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COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

Digitising European Industry
Reaping the full benefits of a Digital Single Market

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1 Context

The manufacturing industry, and its interplay with services, is playing an important role in putting Europe's economy back on track. At the same time, a new industrial revolution, driven by new generations of digital technologies such as big data, is taking place.

Progress in digital technologies in combination with other key enabling technologies is changing the way we design, produce, commercialise and generate value from products and related services. Advances in technologies such as the Internet of Things (IoT), 5G, cloud computing, data analytics and robotics are transforming products, processes and business models in all sectors ultimately creating new industrial patterns as global value chains shift. The challenge ahead is for the European industry to seize fully and swiftly these digital opportunities. This is essential to ensure Europe's mid and long term competitiveness with implications for overall welfare.

Achieving the Digital Single Market (DSM) in Europe is a prerequisite for attracting investment in digital innovations and for faster business growth in the digital economy. In 2015 the European Commission initiated an ambitious strategy to achieve a DSM. A key success factor for reaping the full benefits of a DSM is a highly competitive digital industry in Europe and the integration of digital innovations in all sectors. Embracing digital technologies will help companies to grow beyond the EU internal market and make the EU an even more attractive location for global investments. Digital skills are of crucial importance. The openness of the European market should be maintained and developed further in the digital sphere.

The DSM strategy, especially the pillar on "maximising the growth potential of the digital economy", contains all the major levers for improving industry digitisation with actions in areas such as the data economy, IoT, cloud computing, standards, skills and e-government. It is part of a coherent strategic framework of Commission initiatives aimed at strengthening the overall competitiveness of industry, especially small and medium-sized enterprises (SME). This includes in particular the Investment Plan for Europe, the Energy Union, the Capital Markets Union, the Circular Economy package and the Single Market Strategy. The DSM strategy builds on these initiatives and provides a coherent framework for taking the digitisation of Europe's economy forward.

Faced with the challenge of digitisation, industry across all sectors can build on European strengths in digital technologies for professional markets such as electronics for the automotive, healthcare and energy markets, telecoms equipment, business software and advanced manufacturing. It also has areas where progress is to be made, namely in the level of small business investment in ICT, in the supply of digital consumer products and in web services. High-tech sectors in Europe are fairly advanced in embracing digital innovations while a large part of SME, mid-caps and non-tech industries still lag behind. Large disparities in digitisation also exist between regions.

Whilst it is for business to take the lead in adapting to market realities, an urgent EU-level effort to help coordinate national and regional initiatives to digitise industry is important. Today supply chains span Europe and digitisation raises challenges such as standardisation, regulatory measures and volume of investment that can be only addressed at European level.

This Communication introduces a set of coherent policy measures as part of a DSM technologies and public services modernisation package. The package includes an additional three Communications The Communication explains how the various measures relate to each other. It also aims to establish a framework for coordination between national and EU-level initiatives in this area and relevant policy actions including investments in digital innovations and infrastructure, accelerating the development of ICT standards, exploring regulatory conditions and adaptation of the workforce, including up-skilling. These challenges and opportunities are also valid for developing e-government actions and boosting the public sector's role in stimulating demand for digital solutions.

The focus is on actions with a clear European value added building on, complementing and ensuring the scaling up of national initiatives. It is based on the engagement of all relevant stakeholders, namely large, mid-size and small companies from all industrial sectors, the digital supply industry, social partners, Member States and regions.

