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DIRECTORATE FOR SCIENCE, TECHNOLOGY AND INNOVATION
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Working Party on Innovation and Technology Policy

INNOVATION POLICIES IN THE CONTEXT OF DIGITALISATION: AN INTRODUCTION TO THE POLICY CASE STUDIES

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This document discusses innovation policies that have been adopted to support the digital transition. It offers an initial discussion of the rationales of such policies and describes examples of policy strategies and initiatives. The policy coverage is not comprehensive. Delegates are invited to comment and provide information on other policy strategies and initiatives.

Delegates are also invited to propose case studies. These could focus on one of the following three topics: (1) Digitalisation-related innovation policy strategies; (2) The creation of centres or platforms to promote (i) research and innovation in key digital technologies (e.g. Internet of Things, Artificial Intelligence, data analytics, high-performance computing and additive manufacturing) or (ii) digital technology diffusion across the economy, with a focus on SMEs; or (3) Innovation policy initiatives to stimulate (i) or (ii).

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Executive summary

1. Digitalisation is changing innovation processes in multiple ways and, in this context, innovation policy instruments need to be reviewed so as to appropriately respond to the new context. Innovation policies have a key role to play in addressing barriers to the development of competitive digital innovation ecosystems. Functions include promoting digital technology diffusion; addressing barriers that are faced by entrepreneurs; building R&D capacities in cutting-edge digital technologies; and fostering collaborations.

2. Many countries have implemented policy strategies and plans to support digital innovations. Germany, Estonia and France, among others, have placed the digital transformation at the heart of major science, technology and innovation (STI) strategies. *Industry 4.0* or *Smart Industry* plans have been set in many countries (e.g. the *Smart Industry Strategy* in Sweden, the *National Plan Industry 4.0* in Italy). The latter aim to support "strategic sectors" which often relate to manufacturing (e.g. high-tech medical devices, additive manufacturing, new materials, automotive) but in some cases also services sectors (e.g. logistics, creative industries, intelligent mobility).

3. Different policy instruments have been adopted to support businesses (particularly SMEs) in the digital transformation. Examples include the ICT innovation vouchers to help SMEs adopt digital technologies in different European regions; and awareness-raising activities such as the virtual maps which showcase examples of SMEs engaged in Industry 4.0 transformations developed in France, Germany and Japan. Entitites that promote capacity building with regards to technological and organisational competences have also been created (e.g. *Mittlestand 4.0 Competence Centres* in Germany).

4. Moreover, the policy instruments to support innovative entrepreneurship in the context of the digital transformation include early-stage funding provided to digital start-ups (e.g. by the *National Digital Research Centre* in Ireland); funding to innovative R&D projects that are relevant to the digital transformation of industry (e.g. the *Production of the Future Programme* in Austria); and the provision of mentoring and networking opportunities for digital start-ups (e.g. *Start-up Sweden*, *Tech City UK*).

5. In addition, several programmes support interactions among universities, research centres, large firms and SMEs in support of the digital transformation. Such interactions are promoted by 1) the creation of specialised research and innovation centres that connect businesses with research and academic communities (e.g. *Catapult Centres* in the UK; *Manufacturing USA* in the United States), 2) the provision of support for regional "digital" clusters (e.g. *Cluster Intelligent Factories Lombardy*, Italy; *Cap Digital* in Paris, France), and 3) the creation of discussion platforms (e.g. *Plattform Industrie 4.0* in Germany; *Association Industry 4.0* in Austria). Emphasis is often set on fostering interdisciplinary and cross-sectoral collaboration for innovation (e.g. *Smart Industry Fieldlabs* in the Netherlands).

6. Industry has also launched its initiatives. Examples include the platform *Industrial Value Chain* in Japan, which gathers stakehoders to discuss the design of a new industrial structure that combines manufacturing and digital technologies; and the association *Labs Network Industrie 4.0* in Germany, which supports SMEs by providing them access to test centres.

7. Most strategies and policy instruments have been implemented recently and more experimentation is under way. The 2017-18 TIP project aims to help support the identification of suitable policy instruments by providing for a discussion of different practices across countries. This will also build on national case studies. Case studies could, in particular, focus on one of the following three topics: 1) Digitalisation-related innovation policy strategies; 2) The creation of centres or platforms to promote i) research and innovation in key digital technologies (e.g. Internet of Things, Artificial Intelligence, data analytics, high-performance computing and additive manufacturing) or ii) digital technology diffusion across the economy, with a focus on SMEs; or 3) Innovation policy initiatives to stimulate (i) or (ii).

Introduction

8. New digital technologies are transforming innovation in established businesses and industry sectors in multiple ways. They offer opportunities to improve the efficiency of production processes; facilitate access to new customers and suppliers; and enable the creation of new markets and business models. There are also challenges: digital innovations threaten to disrupt established markets and their businesses and alter opportunities for market entry, particularly in a context where platforms are increasingly important. With changing demands on businesses and new opportunities for them to share and communicate with others, businesses are innovating in new ways. This also often requires adding new capabilities, such as software programming skills, to established industry expertise. Perceived threats to competitive advantage may also push firms to explore innovation more intensively.

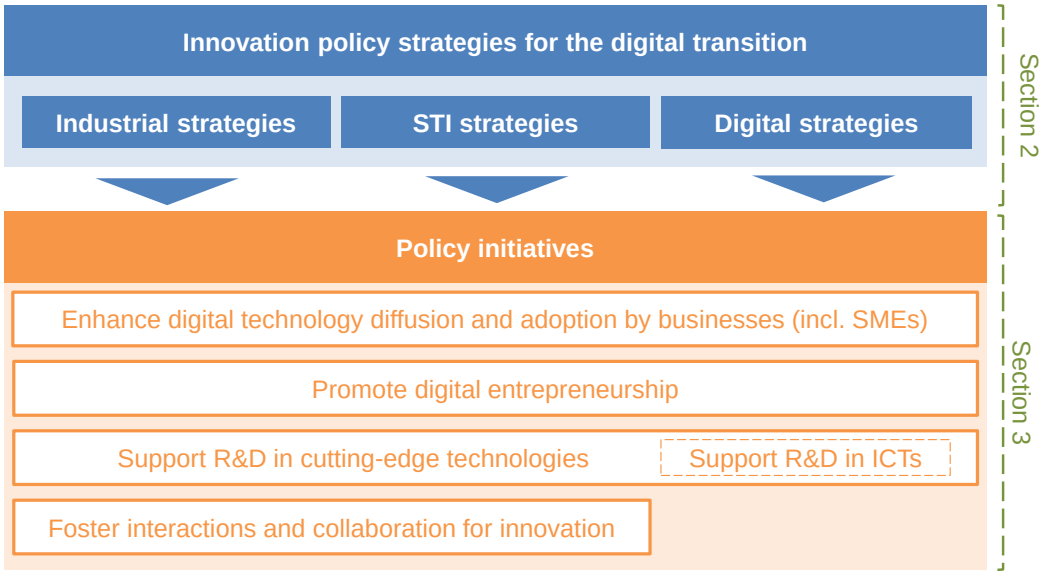
9. The transformation of innovation processes raises a number of questions on the role innovation policies should play in the digital transformation, including notably the following: Are innovation policies developed prior to the digital economy appropriate to supporting a vibrant digital innovation ecosystem? In what ways should they be adjusted to best deal with more rapid change, increased risks and uncertainties, the global nature of markets for innovation and the increased role of platforms? What types of innovation policy instruments are most effective to create a vibrant digital innovation ecosystem, and what instruments work best in what contexts?

10. The objective of this document is to provide initial inputs for the TIP project on Digital and Open innovation [DSTI/STP/TIP(2017)2] by discussing examples of innovation policy approaches adopted across countries to deal with the digital transformation. The document presents innovation policy strategies and plans for the digital transformation and discusses the vision, priorities and general guidelines for action they establish. It also presents a number of initiatives/programmes and policy instruments that have been implemented to i) enhance digital technology diffusion across the economy (with a focus on SMEs); ii) promote innovative entrepreneurship in the context of the digital transformation; and iii) strengthen research and innovation in key sectors and technologies for the digital innovation economy (Figure 1). This document does not give an exhaustive account of policies but offers an initial overview of policy trends to be complemented in future work.

11. This project contributes to the OECD-wide Going Digital project, and particularly to efforts aimed at identifying how digital transformation challenges existing policies and how best these can adjust to serve policy objectives in different areas. It builds on the overarching framework set out by the Going Digital project [see DSTI/CDEP/GD(2017)4].

12. The remainder of the document is structured as follows: Section 1 presents the rationales for implementing innovation policies in the context of digitalisation. Section 2 raises key questions regarding how should innovation policies adjust to the digital transformation. Section 3 identifies general trends and common features of strategic innovation policies for the digital transformation, and section 4 presents specific policy initiatives classified by main objective. Section 5 outlines the scope and focus of the policy case studies to be developed as part of the 2017-18 TIP project on Digital and Open Innovation. Definitions of key terms used in the document to describe the different approaches to digital innovation, such as digitalisation, digital economy and Industry 4.0, are provided in the Annex.

