe and the EESC, in their respective position paper and opinion, stressed that strategies to advance the digital transformation of businesses must be accompanied by strategies to deal with possible job displacements through upskilling, reskilling and social security funds to ensure a human-centred approach to digital transformation.

Priority actions to facilitate uptake of digital enablers by businesses

Slido Poll, Leading the Digital Decade Conference, Digital Busienss Panel (not representative)

Action	Percentage
Expand innovation infrastructures, such as Digital Innovation Hubs	58%
Foster additional public and private investments for digital awareness and digital transformation	52%
Adopt intermediate targets on the road to 2030, by country and, if necessary, by sector	30%
Condition EU and/or national aid to a minimum digital transformation	28%
Reinforce with additional targets, in terms of technology and/or target audience	20%
Collaborate with Member States on the basis of reinforced monitoring capability	18%

d) Digital public services

Proposed EU actions to facilitate the digitalisation of public services focus on increasing technical, organisational and political interoperability to share data between administrative layers (local, national, regional, and EU layers). Overcoming existing administrative/ procedural silos will require strong political will and EU leadership. It was proposed to focus on creating a European solution that links national digital identities and provides maximum benefits to European citizens. Member States repeatedly expressed their support for the Commission's recent proposal for a framework for a European Digital Identity in this context (TTE). Public sector stakeholders identified a need for actions to build trust between public administrations, between people and administrations, and between public administrations and European industries that can supply the necessary ICT infrastructure and services.

Besides interoperability, stakeholders called for actions to increase the digital literacy of public authorities in general and on cybersecurity in particular. Public administrations called for EU Data Spaces to share cybersecurity target information (LDD). There are expectations that the review of the NIS Directive will enforce mandatory information sharing steps that will provide information and cyber security data to handle incidents in a timely and collaborative manner. Practitioners that applied the current NIS Directive complained that the expectations for applying the NIS Directive all over Europe were not clear and the relevant national security authorities were not supportive enough.

The EESC, in its opinion, called on the Commission to support citizens who cannot yet benefit from such services due to a lack od knowledge, skills, software or hardware. To ensure inclusive access, civil society organisations should be involved in the digitalisation process.

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Prior to achieving interoperability on EU level, Member States must progress with vertical integration (integration of services and processes inside the organisation) and horizontal integration (integration of services and processes across organisations) on the national level.

Moreover, stakeholders agreed that national public administrations should recruit more ICT professionals and strengthen partnerships with academia and the private sector to benefit more from the young academics and entrepreneurs that are working in the GovTech industry (LDD).

ANNEX 2: BASELINE DATA

The below table presents the baseline data for each Member State for those targets, for which data are available.

Member State	At least basic digital skills	ICT specialists	Female ICT specialists	Fixed Very High Capacity Network (VHCN) coverage	5G coverage	SMEs with at least a basic level of digital intensity	Big data	Cloud	AI	Digital public services for citizens	Digital public services for businesses
	% of individuals	Total number	% of ICT specialists	% of households	% of populated areas	% of enterprises	% of enterprises	% of enterprises	% of enterprises	Score (0-100)	Score (0-100)
	Year: 2019	Year: 2020	Year: 2020	Year: 2020	Year: 2020	Year: 2020	Year: 2020	Year: 2020	Year: 2020	Year: 2020	Year: 2020
AT	66%	193,500	20%	39%	50%	63%	9%	20%	37%	88	85
BE	61%	240,800	17%	68%	4%	75%	23%	43%	24%	71	85
BG	29%	103,300	28%	43%	0%	33%	6%	8%	31%	57	87
CY	45%	12,800	18%	26%	0%	49%	6%	22%	not available	66	86
CZ	62%	219,800	10%	33%	0%	59%	9%	20%	40%	71	76
DE	70%	1,947,000	18%	56%	18%	62%	18%	20%	28%	72	88
DK	70%	156,000	22%	94%	80%	88%	27%	57%	22%	84	96
EE	62%	42,400	22%	71%	0%	74%	10%	48%	15%	91	98
EL	51%	79,300	27%	10%	0%	not available	13%	not available	34%	54	54
ES	57%	727,100	20%	92%	13%	62%	9%	22%	22%	82	94
FI	76%	191,500	23%	67%	12%	88%	22%	62%	20%	87	93
FR	57%	1,218,900	20%	53%	0%	55%	22%	21%	19%	73	91
HR	53%	61,400	18%	47%	0%	62%	14%	29%	21%	60	73
HU	49%	170,600	12%	49%	7%	46%	7%	17%	17%	54	76
IE	53%	129,400	21%	83%	30%	66%	23%	41%	14%	86	100
IT	42%	828,000	16%	34%	8%	69%	9%	38%	18%	69	89
LT	56%	44,500	24%	67%	0%	54%	11%	23%	34%	73	96
LU	65%	18,500	20%	95%	0%	64%	19%	23%	32%	90	97
LV	43%	33,000	23%	88%	0%	42%	9%	18%	21%	87	85
MT	56%	11,400	11%	100%	0%	71%	31%	38%	not available	100	95
NL	79%	527,100	18%	90%	80%	75%	27%	47%	24%	86	83
PL	44%	553,900	15%	65%	10%	52%	8%	15%	18%	65	67
PT	52%	190,500	22%	87%	0%	51%	11%	21%	31%	84	86
RO	31%	202,700	26%	76%	12%	33%	5%	13%	31%	44	49
SE	72%	379,700	21%	81%	14%	82%	19%	59%	30%	88	94
SI	55%	42,500	17%	66%	0%	68%	7%	26%	33%	74	78
SK	54%	105,800	16%	50%	0%	52%	6%	18%	15%	64	79
EU	**56%**	**8,431,300**	**19%**	**59%**	**14%**	**60%**	**14%**	**26%**	**25%**	**75**	**84**