It is accompanied by three further communications and three staff working documents:

- The Communication on a **European Cloud Initiative** presents the plan for building a world class cloud and data infrastructure for science and engineering that will provide scientists and engineers in the EU with wide computing and data handling capacity. It will provide a virtual environment with open and seamless services for research data storage, management, analysis and re-use, across borders and disciplines ('the European Open Science Cloud'). The initiative will boost Europe's innovation capacity in all areas and reinforce its digital technology capability from high end computing down to low power components. The initiative will give Europe a global lead in data infrastructures and services, and ensure that European science, technology and industry reap the full benefits of data-driven science. It is accompanied by two **staff working documents on High-Performance Computing and on Quantum Technologies**.
- The Communication on **Priorities for ICT Standardisation** identifies the essential ICT standards and presents measures to accelerate their development in support of digital innovations across the economy. It sets out priorities for standards based on broad consultation and presents concrete actions for achieving them.
- The **E-Government action plan** on the digital transformation of public services focuses on business and citizen needs, i.e. solutions that are online, cross-border, interoperable by default and solutions that are, by design, end-to-end.
- The **staff working document on the Internet of Things** highlights the challenges and opportunities of IoT in Europe.

2 The growing footprint of digital technologies

With about 4% of GDP, the ICT sector in Europe represents an important share of the economy employing more than 6 million people. The value added of this sector in the EU (production of digital goods), spanning from components to software products is above 580 B€[1] and represents close to 10 % of the added value of industrial activity overall.

Recent studies[2] estimate that digitisation of products and services will add more than 110 B€ of revenue for industry per year in Europe in the next 5 years. Just in Germany, further digitisation of industry is expected to bring up to 8 % of productivity growth over ten years[3] and a revenue growth of about 30 B€ per year[4]. It will also lead to a 6 % increase in employment. Close to a third of the growth of the overall industrial output in Europe is already due to the uptake of digital technologies[5].

[1] Moreover, the ICT sector originates about 17% of the total business expenditure in R&D, PREDICT is.jrc.ec.europa.eu/pages/ISG/PREDICT.html

[2] PwC, opportunities and Challenges of the industrial internet (2015), and Boston Consulting Group: the future of productivity and growth in manufacturing industries (2015)

[3] Boston Consulting Group (2015), op.cit.

[4] Close to 1% of German GDP

[5] Estimates by LIFE + series of studies 2016.

Today, more than a quarter of the growth of value added in the automotive sector comes from the integration of digital innovations in the car and in the design and production of cars. Finally, digital innovations are a key enabler for meeting the objectives of many of our societal challenges from sustainable health systems to the improvement of resource and energy efficiency as addressed in Commission policies like the Energy Union and the Circular Economy. The internet, the web and recent developments in virtual and augmented reality continue to reshape the production and business models of all creative industries.

This additional value creation from digital innovations occurs in:

- **Products:** Driven by the development of the Internet of Things, the further integration of ICT in all types of products and artefacts offers a wide range of opportunities for the growth of new industries including start-ups and is transforming all sectors of the economy. This includes developments of markets like the connected car, wearables or smart home appliances.
- **Processes**: the further spread of automation in production and the full integration of simulation and data analytics in processes and supply chains are bringing substantial gains in productivity and resource efficiency over the full cycle from product design to lifecycle management.
- **Business models** by re-shuffling the value chains and blurring boundaries between products and services**.** Smart connected products come with services and customers adopt changing behaviour e.g. on "ownership", co-creation and sharing (the apps economy). The impact of adding services to the product portfolio of manufacturing companies has been shown to increase profitability by up to 5.3% and employment by up to 30%[6].

The convergence of a number of technologies is driving the digital change, notably IoT, big data and cloud, robotics and artificial-intelligence, and 3D printing. They enable industry to respond to major aspirations of today's customers, such as personalisation, higher safety and comfort as well as energy- and resource efficiency. For example, the combination of advanced sensors and big data in industrial processes can reduce energy consumption[7] and the use of raw materials.

These innovations result in closer interdependence between progress in digital technologies and their use across industries. To be able to reap the full benefits of digital technologies, Europe needs both, a highly innovative digital sector and an upgrade of the digital innovation capacity of all industries. It also requires an innovative public sector showing the way in digital transformation to improve efficiency and ensure high quality service for all citizens.