Figure 1. Overview of the innovation policies discussed in the document



1. Rationales for innovation policies in a context of digitalisation

13. Innovation is a key driver of growth: it enhances the productivity and competitiveness of national industries, and boosts job creation and contributes to well-being. Policies to promote innovation have been implemented in response to a number of market failures that may result in less innovation than would be desirable from a societal perspective (OECD, 2015c). Factors leading to less innovation than optimal include:

1. **Capability and resource failures** i.e. insufficient know-how to deploy new technologies or implement organisational changes to adapt to them significally hinder innovation. In the context of digitalisation, disparities in terms of capacities and resources across firms and sectors to adopt new digital technologies may not only reduce the potential of those innovations to foster productivity and growth, but also contribute to increasing gaps in productivity performance across firms and sectors. This may result in a "dual economy", where the innovative, technologically advanced and highly productive sectors coexist with the traditional, low productive sectors that benefit little from new technologies (see Planes-Satorra and Paunov, 2017).

2. **Market failures and imperfections** arising from the fact that private returns of innovation are lower than social returns due to knowledge spillovers that do not allow the inventor to appropriate all benefits from the innovation (although there are mechanisms to reward investments in the creation of knowledge, such as intellectual property rights). Digitalisation may increase knowledge spillovers and lead to lower investments in innovation. However, changes brought by digitalisation may also change the returns of firms for their investments. Other market failures include biases in the markets towards existing technologies (technology lock-ins[1]) and barriers to entry that arise from increasing returns to scale (e.g. due to network effects in the case of digital innovation).

[1] Central to the idea of lock-ins is that it is costly for users to move to another technology once adopted. Consequently, they tend to persist for extended periods, even if superior substitutes are created.

3. **Barriers faced by innovative entrepreneurs**. Innovative entrepreneurs may face barriers to access finance for innovation and to access suitable support infrastructure (e.g. support from research institutions), among others. Lack of sufficient assets to overcome those barriers (e.g. limited resources to build internal research capacities) may hinder the success of innovative entrepreneurs in the context of the digital transformation (IPP, 2017a). The high dynamism and risks associated with the digital economy (where new products may be very successful or fail completely) may add further challenges regarding access to finance for SMEs, as demonstrating the value of new products to providers of finance may be harder.

4. **Absence of enabling conditions for productive investment in innovation**. Inadequate ICT and research infrastructure and regulatory uncertainty are some examples of barriers hampering investments in innovation. For example, the lack of legislation concerning some innovative business models facilitated by digital technologies (e.g. in the sharing economy) may produce uncertainties and consequently limit investments in such innovations.

5. **Lack of co-operation within the innovation system**. Some barriers might prevent the creation of linkages and networks among researchers and innovators in the innovation ecosystem (incl. firms, universities and public research institutes), such as the misalignment in interests and motivations for research and innovation. For example, public researchers may have higher incentives to conduct fundamental research that can be freely diffused, regardless of its commercial potential, and plan activities over long time periods; while private organisations have incentives to focus on applied research and plan activities around short term financial criterial and product development cycles (IPP, 2017b).

14. Innovation policies supporting businesses, public research and science-industry linkages in the context of digitalisation can play a key role in addressing these barriers, particularly by:

- **Promoting digital technology diffusion and adoption by businesses**: New digital technologies are developing quickly and may not diffuse evenly and pose challenges in a period of rapid and frequent change. Small firms, for example, tend to use emerging technologies less frequently than large firms (OECD, 2016c). There are many examples of this. Data for the UK show that in 2014, 21% of smaller firms (10-49 employees) in the country were using cloud computing services, compared to 54% of large firms (250 or more workers) (OECD, 2015a). This is partly explained by the lack of information, skills, expertise, training, resources and confidence to adopt new technologies. Technological lock-ins can also be behind low adoption of more advanced technologies (OECD, 2017a). Innovation policies can play a key role in adderessing those market failures by promoting technology diffusion and helping companies to digitally transform.

- **Facilitating innovative entrepreneurship in the context of the digital transformation**: Innovative entrepreneurship that builds on possibilities of digital technologies is critical not only for competitiveness in this very dynamic economic sector but also to facilitate the adoption of digital technologies (as these firms acquire capabilities that allow adopting digital technologies to the specific national context). Digital start-ups, however, frequently face well-known barriers to establish themselves and grow, for example, with regards of access to finance and research infrastructure. Cumbersome regulatory frameworks affecting the flexibility of businesses to experiment with digital innovations may also hinder gains from digitalisation. Innovation policies are critical for addressing those barriers (OECD, 2015b).

- **Building strong R&D capacities in cutting-edge technologies**: Countries with strong capacities to develop and adopt key emerging digital technologies (e.g. Internet of Things, big data analytics, cloud computing, simulations, additive manufacturing) will be better positioned to take

up the vast opportunities they will offer for industry, and to reap possible benefits from being first to offer technologies in globalised competitive markets. Innovation policies can play a key role in promoting R&D investments and strengthening the capacities in core sectors and technology areas, addressing a number of barriers that may otherwise prevent firms and research institutions to engage in these core investments.

- **Fostering collaborations for innovation:** In the new context, firms rarely have all capabilities to fully develop new technologies on their own (e.g. the automotive industry increasingly relies on innovations in artificial intelligence from outside the industry). The increasing need for multi-disciplinary cooperations and the blurrying lines between sectors make collaboration across companies and between companies and public research actors (both within and across countries) increasingly important. In addition, in a context of rapid technological changes, it is more important than ever that research findings are rapidly translated into innovative goods and services. Innovation policies can set the appropriate frameworks to enhance vibrant innovation ecosystems, encourage science-industry linkages and business-to-business collaborations (also across countries), and facilitate the rapid transformation of innovations from the laboratory to production.

- **Addressing emerging societal challenges**: Innovation faces growing demands to address global challenges, particularly those regarding the environment, health, food security and poverty (OECD, 2016). Digital innovations can contribute to address some of those challenges. For example, some e-health and e-education applications have the potential to increase the welfare of disadvantaged groups (see OECD, 2017b). Innovation policies can provide the appropriate incentives to encourage research and innovation actors to develop digitally-enabled responses to emerging challenges: this requires not only promoting investments but also encouraging collaborations, as responses to complex challenges may only come from mutidisciplinary approaches.

15. In addition, given the increasingly global nature of markets for innovation and of challenges that innovation policies have to address, questions arise regarding the geographical scope of innovation policies: To what extent are the national and regional/local scales the most appropriate to address innovation policy challenges arising in the context of digitalisation? Is international collaboration in innovation policy a possible avenue to explore further?

16. Moreover, for innovation policies to effectively support a vibrant digital innovation ecosystem, these need to be implemented in co-ordination with a wide array of policies that also have effects on growth and welfare. In particular, education and training policies are key to ensure that skills and competences are adapted to the digital transformation. Labour market policies also have a role to play as they shape conditions for firms to recruit workers as well as opportunities for innovative entrepreneurship. Competition policy also has a role to play as it sets the context under which firms in the digital economy compete. Moreover, there is a range of policies that are critical to the digital economy such as privacy and security issues that, while not directly related to innovation, affect the scope for innovation as they determine both trust in the digital economy as well as opportunities to exploit digital information. The OECD-wide Going Digital project will address those wider policy themes and the overall implications for a whole-of-government approach to digitalisation.

2. What are the impacts of digitalisation on innovation policy?

17. Digitalisation is changing innovation processes in multiple ways and consequently affects innovation policies. New business models are emerging, actors in the innovation system are collaborating in new ways and increasingly at a global scale, and innovation cycles are becoming quicker. Given these

and other changes, innovation policies developed prior to the digital economy may not be fully suited to support the digital innovation ecosystem. This raises a fundamental question: how should innovation policies be adjusted in order to foster innovation in the context of the digital transformation?

18. The transition towards a digital economy may require changes in policy approaches. Issues range from reviewing whether application procedures for innovation grants allow support for new core innovation fields; whether procedures are sufficiently rapid and efficient to be relevant to innovators; and whether new instruments should be considered. In addition, innovation policy might focus on such issues as intellectual property rights, both for publicly funded research and business inventions, as market rewards might change with digitalisation, requiring a different strength of IPR.

19. Specific questions to be addressed include the following:

- How can innovation policy best deal with more rapid change, increased risks and uncertainties, the global nature of markets for innovation and the increased role of platforms?
- What challenges does national policy face in the context of an increasingly global innovation context?
- What types of instruments have been put in place by different countries to create vibrant digital innovation ecosystems?
- What types of support tools (grants, cluster and network-building policies, access to finance, etc.) have been adopted to stimulate innovation?
- What measures have been adopted to foster industry-science knowledge diffusion in the context of the digital transformation?
- What role do legal and regulatory changes (IPR, competition, standards, etc.) play in the digital context?
- How can innovation policy promote inclusive growth?
- What is the best way for innovation policies to connect to other policy domains?

20. This document provides an initial overview of policies adopted across OECD countries to respond to the challenges of the digital transformation. The TIP Digital and Open Innovation project (2017-18) aims to address these questions in detail and to provide practical policy recommendations. Country policy case studies will provide the basis for the analysis and policy discussions (see section 5 for more details on the scope of the case studies).

3. Innovation policy strategies for the digital transformation

3.1. Science, technology and innovation (STI) strategies and plans

21. OECD countries have one or more strategies for science, technology and innovation (STI) (OECD, 2016a), i.e. plans setting the vision, priorities and general guidelines for action. These STI strategies put emphasis on promoting business innovation and innovative entrepreneurship and some of them focus explicitly on ICTs. Some strategies also place digitalisation at the heart of their strategic orientation (as for example Germany, France and Estonia, discussed below). Industrial policy initiatives that discuss the digital transformation have also been recently included as part of some STI strategies, often

focusing on manufacturing; in some cases, these policies are sector- and/or technology-oriented (see section 3.2 on industrial policies for more details).

22. Examples of STI strategies that place digitalisation-related objectives at the core of their strategic orientations include:

- The *New High Tech Strategy* in Germany establishes priorities for research and innovation, and the "digital economy and society" is the first of those priorities. The strategy supports science and industry in implementing *Industry 4.0*, as the successful development and integration of digital technologies within industrial application sectors is considered key for the country's future competitiveness (see *Plattform Industrie 4.0* initiative in section 4.3.4). Other areas of support are smart services, big data applications (particularly focusing on SMEs), cloud computing, digital networks, digital science, digital education, and digital life environments (Federal Ministry of Education and Research, 2017).

- In *France Europe 2020: A strategic Agenda for Research, Technology Transfer and Innovation*, research is placed at the centre of France's policy priorities. Research (including basic research) is viewed as key to address the main emerging scientific, tecnological, economic and social challenges and to foster competitiveness. Main priorities include strengthening research in breakthrough technologies and investing in digital training and infrastructures (Ministère de l'Education nationale, de l'Enseignement supérieur et de la Recherche, 2013).

- The main objective of the *Estonian Research and Development and Innovation Strategy 2014-2020 "Knowledge-based Estonia"* is to increase the knowledge-intensity and competitiveness of the economy. Information and communication technologies (ICT) (e.g. the use of ICT in industry, cybersecurity, software development) are identified as one of three key priority areas for investment in research, development and innovation (RDI); the other two are resource efficiency and health technologies and services (Ministry of Education and Research, 2014).

- Slovenia's Smart Specialisation Strategy includes *Industry 4.0* as one of the three key priority areas for action. It particularly refers to the need of optimising and digitalising production processes and the application of a range of enabling technologies (e.g. robotics, nanotechnologies, modern production technologies for materials) in specific priority areas (e.g. smart buildings, circular economy, mobility) (Government Office for Development and European Cohesion Policy, 2017).

3.2. Industrial policy strategies and plans

23. Some countries have developed industrial policies[2] (as part of STI strategies or as strategies on their own) providing support for business innovation, sometimes focusing on specific technology areas or sectors (often but not exclusively in manufacturing) (OECD, 2016b). Concerns about the decaying capacity of manufacturing sectors to remain a source of growth as well as prospects for the advent of a *fourth industrial revolution* as a result of emerging technology breakthroughs are behind this renewed interest in industrial policy (OECD, 2017a).

[2] Industrial policies are defined as "any type of intervention or government policy that attempts to improve the business environment or to alter the structure of economic activity toward sectors, technologies or tasks that are expected to offer better prospects for economic growth or societal welfare that would occur in the absence of such intervention" (Warwick, 2013)

24. Industrial policies are being implemented to ensure that national economies develop competitive advantages in emerging sectors and that domestic firms can (continue to) perform high-value added activities in value chains. These policies often have some of the following characteristics: 1) support the development of cutting-edge technologies (particularly at the upstream stage of development); 2) provide innovators with applied research centres and demonstration facilities (e.g. test beds, pilot lines and factory demonstrators) with the objectives of facilitating the transition of innovations from the laboratory to production; and 3) promote interaction and cooperation among different innovation actors (e.g. universities, research centres, large firms and SMEs), with a focus on inter-disciplinary and cross-sectoral collaborations for innovation. More generally, these strategies also aim at improving framework conditions for innovation, including by addressing barriers faced by innovative entrepreneurs (OECD, 2016a; OECD, 2016b).

25. Digital innovation and the adoption of new technologies by industry (particularly traditional sectors and SMEs) are often at the core of these initiatives. Relevant examples of policies in this context include the following:

- The *Plan Marshall 4.0* is the industrial policy strategy implemented in Wallonia (Belgium) to promote innovation-driven economic development in a context of digitalisation. It has five axes, one of which is to support digital innovation. To that end, a plan for a transition to the digital economy has been developed: *Made Different Digital Wallonia*. It has five pillars: 1) supporting the digital sector and its internationalisation (e.g. by stimulating growth of digital start-ups and facilitating their access to finance); 2) promoting the modernisation of the production system and help all firms in the transition (e.g. through awareness, diagnostics and support to companies, and by implementing regulatory, fiscal and operational tools facilitating e-commerce); 3) accelerating the digitalisation and openess of public services; 4) ensuring a connected territory to boost its attractiveness and competitiveness and encourage a wide-spread use of cutting-edge digital tools; and 5) enhancing the development of digital skills (Digital Wallonia, 2017).

- The *National Plan Industria 4.0* is Italy's industrial policy strategy and has three main pillars: 1) promoting private investments in Industry 4.0 and in research and innovation, namely in the areas of advanced manufacturing solutions, additive manufacturing, augmented reality, simulation, horizontal and vertigal integration, industrial Internet, cloud, cybersecurity, and big data and analytics; 2) strengthening skills for the digital economy; and 3) generating interest on Industry 4.0 opportunities and create the public-private governance (Ministero dello Sviluppo Economico, 2017).

- Japan's *Robot Strategy* aims to expand the use of advanced robotics across Japanese industry, for the "realisation of a new industrial revolution driven by robots". It has three main pillars: 1) enhancing innovation in robotics by investing in infrastructure and human resources; 2) increasing the use and diffusion of robots across all sectors of the economy and all firms (including the smallest); and 3) participate in the establishment of global standards and safety rules in the field of robotics (e.g. standards for safety of personal care robots) (Ministry of Economy and Trade, 2015).

- Spain's *Connected Industry 4.0* strategy has four pillars: () ensure knowledge and skills development for Industry 4.0, mainly through awareness raising activities and training; 2) foster multidisciplinary collaboration, by facilitating the creation of collaborative environments and platforms; 3) encourage the development of digital enablers by providing support to technology companies; and 4) promote the adoption of digital technologies by industry, particularly SMEs, by providing funding for digitalisation projects and advice (Ministerio de Economía, Industria y Competitividad, 2017).

- The main objective of Sweden's *Smart Industry strategy* is to improve companies' capacity of adjusting to the rapid transformation in which the Swedish industrial sector is currently involved in the context of digitalisation and globalisation. To that end, it focuses on four areas, including among them exploiting the potential of digitalisation (Industry 4.0).[3] As part of this first focus area (Industry 4.0), the strategy points towards the need to stimulate the development, spread and use of the digital technologies that have the greatest potential to lead the industrial sector's transformation; exploit the potential of digitalisation broadly, irrespective of industry, company size and geographical location; encourage new business and organisational models in order to tap the potential of the new technologies; meet new knowledge requirements that are brought about by digital development; and adapt framework conditions and infrastructure to the digital era (Government Offices of Sweden, 2016).

26. Some countries have implemented initiatives focused on specific sectors or technologies. Examples include the following:

- In China, the strategy *Made in China 2025* aims to transform and upgrade the Chinese manufacturing system by enhancing innovation, product quality, environmental sustainability, and the development of human resources. The initiative focuses on 10 key technology areas: new generation information technology, computerised machines and robots; aerospace and aeronautical equipment; maritime equipment and high-tech shipping; advanced railway transportation equipment; new energy and energy-saving vehicles; energy equipment; agricultural machines; new materials and biopharma; and high-tech medical devices (OECD, 2017a). Among other measures, it has the objective of developing innovation centres following the example of the US' *National Network for Manufacturing Innovation* (see section 4.3.1).