3 Seizing digital opportunities: Where does Europe stand?

Several national and regional initiatives such as Industrie 4.0 (DE), Smart Industry (NL), Catapults (UK) and Industrie du Futur (FR) were launched recently to tap into the opportunities offered by digital innovations in industry. They show the commitment across Europe to seize the digital opportunities ahead. However, addressing the challenges of digital transformation at national level alone bears the risk of leading **to further fragmentation** of the single market and to efforts below the critical mass needed to attract private investments.

Competition between economies world-wide to attract private investment in digital innovations is fierce. Between 2000 and 2014, investments in ICT-related products in the EU represented about a third of those made in the US. Similarly, the overall amount invested by EU companies in research

[6] Crozet, M. and Milet, E., Should everybody be in services? CEPII working paper 2015.

[7] E.g. Sensors installed on machinery report back of abnormal behaviour saving energy in billions of Euros.

and innovation represents only 40% of US companies' investments. While Member States and regions have an important role to play in facilitating access to finance and attracting investments, EU level actions can bring the necessary scale and coverage to ensure impact. The added value of further cooperation between national and regional innovation policy-makers is well addressed in the Smart Specialisation approach[8] and bottom-up inter-regional initiatives have emerged[9].

The state of the digitisation of industry varies across sectors, particularly between high tech areas and more traditional ones, and also between Member States and regions. There are also **large disparities** between large companies and SME[10]. The large majority of SME and midcaps are seriously lagging behind in embracing digital innovations. European industry risks falling behind when it comes to building the very foundations of its digital future.

Digital industry in Europe can build on a number of assets, notably the size of the EU market that should attract further investments as it develops into a digital single market. It also has clear **strengths in professional (e.g. B2B) and sectoral markets** such as embedded and business software, telecom equipment, robotics, automation, laser and sensor technology as well as electronics for automotive, security, healthcare and energy markets. However, Europe needs to improve significantly its attractiveness to investments in the production of digital products, from components to devices and software, **for consumer markets and in web and data platforms** and relevant applications and services. This is also the case for personal computing, servers, and all consumer packaged software.

While bringing new opportunities, digital innovations are also transforming the whole business landscape. They open the door for new competitors in key parts of the value chain (e.g. data or web platforms). European businesses[11] are increasingly concerned that such a scenario will lock them in with a few suppliers or platform owners and will also **shift a major part of value creation outside their business sphere**.

There is a need to accelerate the development of **common standards and interoperable solutions**. Interoperability is essential for the deployment of the IoT and the seamless flow of data across sectors and regions. Availability of standards and common specifications is a clear requirement e.g. for the deployment of connected cars that interact not only with the road infrastructure but also with other vehicles and devices, and for the avoidance of consumer lock-in with given providers.

Digitisation of the industrial fabric brings also **new regulatory challenges**. This includes issues relating to data generated by the multitude of new smart products, liability of more autonomous systems and safety with the increasing need for interaction between humans and smart devices. It requires striking the right balance between legitimate business interests and the fundamental rights ensuring protection of personal data and privacy, as set out in the General Data Protection Regulation.

The further development of the Internet of Things and big data pose also important **trust and security** challenges for any company and for public acceptance.

About 40% of EU workers[12] have an insufficient level of digital skills. The **need for new multidisciplinary and digital skills** is exploding, such as combined data analytics and business or

[8] 10 % of Smart Specialisation priorities relate to ICT, "Mapping Innovation Priorities and Specialisation Patterns in Europe," JRC-IPTS 2015, s3platform.jrc.ec.europa.eu/-/mapping-innovation-priorities-and-specialisation-patterns-in-europe

[9] e.g. the Vanguard Initiative for New Growth fostering complementarities among regions (s3vanguardinitiative.eu)

[10] The Digital Economy & Society Index (DESI), ec.europa.eu/digital-single-market/en/desi

[11] industry position papers

[12] EUROSTAT, digital skills of the labour force 2015

engineering skills. The gap between the demand for, and availability of digitally skilled workers in Europe is growing. Digital innovations have also a great potential for additional jobs creation in industry with the growth of new businesses and by helping preserve and re-shore industrial jobs. Looking only at ICT professionals, more than a million additional jobs have been created over the last three years. Despite this, it is expected that rapidly growing demand will lead to more than 800 000 unfilled vacancies by 2020. At the same time, advances in automation, robotics and smart systems are increasingly transforming the nature of work, not only for repetitive tasks but also for sophisticated tasks in administrative, legal or supervisory functions. Work in a digitised economy will involve also new skills and capacities including more creativity, communication and adaptability. It will require a massive upskilling of the workforce at all levels.