- France's strategy *New Industrial France* aims to modernise the country's production system and provide support for manufacturers as digitalisation transforms their business models, organisations and the way they design and market their products. The programme has five pillars: 1) developing cutting-edge technologies to ensure that France remains competitive in emerging sectors and ensuring that those technologies are available across the economy; 2) helping companies (particularly SMEs) adapt to the new paradigm by providing customised support; 3) training employees to perform new tasks and jobs; 4) providing visibility to innovative French technical solutions both in France and abroad; and 5) strengthening European and international cooperation to support joint technological and training efforts. The New Industrial France programme is based on 9 industrial solutions that provide responses to key economic and social challenges. These are data economy, smart objects, digital trust, smart food production, new resources, sustainable cities, eco-mobility, medicine of the future and transport of tomorrow (Ministère de l'Économie et des Finances, 2017).

3.3. Digital strategies and plans

27. STI strategies and plans with a focus on the digital transformation often complement national digital strategies. These are discussed in the forthcoming Digital Economy Outlook. The background report to the 2016 Ministerial Meeting on the Digital Economy (OECD 2016b) points that, beyond traditional ICT supply-side objectives (e.g. development of ICT infrastructure, improving access to broadband,

[3] The other 3 objectives are less specific to digitalisation and include: 1) improving the industrial sector's capacity for sustainable and resource-efficient production (including by exploiting the potential of new digital technologies for the transition to a fossil-free and circular economy); 2) ensuring the supply of appropriate skills to the industrial sector (including those required for the transition to a digitalised economy); and 3) creating an attractive innovation environment.

promoting the ICT sector, etc.), these strategies also put emphasis on demand-side objectives, such as promoting: 1) the adoption of ICTs by businesses, particularly among SMEs and firms in traditional sectors; 2) innovative entrepreneurship in digital sectors; and 3) the expansion of digital skills and competences (both basic and specialised) to all social groups as key for social inclusion and adaptation to new labour market demands. While these are closely linked with innovation policy objectives, the approach taken differs: digital strategies' main aim is to maximise the social and economic potential of ICTs, as a means of spurring innovation and growth; while innovation policies focus on fostering innovation, also in the context of digitalisation.

28. Examples of digital strategies include the following:

- *Digital Belgium*: Promoting the digital economy is one of the five pillars of this action plan. Different intiatives are envisaged, including a start-up plan offering tax shelter for start-ups and fiscal incentives for crowdfunding; and the implementation of innovation-friendly legislation so that innovative business models facilitated by digital technologies (e.g. in the sharing economy) can operate in a legally stable framework. The other four pillars refer to investing in digital infrastructure, strengthening digital confidence and security, promoting digital skills and jobs, and digital government (Digital Belgium, 2017).

- Ireland's *Doing more with Digital: National Digital Strategy for Ireland – Phase 1* focuses on promoting digital engagement by implementing measures in four key areas: support trading online and digital entrepreneurship; use ICTs to its full potential across the education system; increase the number of Internet users; and improve the delivery of governmental services online (e-goverment) (Department of Communications, Energy and Natural Resources, 2013).

- ICT for Everyone – A Digital Agenda for Sweden aims to make Sweden become "the best in the World exploiting the opportunities of digitalisation". It identifies the need for efforts in four strategic areas: making the Internet and other digital services easy and safe to use; promote the development of digital services that create benefit; develop digital infrastructure; and strengthen the role of ICT for societal development (Government Offices of Sweden, 2011).

- The recently developed UK Digital Strategy 2017 has seven pillars: building world-class digital infrastructure; giving everyone access to the digital skills they need; making the UK an attractive place to start and grow digital businesses; helping businesses adopt digital technologies; strengthening cybersecurity; further developing e-government; and unlocking the opportunities provided by data and improving public confidence on its use (Department for Culture, Media and Sport, 2017).

29. Some countries, such as the Russian Federation and the USA, do not have an overarching national digital strategy, but have implemented strategies and policies focused on specific issues or sectors (OECD, 2016b).

4. Specific innovation policy initiatives

30. Countries have introduced specific initatives to ensure a successful transition of their innovation ecosystem to a digital economy. As illustrated in Figure 1, these often have one of the following objectives: 1) enhancing digital technology diffusion (with a focus on SMEs) (section 4.1); 2) promoting innovative entrepreneurship in the context of the digital transformation (section 4.2); and/or 3) fostering research and innovation in key digital sectors and technologies (section 4.3). Other key objectives of initatives that are not analysed in detail in this document include promoting investments in digital skills and competences, as well as establishing favourable general framework conditions for innovation.

31. A trend worth highlighting is that some of these initatives have not been initiated by governments but by industry actors, sometimes jointly with academia. This is particularly the case of platforms and some cluster initiatives (see section 4.3).

4.1. Enhancing digital technology diffusion for innovation

32. Several countries have implemented specific initiatives to support SMEs adjust to the digital transformation. According to the background report to the 2016 Ministerial Meeting on the Digital Economy, most of these initiatives focus on: 1) Awareness raising and training; 2) Providing financial support; and 3) Enhancing networking opportunities (OECD, 2016b). Examples include the following:

- France, Germany and Japan have developed virtual maps that allow identifying examples of domestic SMEs in different sectors that are engaged in an "industry 4.0" transformation. SMEs can search for cases by geographical area and size, among others. These virtual maps aim at raising awareness about opportunities offered by the digital transition to SMEs, and provide information about the challenges faced by those initiatives and how they were faced.

- *Mittlestand 4.0 Competence Centres* in Germany promote greater use of ICTs and eBusiness among SMEs. They focus on raising awareness on the opportunities and challenges of digital technologies for firms, strengthening their technological and organisational competences, and providing them with opportunities for demonstrations and testing, among others (OECD, 2016b). In addition to this initiative, some companies related to the *Plattform Industrie 4.0* in cooperation with three business associations[4] have created the association *Labs Network Industrie 4.0* that aims to support German SMEs by providing them access to test centres, where they can test their new technologies, innovations and business models and review them prior to their market launch. They also facilitate the process of standardisation of validated results (Labs Network Industrie 4.0, 2017).

- Some countries have implemented innovation vouchers to help SMEs innovate through the uptake of ICTs. For example, the *trading online voucher scheme* in Ireland assists SMEs in developing their e-commerce capability to trade online, by providing them with up to EUR 2 500 that have to be matched by own funding (Department of Communications, Climate Action and Environment, 2017). Some European regions have also implemented *ICT Innovation Voucher programmes* targeted at SMEs and funded by the EU Structural Funds; vouchers cover ICT services (e.g. ICT design and development, e-Commerce, e-skills, business solutions services, new ICT-based business models) offered by accredited providers (European Commission, 2017).

- *Digilyft* in Sweden is a pilot initiative to bring more industrial and industry-related service companies to use digital technologies. It gives companies the opportunity to learn from others about the challenges and opportunities that digitization brings. Companies are also provided with coaching and advice to implement digitization projects in their own company (Tillväxtverket, 2017a).

4.2. Promoting innovative entrepreneurship in the context of the digital transition

33. The competitiveness of economies in the new digital context may be supported by having a number of firms that strongly exploit the potential of digital technologies. Some countries have already

[4] BITKOM (Germany Digital Association), VDMA (German Engineering and Plant Engineering Association) and ZVEI (German Electrical and Electronic Manufacturer's Association).

implemented specific programmes to promote digital entrepreneurship and support digital start-ups (i.e. firms that introduce a new digital product, product add-on or service to the market) (see also Box 1):

- The *National Digital Research Centre* (NDRC) in Ireland[5] is an early stage investor in tech companies. It provides the people, time, space and investment needed at the earliest stages of company creation. It invests primarily using an accelerator model, providing modest amounts of capital combined with substantial business development support to early stage companies. They have different initatives for different types of start-up, that in all cases provide investment and business support and mentoring (NDRC, 2017).

  - NDRC LaunchPad is a digital accelerator that provides teams at the early stages of developing a business proposition of global scale with investment, business support and mentoring to tranform ideas into commercially viable start-ups.

  - NDRC VentureLab provides science-based start-ups that have a strong IP proposition with investment, training and mentoring programme to be able to attract follow-on investments.

  - NDRC Catalyser targets start-ups and founder teams with deep research-based expertise and technology that address significant global unmet market needs or problems.

- In Korea, 17 *Creative Economy and Innovation Centres* have been created across the country to support innovative start-ups and SMEs. They particularly focus on the fields of the Internet of Things (IoT), biotech, 5G, cloud computing, big data and artificial intelligence (AI). These centres provide firms with financial support, opportunities for collaborating with big enterprises, advisory services for implementing managerial and technological innovation, and support for accessing new markets (Ministry of Science, ICT and Future Planning, 2017).