The above hurdles require a collective public and private effort.

4 The way forward

Digitisation provides a unique opportunity for attracting further investments into innovative and high growth digital and digitised industries in Europe. Industry in the EU can build on its strengths in professional digital technologies and on its strong presence in traditional sectors to seize the wide range of opportunities that IoT, big data and AI-based systems offer and capture a share of the emerging markets of future products and services.

While adapting to the digital industrial change is primarily a matter for business, a targeted public policy can play an important part in creating the best conditions for that to happen in all sectors in a competitive environment bolstered by the competition rules. This is particularly important for the vast number of small and medium-sized enterprises that underpin the European economy. Public policy should aim at a thriving digital sector fuelling the digitisation of the whole industrial fabric, from construction, health and agro-food to creative industries.

The purpose of this Communication is therefore **to reinforce the EU's competitiveness in digital technologies and to ensure that every industry in Europe, in whichever sector, wherever situated, and no matter of what size can fully benefit from digital innovations.**

Facilitated by a dynamic framework for coordination and experience sharing between public and private initiatives at EU, national and regional level, the proposed actions are expected to mobilise close to 50 B€ of public and private investment[13] in the next 5 years, explore and adapt when needed the legislative framework[14] and reinforce coordination of efforts on skills and quality jobs in the digital age.

4.1 A framework for co-ordination of initiatives for digitising industry

More than 30 national and regional initiatives for digitising industry have been launched across Europe in recent years. With value chains increasingly distributed across Europe, the further digitisation of industry brings challenges that can only be resolved through a collective EU-wide effort. It is at EU level that the pooling of public resources can rapidly reach the critical mass needed to attract the right level of private investment. There is a need to address standardisation and

[13] Based on the planned activities in H2020, COSME and national public and private efforts amounting to about 35 B€, up to 5 B€ for regional investment on innovation hubs, 10 B€ co-investment in first production capacities

[14] Possible legislative proposals will be subject to Commission better regulation requirements, in line with Commission's Better Regulation Guidelines, SWD(2015) 111

examine the regulatory fitness of legislation at EU level to ensure the development of a single market and there is also a substantial value in sharing best practices in areas like skills and jobs for the digital change.

In the first half of 2016, the Commission, together with Member States and industry, will set up a governance framework to (i) facilitate the coordination of EU and national initiatives on digitisation, (ii) mobilise stakeholders, and resources across the value chain, on actions towards the achievement of a Digital Single Market, building upon existing multi- stakeholders dialogues [15], and (iii) exchange best practices:

- **Twice a year, a high-level Roundtable** of representatives of Member States' initiatives, industry leaders[16], and social partners ensuring a continuous EU-wide dialogue, with preparatory activities developed, when needed, in specific **Working Groups** addressing both sector-specific and cross-sector issues.
- **A yearly European stakeholder forum** for wider consultation and outreach involving stakeholders from the full digital value chains.

The Commission will **regularly report** on the progress of the actions**.** It will develop by end of 2016 and update on a yearly basis a **catalogue of national and regional initiatives and priorities**.

4.2 Co-investing in boosting Europe's digital innovation capacities

The stimulation of private investment in digital innovations in all industrial sectors across the EU is a major challenge to be addressed at regional, national and EU level. As shown recently with the European Fund for Strategic Investment, the EU as a whole can mobilise resources for investment, when needed, that no individual Member State could raise on its own and with leverage effect on private investments that is far beyond the reach of many Member States. The approach to trigger further investments is both demand and supply driven and mobilises all policy instruments from financial support to coordination and legislation. By ensuring the development of digital innovation hubs across Europe, access to latest technologies will be possible for any industry in Europe with the aim of spurring a wave of bottom-up innovations across sectors. Public private partnerships on innovation and strategic R&D, will be established and reinforced to ensure EU-wide industry academia collaboration involving stakeholders across value chains. They will provide unique means to pool the resources needed for ground breaking developments in digital technologies and platforms including high performance cloud infrastructure for science and innovation as well as large scale test-beds to accelerate standards setting.

4.2.1 Boosting digital innovations in all sectors: Digital Innovation Hubs across Europe

Europe can gain decisive competitive advantages internationally if it is capable to generate across Europe a wave of bottom-up digital innovations involving all industrial sectors. With the rapid pace of change in digital technologies, most decision makers in industry have difficulties to decide when to invest, up to what level and in which technologies. Around 60% of large industries and more than 90% of SME feel lagging behind in digital innovation[17]. Similarly, there are strong digitisation discrepancies between industrial sectors[18].

[15] Such as the Round Tables on digitising industry, Strategic Policy Forum and the MSs Board for Digital Transformation.

[16] Including PPPs leaders

[17] Roland Berger study on digital readiness of industry

[18] PwC study, the 2015 industry digitisation index for Europe

When asked about public support to address the above, industrial stakeholders point out to the urgent need for "facilities to experiment with, and test digital innovations" before investing in digitisation. Regions and cities with a higher digital readiness had invested in digital competence centres (e.g. Research and Technology Organisations (RTOs) and university labs) offering such support to industry[19]. As regions with strong clusters in digital industries[20] are characterised with very high innovation levels, there is also scope to better use clusters with technology infrastructure and innovation intermediaries.

EU actions[21] supporting such competence centres have shown not only an increase of competitiveness of existing industries, notably for SME and mid-caps, but also additional business creation in new digitised products and services. This is also the case for networks of start-up accelerators such as Startup Europe and FIWARE initiatives. It is the ambition of the Commission to focus 500M€ over the next 5 years from Horizon 2020 budget to these actions.

The impact is even higher when support to competence centres is combined with actions to facilitate access to finance and with outreach and brokerage actions. The result is a full "digital innovation hub" (DIH) fostering "many-to-many" connections between competence centers, industry users and suppliers, technology experts and investors and facilitating access to EU-wide markets. Networking these DIH across Europe would create a one stop-shop to the latest digital technologies accessible for any business. In this context, the synergies between digital and other key enabling technologies could also be encouraged.

Almost 90 % of regions either prioritised ICT (two third of Member States) and/or advanced manufacturing (half of the Member States), or plan to use ICT for supporting their priorities, in their smart specialisation priorities. In those regions the European Structural and Investment Funds and the European Fund for Strategic investment (EFSI) and more specifically its SME window could be used to support DIH. To create new, or reinforce competence centers offering the services of a DIH across the whole EU and stimulate their use by industry, e.g. with digital innovation and skills vouchers, a significant national and regional effort is needed, in the order of 5 B€ investment over 5 years.

A thematic smart specialisation platform for industrial modernisation and investment supported by the related European strategic cluster partnerships, among others will support cross-regional access to competence centres and digital clusters.