- The programme *Start-up Sweden* organises week-long boot camps (i.e. a gathering of entrepreneurs in a specific site allowing them to be exposed and learn from each other) targeted at Sweden's most promising digital start-ups. Ten companies are selected to participate in each edition of the bootcamp, providing them with the opportunity to expand their networks with other companies, investors, potential customers and partners. During the week, they are encouraged to share experiences, they receive practical advice in business development by other start-ups and experts in various fields, and get to practice their sales pitch with coaches and sales pitch experts. Start-ups also have the chance to meet private and public investors in the Sweden Demo Day, where they present small exhibits and pitch for 1 minute in front of investors (Tillväxtverket, 2017b).

- *Tech City UK* helps digital entrepreneurs at different stages of the lifecycle of their digital business through various programmes, including the provision of expert courses, networking opportunities as well as mentoring support for scaling up digital technology companies. Tech City was first launched to support East London tech cluster, and has expanded to support Greater London and other major cities around the UK. Tech North is a specific initiative to attract and develop talent, entrepreneurship and investment across the digital clusters of Hull, Leeds, Liverpool, Manchester, Newcastle, Sheffield and Sunderland as well as areas in-between (Tech City UK, 2017).

5 The National Digital Research Centre (NDRC) was established in 2007 by University College Dublin, Trinity College Dublin, Dublin City University, Dún Laoghaire Institute of Art, Design and Technology & National Collegue of Art and Design. It is supported by the Department of Communications, Climate Action and Environment.

Box 1. EU programmes to support digital SMEs and start-ups

Several programmes have been implemented at EU level to support high-tech and innovative digital SMEs as well as start-ups and promote the diffusion of digital technologies to the wider group of SMEs. These initiatives are summarised in the table below:

Programme	Objective
ICT for Manufacturing SMEs (I4MS)	Promote the development and adoption of ICT innovations so as to modernise Europe's manufacturing capabilities. It targets SMEs that are either suppliers of high-tech or early adopters of new technologies. SMEs may benefit from: direct financial support to improve their products or manufacturing processes; acquiring new technologies and knowledge; accessing new markets and partners outside their local ecosystem.
Smart Anything Everywhere Initiative (SAE)	Support innovation through digital technologies by fostering collaboration among researchers, large firms and SMEs facilitated by Europe's network of competence centers. The objective is to transfer knowledge and resources across the economy.
iHub (the Internet innovation hub)	Contribute to the production and development of Internet technologies by providing business development and training services to companies.
Open Data Incubator Europe (ODINE)	Incubator for businesses that exploit business opportunities offered by commercial exploitaition of open data to help them fast-track the development of their products.
European Institute of Innovation and Technology (EIT)	Boost innovation capacities and foster entrepreneurship by bringing together businesses, education and research institutions to form dynamic cross-border partnerships: the Knowledge and Innovation Communities (KICs). KICs develop innovative products and services; start new companies; and train new entrepreneurs.
European Coordination Hub for Open Robotics Development (ECHORD++)	Promote development of innovative robotics technologies to meet industry demands, find new applications for such technologies, and increase access to expertise.
Access Center for Photonics Innovation Solutions and Technology Support (ACTPHAST)	Support photonics innovation by European companies (particularly SMEs) by facilitating access to expertise and research facilities, financing research undertaken by SMEs and implementing outreach activities.
Supercomputing Expertise for SME network (SESAME NET)	Network of centres to facilitate access by industry (in particular SMEs) to High Performance Computing (HPC)* expertise, so as to help them face technical challenges and expand their knowledge and understanding of the potential and benefits of HPC. They also disseminate best practice in HPC industrial use.

Note: * High-performance computing (HPC) is the use of super computers and parallel processing techniques for solving complex computational problems. High-performance computing is typically used for solving advanced problems and performing research activities through computer modeling, simulation and analysis.

Source: European Commission

4.3. Fostering research and innovation in key emerging technologies and sectors

34. Countries with strong capacities to develop and adopt cutting-edge digital technologies will be better positioned to have a successful transition to a digital economy. While there is some consensus internationally regarding the identification of key emerging (including digital) technologies (e.g. Internet

of Things, Artificial Intelligence, additive manufacturing), research priorities vary across countries depending on their research and industrial strenghts. Research domains are also increasingly multidisciplinary and in constant evolution. In addition, it is the combination and integration (also called 'convergence') of different technologies that is likely to enable the development of new applications (OECD, 2017a). This makes it challenging for policy makers to define specific priority research domains.

35. In this context, there is an increasing policy trend in promoting interactions among different actors in the innovation and research ecosystems (i.e. universities, research centres, large firms and SMEs, government). Such interactions are fostered in different ways, including through the creation of specialised research and innovation centres where companies partner with the research and academic communities, the promotion of regional clusters, as well as the establishment of platforms or forums for discussion. These initiatives highlight the importance of interdisciplinary and cross-sectoral collaboration for innovation.

4.3.1. Creation of specialised research and innovation centres

36. Some policy initiatives consist on the creation of (networks of) research centres where public researchers and businesses work together to address specific technology challenges and foster innovation. Sometimes these centres are located within the premises of higher education and public research institutions. These centers thus promote an effective use of multi-disciplinary competences and research infrastructures, and facilitate the development of new products and services. Examples include the following:

- *Catapult Centres* in the UK are a network of not-for-profit, independent physical centres which connect businesses with the UK's research and academic communities. Each of them focuses on a strategic technology area in which the UK has great potential for growth. They offer a space with the facilities and expertise to enable businesses and researchers to collaboratively solve key problems and develop new products and services on a commercial scale. They support businesses to access foreign markets, create and retain high value jobs and attract inward investments from global technology businesses.

  There are currently nine catapult centres aimed to increase the UK's capability for innovation in specific industry areas (Cell and Gene Therapy, Compound Semiconductor Applications, Digital, Energy Systems, Offshore Renewable Energy, Future Cities, High Value Manufacturing, Medicines Discovery, Precision Medicine, Satellite Applications, Transport Systems). The Digital Catapult in particular aims to make UK businesses more competitive by stimulating digital innovation. It currently focuses on digital manufacturing and creative industries, and is exploring opportunities in the digital health and care sectors. It focuses on a range of technologies, including the Internet of Things, Artificial Intelligence and virtual and augmented reality technologies (Catapult, 2017).

- Also in the UK, the *EPSCR[6] Manufacturing the Future* supports basic manufacturing research to the stage where applications can be developed by companies or agencies such as Innovate UK and the Catapult network. Research covers underpinning science, simulation and design, production, fabrication, systems and services. Priorities are in four themes: 21st century products; digital manufacturing; sustainable industries; and new industrial systems (EPSCR, 2017).

- The *Manufacturing USA*, formerly known as the National Network for Manufacturing Innovation programme, consists on the establishment of manufacturing innovation institutes across the USA. Within each institute, manufacturers of all sizes partner with academia and government to share

6 EPSRC stands for Engineering and Physical Sciences Research Council

and solve industry-relevant advanced manufacturing technology and workforce challenges, and to build a robust, sustainable national manufacturing R&D infrastructure, so as to enhance industrial competitiveness and economic growth. Each institute has a unique technological concentration and is designed to be a public-private membership organization that provides vision, leadership, and resources to its members. Industry, academia, and government partners are leveraging existing resources, collaborating, and co-investing to nurture manufacturing innovation and accelerate commercialisation (AMNPO, 2017).

- Denmark's *MADE Digital* [7] programme brings research institutions, advanced technology groups and companies from different industrial segments together in a collaboration to develop and implement digital solutions, tailored to the specific needs of Danish manufacturing companies. Innovation Fund Denmark supports this initiative, and from 2017 to 2019 MADE Digital will launch 30 digital research projects in areas in need of new solutions. The aim of the project is to provide new knowledge through research and help large-scale companies and SMEs to implement the digital solutions. Some projects are specifically targeted at SMEs (MADE, 2017).

- *Flanders Make* in Flanders (Belgium) is a research centre for the manufacturing industry. It collaborates with research labs at all Flemish universities, and has been created to support both SMEs and large manufacturing companies with industry-driven, pre-competitive research in four technology domains (power electronics & energy storage, mechatronics & design methods, production processes and people-driven system development) so as to lead to product and process innovations in three fields (vehicles, machines and factories) (Flanders Make, 2017).

- *Smart Industry Fieldlabs* have been created in the Netherlands. These are physical and digital spaces for companies and research institutions to develop, test and implement new Smart Industry technological solutions (e.g. in the fields of automation, zero defect manufacturing, flexible production, chain collaboration, customer intimacy, value creation based on big data and on a number of core technologies such as 3D printing and robotics). Field Labs ensure an interdisciplinary approach (e.g. manufacturing in combination with ICT) and link research to domains where the Netherlands has specific strengths (Smart Industry, 2017).

4.3.2. Enhance private investment in research and innovation for the digital transition

37. Examples of specific programmes that aim at fostering private investment in R&D to significantly boost digital innovation capacities include the following:

- In Austria, the *Production of the Future Programme* provides funding for innovative R&D projects relevant to the manufacturing industries. The goal is to support the creation of competitive products so as to spur national productivity (Austrian Research Promotion Agency, 2017).