The Commission plans to focus 500M€ investment from Horizon 2020 on digital innovation hubs on:

- **Networking and collaboration of digital competence centres** and cluster partnerships.
- Supporting **cross-border collaboration** of **innovative experimentation** activities.
- Sharing of best practices and developing, by end of 2016, a **catalogue of competences**.
- **Mobilising regions** with no Digital Innovation Hub to join and invest[22].
- Wider use of **public procurement** of innovations to improve efficiency and quality of public sector

[19] E.g. UK Catapult, NL Smart Industry Field Labs, German SME and mid-caps centres, …

[20] Map of European digital clusters in the Atlas of European ICT Poles of Excellence: is.jrc.ec.europa.eu/pages/ISG/EIPE.html

[21] I4MS: www.i4ms.eu, SAE: smartanythingeverywhere.eu, ECHORD++: echord.eu, ACTPHAST: www.actphast.eu, FIWARE: www.fiware.org and Start-up Europe initiatives

[22] E.g. the mentoring programme in I4MS

The Commission will also set up in June 2016 a thematic smart specialisation platform for industrial modernisation.

The Commission encourages **Member States** and Regions to invest in DIH and incentivise industry to embrace digital innovations and foster synergies with other key enabling technologies..

4.2.2 Partnerships for leadership in digital technologies value chains and platforms

Amongst the challenges that can be addressed through pooling of public and private resources in Europe are the large investments needed in high performance computing facilities and data infrastructures for science and engineering. The accompanying **Communication on the European Cloud Initiative** shows how such a collective effort in partnership with Member States and industry can boost Europe's innovation capacity across scientific disciplines and industrial sectors. It also shows how such an investment can help reinforce the supply chain for strategic high performance computing in Europe from low power components to computing architectures, Cloud technology and data analytics.

More should also be done to facilitate coordination of the large but fragmented R&D&I efforts in other key digital technology fields. This can be achieved by strengthening the coordination role of the Public Private Partnerships (PPPs) established in H2020 so that **they become real aggregation frameworks** and ecosystems for digital industrial innovations. PPPs can act as main vehicles for implementing EU-wide digital industrial strategies, ensure closer links between R&D&I and standardisation efforts and foster the use of all available financial instruments, such as the work started towards a 5G Action Plan calling for coordinated investment in the next generation ubiquitous 5G networks, in order to deliver on industry's connectivity needs.

Current PPPs cover the whole digital value chain from components up to applications. They include PPPs in nano-electronic components and embedded software (ECSEL), photonics, robotics, 5G communications, high performance computing, cybersecurity (planned), and big data[23].

The example of the ECSEL Joint Technology Initiative[24] shows that such alignments of regional, national and EU strategies are feasible and can draw considerable private investments and achieve ground-breaking impact on competitiveness. They provide unique means to support large-scale federating initiatives such **as pilot lines for production or large scale reference implementations** bridging the so-called innovation "valley of death"[25] and translating research ideas into marketable products and services.

Of particular importance in this context is the use of the **Important Project of Common European Interest (IPCEI),** in accordance with the TFEU, to foster large scale investments in production capacities in highly innovative areas with large spill over effect across the economy. Such IPCEI is being prepared by industry and MSs to boost Europe's production capacity in low-power components for the IoT. It represents a total of 6 B€ of investment with 1 B€ from the public sector. Similar initiatives are also being explored for the areas of HPC and big data and in connected and automated vehicles.

[23] Details can be found at ec.europa.eu/research/industrial_technologies/other-ppps_en.html

[24] ECSEL is a tripartite PPP in the area of electronic components and embedded software. It is supported with 1.2 B€ from the EU in H2020, 1.2 B€ from MSs and from industry. So far, industry investment is close to the double of public investment and should therefore reach up to 5 B€ in 2014-20

[25] High-level expert group on Key Enabling Technologies, June 2011

Overall, more than 20 B€ are already planned to be invested in the coming 5 years in the digital-sector PPPs by industry and the EU in support of strategic R&I agendas[26]. Given the national level of public support to R&I in ICT, the **total investment can reach up to 35 B€** in the next 5 years if Member States would dedicate at least 3 B€ per year to these strategies including financing opportunities from EFSI and ESIF. Such levels of focused investments will bring a radical step change to Europe's innovation capacity and endow industry with unique differentiating factors to compete at a global scale.