- In Finland, *Tekes' Industrial Internet Growth programme* [8] funds projects in which Internet of Things and Big Data are used to develop new services and business models. It aims to renew the business operations of companies through the Industrial Internet. Tekes is also implementing the 5thGear programme, which funds projects that aim to solve challenges related to the next generation wireless data communications (Tekes, 2017).

[7] MADE stands for Manufacturing Academy of Denmark.

[8] Tekes is the Finish Funding Agency for Innovation.

- As part of the *National Plan Industria 4.0*, Italy has implemented measures aimed at promoting innovative investments. This includes 30% tax deductions for investments of up to EUR 1 million in innovative start ups and SMEs; reduction of capital gain taxes in case of medium and long term investments on innovative SMEs; and a business accelerator programme to finance the estalishment and growth of new companies focused on industry 4.0 technologies (Ministero dello Sviluppo Economico, 2017).

- The *Advanced Manufacturing Supply Chain Initiative* (AMSCI) in the UK is a competitive fund that provides loans and grants for capital investment, research and development expenditure and training for industrial projects to create globally competitive supply chains in sectors such as aerospace, automotive chemicals and low carbon. It is designed to promote collaborations within supply chains, including projects involving the re-shoring of manufacturing operations to the UK (European Commission, 2016).

4.3.3. Cluster policies

38. Several initiatives also take a territorial approach. Their objective is to bring together different regional actors in a specific manufacturing sector / technology area and promote partnerships for research and innovation, to enhance their competitiveness and become leaders in the sectors at the national and international scales (see also DSTI/STP/TIP(2017)4). Examples include:

- *It's OWL* is a technology and innovation platform created to ensure growth and employment in the region of Ostwestfalen-Lippe (Germany) by placing it at the forefront of global competition in the field of intelligent technical systems. The region has a strong industry base in the fields of mechanical engineering, automotive and energy technologies; and universities are known for cutting-edge interdisciplinary research in the fields of self-optimisation, cognition and industrial automation. The technology platform gathers 25 core companies with innovation projects, 6 universities, 18 research institutes and more than 100 associated companies and 30 economy-oriented institutions (It's OWL Clustermanagement, 2016). The platform places emphasis on ensuring technology transfer, particularly to SMEs (It's OWL Clustermanagement, 2017).

- *Cluster Intelligent Factories Lombardy* aims to promote and facilitate research and innovation for the manufacturing sector in the region of Lombardia (Italy), by connecting and favouring cooperation among companies, universities, and research institutions. It also supports the development of extra-regional networks (within Italy but also across European regions) (Associazione Fabbrica Intelligente Lombardia, 2014).

- Dublin's *Digital Hub* is the largest cluster of digital media, technology and Internet businesses in Ireland. It provides flexible office space and business support services to growing technology companies, and is involved in providing digital-related learning and training opportunities geared to the local community (Digital Hub, 2017).

- The French Cluster for Digital Transformation (*Cap Digital*) in Paris gathers innovative SMEs, research and higher education institutions and firms in digital industries. It fosters links and collaborative research among them, and provides members with training and funding for R&D projects, among others. It is part of the French cluster policy *Pôles de Compétitivité* (Cap Digital, 2017).

- Korea's *Creative Economy and Innovation Centres*, presented in section 4.2, also take a territorial approach: through their centres located in different regions, they aim at simultaneously supporting innovative entrepreneurship in the context of the digital transition and fostering

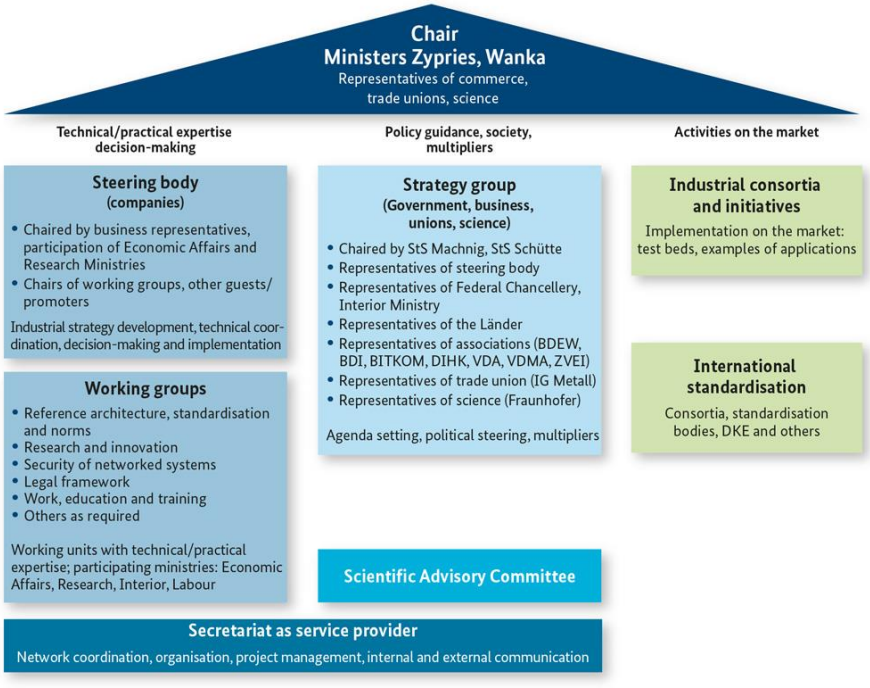
regional development (i.e. reducing gaps in innovation capacities across regions) (Ministry of Science, ICT and Future Planning, 2017).

4.3.4. Platforms and forums

39. Many countries have implemented initiatives to enable different actors in the economy to share knowledge and collaboratively design frameworks aimed at addressing the challenges faced by companies, research institutions and society as a whole in the context of the digital transition. Some examples include the following:

- The *Plattform Industrie 4.0* in Germany gathers business representatives, policy makers and experts from science, associations and trade unions, and provides support for the coordinated and organised transition to the digital economy (Figure 2). The platform aims to identify all relevant trends and developments in the manufacturing sector and to combine them to produce a common overall understanding of *Industrie 4.0* and provide policy recommendations. The platform's technical work is carried out in thematic working groups. The working groups develop specific recommendations for action that should ensure a competitive advantage for all partners in Germany. The working group on research and innovation identifies the research necessary to advance Industrie 4.0 in Germany. The platform does not realise activities in the market (such as demonstration centres, research projects or company-led projects) but it proactively supports them (Federal Ministry for Economic Affairs and Energy, 2017).

Figure 2. Structure of Plattform Industrie 4.0, Germany



Source: Federal Ministry for Economic Affairs and Energy (2017).

- The *Association Industry 4.0 Austria* is a platform that aims to foster collaboration among all stakeholders (industry, science, regional and national policy makers, associations, trade unions and NGOs) and facilitate new technological developments and innovations in the context of digitization, and to find sustainable solutions to challenges faced by different actors. In particular, its mission includes: to leverage interests between actors; to accompany the processes of change

driven by digitalisation; to provide knowledge and services on Industry 4.0 to companies, academia, RTOs and to the general public; to define fields of action and to advise policy makers; to develop joint strategies with high leverage on Industry 4.0; to launch initiatives to steer regional, national and international activities; and to enable the exchange of experience, best practices, data and studies. As in the case of Germany, the Platform is organised around 7 Working Groups (Plattform Industrie 4.0, 2016).

- Japan's *Industrial Value Chain Initiative*, initiated and led by industry, is a forum that brings together professionals with knowledge about industrial production processes from different industries and members from academia to discuss how to design a new industrial structure that combines manufacturing and information technologies. The work of this forum is organised around Business Scenario Workgroups and 8 platform workgroups (Industrial Value Chain Initiative, 2017).

- The *Intelligent Factories Cluster* in Italy gathers industry representatives (both from large enterprises and SMEs), representatives of universities and private and public research bodies, as well as other organisations (e.g. trade unions, NGOs, entrepreneurial associations). The cluster's mission is to develop and implement a strategy based on research and innovation, able to orient the transformation of the Italian manufacturing sector towards new product, services, processes and technologies; create a stable and more competitive national manufacturing community; and connect national and regional research policies with international ones, with the aim of improving enterprises' and regions' possibilities of using European research funds. One of the main activities of the cluster is to support the development of applied research projects. For example, the four ongoing projects focus on sustainable manufacturing, adaptive manufacturing, smart manufacturing and high-performance manufacturing (Cluster Fabbrica Intelligente, 2014).

4.3.4. Initiatives to foster research and innovation in Artificial Intelligence

40. Some countries have developed or are working to develop policies to maximize the economic and societal benefits of Artificial Intelligence (AI). They do so by investing in basic and applied research in AI fields and supporting pilot projects in real-word settings, among others. Some examples include the following:

- In the USA, the *Robust Intelligence (RI) programme* of the National Science Foundation provides funding for fundamental research in artificial intelligence and related areas at US academic and research institutions. The programme encourages synergies among different research traditions (incl. artificial intelligence, computer vision, human language research, robotics, machine learning, computational neuroscience, cognitive science) as the way of advancing the frontiers of all those research areas (National Science Foundation, 2017). At the strategic level, the *National Artificial Intelligence Research and Development Strategic Plan*, released in October 2016, sets a range of priorities for federally-funded research, including developing methods for human-AI collaboration, understanding and addressing the ethical, legal and societal implications of AI, and ensuring the safety and security of AI systems. This Plan was accompanied by the report *Preparing for the Future of Artificial Intelligence* (National Science and Technology Council, 2016).

- The *UK Digital Strategy*, released in March 2017, states the objective of creating "the conditions for the artificial intelligence industry to thrive and grow in the UK". To that end, the strategy sets the allocation of GBP 17.3 million in grants to the Engineering and Physical Sciences Research Council (EPSRC) to support the development of new Robotics and Artificial Intelligence (RAI) technologies in UK universities. The University of Manchester, for example, will lead a project

to develop robotics technologies capable of operating autonomously and effectively within hazardous environments such as nuclear facilities, while researchers at Imperial College London will focus on the field of surgical micro-robotics. Funds will also be provided to support collaboration within the *UK Robotics and Autonomous Systems (UK-RAS) Network*, so as to enable researchers in robotics and artificial intelligence to accelerate the translation of fundamental research into enabling technologies and promote cross-sector growth. In addition, one of the areas of technology focus of the *Digital Catapult Centre* (see section 4.3.1) is Artificial Intelligence (particularly machine learning) (Department for Culture, Media and Sport, 2017).

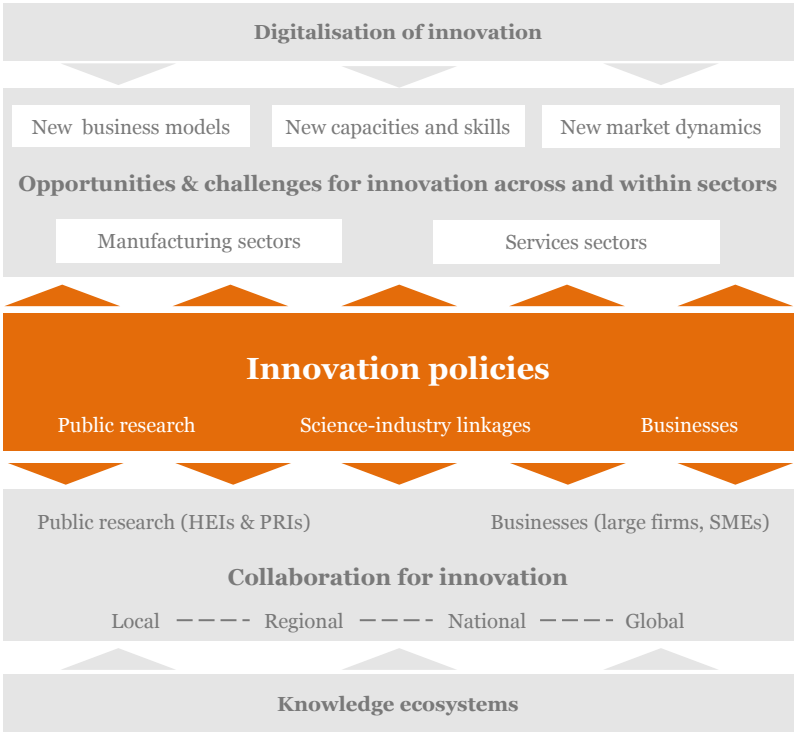
- In Japan, the *Artificial Intelligence Research Centre (AIST)* is a public research institute established in 2015. It promotes fundamental research in AI technologies and their application to real-world problems. Research focuses in two fields: computing inspired by brain architecture and neuro-computing, and data-knowledge integration. The centre is actively engages with industry and other research institutions in Japan and worldwide. An example of such cooperation is the recently established *Panasonic-AIST Advanced AI Cooperative Research Laboratory* (AIST, 2017).

- AI is also one of the key areas of focus of Korea's *Creative Economy and Innovation Centres* (described in section 4.2), which provide support to innovative start-ups and SMEs.

5. Next steps: Defining the scope of policy case studies

41. The TIP project on Digital and Open Innovation (2017-2018) aims to explore more in-depth the specific innovation policy instruments implemented across countries to build on the opportunities and address challenges brought about by digitalisation for businesses (Figure 3) (for details on the specific questions to be addressed by this strand of work, see DSTI/STP/TIP(2017)2). The analysis will build on a range of country case studies. The analysis will also revisit the rationales for innovation policy in the context of the digital transition as well as the challenges and how the international context of the digital economy affects the impacts of national policy.

Figure 3. Scope of the TIP project on digital and open innovation: The innovation policy dimension



Source: Terms of Reference of the 2017-18 TIP Digital and Open Innovation Project (DSTI/STP/TIP(2017)2)

42. The policy case studies to be developed in the context of this project activity may focus on recent strategies and initiatives (including those of more novel and experimental nature) in the following three topics:

1. **Digitalisation-related innovation policy strategies.** As shown in section 3, a number of countries have addressed the digitalisation challenges at the strategic policy level differently – some including them in their main STI strategies (e.g. Germany, France), in industrial or in digital strategies. Case studies analysing the articulation of digital objectives within strategic policy agendas will provide insights on the rationales and objectives of specific frameworks adopted; will discuss the role of policy coordination across different policy areas; as well as explain the mechanisms used to ensure that policy directions adopted are in line with industry's needs in a context of high levels of uncertainty and rapid technological change. Box 2 provides some specific questions that could be addressed in those policy cases.

2. **The creation of centres or platforms to promote (i) research and innovation in key digital technologies** (e.g. Internet of Things, Artificial Intelligence, data analytics, high-performance computing and additive manufacturing) **or (ii) digital technology diffusion across the economy, with a focus on SMEs.** Examples of i) include the *Catapult Centres* in the UK, *Smart Industry Fieldlabs* in the Netherlands, and the technology and innovation platform *It's OWL* in Ostwestfalen-Lippe (Germany) (see section 4.3). The *Mittlestand 4.0 Competence Centres* in Germany are an example of ii). Box 3 provides some specific questions that could be addressed in those policy cases.

3. **Innovation policy initiatives to stimulate (i) or (ii)**. The funding for innovative R&D provided by the *Production of the Future Programme* (Austria) is an example of i) Examples of ii) include the *ICT Innovation voucher programmes* implemented in several European countries, the *Digilyft* pilot programme in Sweden and the virtual maps developed in France, Germany and Japan to showcase examples of SMEs engaged in Industry 4.0 transformation. Box 4 provides some specific questions that could be addressed in those policy cases.

43. Delegates are invited to provide comments and suggestions both on the proposed topics of the case studies and the specific questions to be addressed. These will be revised based on the comments received and following discussions with the project's Steering Group. Fully developed templates for policy case studies will be presented in the TIP meeting of December 2017.

Box 2. Case studies template 1: Digitalisation-related innovation policy strategies

Case studies may address, among others, the following questions:

A. Main features of the strategy

- What are the specific digitalisation-related objectives in the strategy? What is the scope and coverage of those objectives? (e.g. Are they addressing digitalisation across the economy or focus on specific sectors and technologies? If so, which ones?)
- What motivated the inclusion of digitalisation-related objectives within the innovation policy strategy?
- What is the relative importance given to the digital components within the strategy compared to other objectives? (i.e. Is it placed at the core of the strategy? Or considered one among a range of other components?)
- Are specific measures for action to reach those objectives outlined? If so, what are the main features of such measures? To what extent have they already been implemented? (e.g. Has a specific policy programme been developed?)

B. Design and implementation

- Did the development of the strategy involve co-ordination with other policy areas (e.g. co-ordination with other ministries or agencies)? What were the mechanisms in place to facilitate such co-ordination? What were the outcomes of this co-ordination?
- What were the mechanisms used to ensure that policy directions adopted are in line with industry's needs, in a context of high levels of uncertainty and rapid technological change? How were industry and other stakeholders involved in the design and implementation process?
- What challenges have been faced during the design and/or implementation of the strategy (if any), with regards to its digitalisation component, and how have these been addressed?
- Has the strategy's impact already been evaluated? If so, what have been its outcomes? If not, how and when are impacts of the strategy planned to be evaluated?

Box 3. Case studies template 2: Centres or platforms to promote *(i)* research and innovation in key digital technologies or *(ii)* digital technology diffusion

A. The process of creation

- What are the main factors and background conditions that motivated the creation of the centre/platform? What stakeholders were involved in its creation? (e.g. Did the private sector play a leading role in its creation?)
- Did the creation of the centre/platform involve co-ordination with other policy areas (e.g. co-ordination with other ministries or agencies)? What mechanisms facilitate such co-ordination?

B. Main features of the centre/platform

- What is the mandate and the specific objectives of the centre/platform?
- What are the centre/platform's main areas of action? (e.g. Research and innovation, legal framework, standards and norms, intellectual property, education and training, etc.)
- Are the activities of the centre/platform focused on specific sectors or technologies? If so, which ones? Are there mechanisms in place to ensure interdisciplinary approaches to research and innovation?

C. The centre/platform in practice

- How is the centre/platform structured? How does it operate in order to achieve its objectives? (e.g. Does it have a steering committee? Does it have a scientific advisory body?)
- In what ways does the centre/platform differ from others (if any) that do not have a digital focus?
- What challenges have been faced during the process of design and/or implementation of the centre/platform (if any) and how are these being (or planning to be) addressed? To what extent do these differ from challenges faced by centres/platforms that do not have a digital focus?
- Are other policy initiatives (also in other policy areas) in line with the objectives of the centre/platform? In what ways do they reinforce each other?

D. International dimension

- Does the centre/platform have an international dimension? (e.g. Does it engage in cross-country collaborations for innovation or other mechanisms for international outreach?)
- In what ways did experiences from other countries inform the development of the centre/platform? Has this experience motivated the implementation of similar centres/platforms in other countries?

E. Impact

- Has the institution's/platform's impact already been evaluated? If so, what have been the outcomes? If not, how and when are impacts planned to be evaluated?

Box 4. Case studies template 3: Innovation policy initiatives to promote *(i)* research and innovation in key digital technologies or *(ii)* digital technology diffusion

A. Main features of the policy initiative

- What are the specific policy objectives of the innovation policy programme?
- What are the main factors and background conditions that motivated the design and implementation of the programme?
- What are the characteristics of the specific innovation policy instrument(s) used? (e.g. type of support provided, target group, selection mechanism and criteria).
- To what extent have the policy instruments been adjusted to address the challenges of the digital economy? (i.e. in what ways do they differ from traditional innovation policy instruments, for example in terms of design, selection criteria and procedures, advertisement of the programmes?)

B. Design and implementation process

- To what extent is the programme tailored to the specific context (national, regional or local)? Can it be replicated in other contexts?
- What challenges have been faced during the design and/or implementation of the intiative (if any) and how have they been addressed? To what extent do these differ from challenges faced when implementing similar instruments that do not deal with the digital transition?
- What are the conditions for the programme to be effective? (e.g. Are additional programmes needed for programme success? What is the impact of framework conditions more generally?
- Are initiatives in other policy areas in line with the objectives of the programme? In what ways do they reinforce each other?

C. International dimension

- Does this initiative have an international dimension? (e.g. Does it consider cross-country collaborations for innovation or other mechanisms for international outreach?)
- In what ways have experiences from other countries informed the development of the policy initiative? Has this experience motivated the implementation of similar programmes in different regions of your country and/or in other countries?

D. Impact

- Has the policy initiative's impact already been evaluated? If so, what have been the outcomes? If not, how and when are impacts planned to be evaluated?

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ANNEX: Definitions

Digitalisation refers to the transformation of the economy and society as induced by the use of information and communication technologies (ICTs) (OECD, 2016b). These changes are constant and affect virtually all sectors of the economy. In this context, the **digital economy** has become a common term used both in policy contexts and academia – however there is no universally accepted definition of it.

The **Internet economy** is often used as a synonym of digital economy, although its scope is narrower. In the OECD Declaration for the Future of the Internet Economy, the Internet economy is defined as covering "the full range of our economic, social and cultural activities supported by the Internet and related information and communications technologies (ICT)" (OECD 2008). The digital economy goes beyond and permeates and impacts countless sectors across the world's economy (OECD, 2015a).

Digital start-ups bring a new digital product, product add-on or service to the market; and digital transformation of existing business activities (e.g. adoption of digital technologies to increase the efficiency or convenience of a product or service or to enable new functionalities).

Industry 4.0 stands for the implementation of digital technologies into industrial production systems and the increasing automation and connectivity in manufacturing. The term was first used by the German government in 2012 and refers to a strategy aiming to digitalise the German manufacturing sector (Bundesministerium fuer Bildung und Forschung, 2015). The "four" in Industry 4.0 refers to the "fourth industrial revolution" or the "next production revolution", as defined in OECD (2016c) (see below). The previous three industrial revolutions refer to changes brought about by water and steam power, electric power and automation, respectively (Davies, 2015; Schwab, 2016).

Since its initial use, the term Industry 4.0 has been widely adopted by other governments and industry to refer to the development of "smart factories". **Smart** factories are factories that allow for increased flexibility, mass customization, speed and autonomy in manufacturing, and for large quantities of data being collected. These factories are expected to significantly reduce costsby increasing efficiency, decrease the duration of innovation cycles and allow companies to follow dynamic market trends (Davies, 2015; Schwab, 2016).

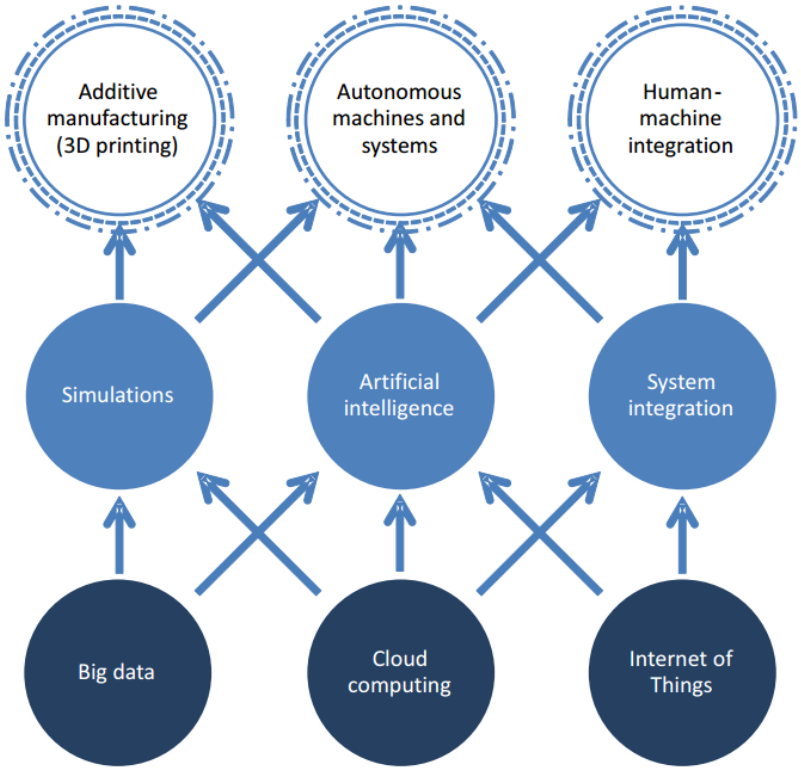
Main technological drivers of Industry 4.0 are digital technologies that enable communication between machines, products and humans in **Cyber-Physical-Systems** (CPS). CPS embed data streams and computation in physical environments and processes (e.g. manufacturing processes). This is realized via Radio Frequency Identification Devices (RFID), which represent chips that have the average size of a rice corn. RFID are attached to products. They are able to transfer data throughout cloud systems to data processing centres that evaluate information and communicate with machines, other products and humans. This enables a new level of synchronisation of manufacturing processes and allows monitoring of product-data in real-time. Artificial intelligence will allow manufacturing systems to go further by self-optimizing automatically, forecasting machine failure, and simulating new manufacturing and product innovations (Davies, 2015; Schwab, 2016).

The **"fourth industrial revolution"** or the **"next production revolution"** entails a confluence of technologies ranging from a variety of digital technologies (e.g. 3D printing, Internet of Things, advanced robotics) to new materials (e.g. bio or nano-based) to new processes (e.g. data driven production, artificial

intelligence, synthetic biology). As these technologies have an impact on the production and the distribution of goods and services in practically all sectors, they are expected to have far-reaching consequences for productivity, skills, income distribution, well-being and the environment. (OECD , 2016c).

Key **digital technologies** enabling the digital transformation of industrial production include Internet of Things, Artificial Intelligence, cloud computing, simulation and big data, among others. Figure A1 depicts the main ones. The technologies at the bottom of the figure enable those at the top, as indicated by the arrows. The technologies at the top (in white), which include additive manufacturing (i.e. 3D printing), autonomous machines and systems, and human-machine integration, are the applications through which the main productivity effects in industry are likely to unfold. In combination, these technologies could one day lead to fully automated production processes, from design to delivery (OECD, 2017a).

Figure A.1. The confuence of key technologies enabling the industrial digital transformation



Source: OECD (2017a).