The Commission plans to launch a set of initiatives supporting the building of the digital industrial platforms of the future. Platforms here are to be understood as multi-sided market gateways creating value by enabling interactions between several groups of economic actors. Among others, platform building requires the development of reference architectures and their gradual implementation, testing and validation in evolving ecosystems that trigger broad value creation[27].

One group of platform building initiatives aims at combining digital technologies, notably IoT, big data and cloud, autonomous systems and artificial-intelligence, and 3D printing, into integration platforms addressing cross-sector challenges. These include:

- **Leadership in IoT*:*** The Commission will invest[28] in demand-driven large-scale pilots and lighthouse[29] initiatives in areas such as smart cities, smart living environments, driverless cars, wearables, mobile health and agro-food. The investment will address notably open platforms cutting across sectors and accelerate innovation by companies and communities of developers, building on existing open service platforms, such as FIWARE[30]. The accompanying **staff working document on IoT** outlines a.o. standardisation and regulation challenges and opportunities for IoT and the role of **the Alliance for IoT Innovations (AIOTI)**.
- **Data platforms*:*** More than 2.7 B€ are invested by industry and the Commission in R&D&I actions within the PPP on big data established as part of the Data Economy strategy[31]. The aim is to support the growth of innovative data-driven businesses in Europe and the exploitation of the potential of the value of data across sectors. This includes the development of competitive open data platforms and the availability of world class data infrastructure in Europe. Key aspects include cyber-security solutions for restoring trust in the data-driven economy and for helping businesses to make safe and secure use of data. Such platforms will support the uptake of data-driven business models by European industries, notably by SMEs.

A second group of planned platform building initiatives addresses the integration of converging digital innovations into sectoral platforms and full solutions, such as:

- **The Connected Smart Factory**: Investments in the Factories of the Future (FoF), Sustainable Process Industry through Resource and energy Efficiency (SPIRE) and Bio-Based Industries (BBI) PPPs allow industry to seize the new opportunities offered by the convergence of HPC, Big Data,

[26] This includes ~5 B€ already foreseen as EU support to PPPs in H2020 and the ~15 B€ private investment committed by industry to these PPPs.

[27] Examples of existing industrial platforms include AUTOSAR (www.autosar.org) in the automotive sector, ISOBUS (www.aef-online.org) in the agricultural machinery sector. On-going industrial platform initiatives include RAMI (www.plattform-i40.de), Industrial Data Space (www.fraunhofer.de).

[28] H2020 budget.

[29] Under the ECSEL Joint Undertaking

[30] The FIWARE platform provides a **set of APIs** and an **open source reference implementation** that ease the development of smart applications in multiple vertical sectors.

[31] COM (2014)442 final

Robotics, IoT and Cloud in manufacturing. A larger number of industries (in particular SME) can access simulation tools and testing facilities to produce better products and services. Laser-based manufacturing is also supported under the Photonics PPP.

- **Connected and automated driving**: The Commission has launched work to facilitate and accelerate their deployment across the EU, including the work of the platform on Cooperative Intelligent Transport Systems and will deliver a Masterplan in 2016. It will build on large-scale pilot deployment, testing and experimenting facilities available across Member States and stimulate EU-wide interoperability and continuity of services. With the support of industry fora such as the GEAR2030 high level group, the Commission will also foster cooperation between telecoms and automotive industry to accelerate the deployment of connected and automated driving in Europe, including through large-scale federating engineering projects across borders.

Other sectoral PPPs address important aspects of digitalisation, such as the Innovative Medicines (IMI) Joint Technology Initiative with its knowledge management pillar and the 'Big Data for better Outcomes' programme[32]. The Commission will also coordinate the actions dedicated to digital industry with the wider framework of actions dedicated to improve competitiveness in the Digital Single Market, including sector-specific PPPs such as Energy-Efficient Buildings and Green Vehicle Initiative.

The European Commission in co-operation with Member States will **focus investments in the PPPs** to:

- **Reinforce the role of PPPs as coordinators of EU-wide R&I effort**, national initiatives and industrial strategies by **focusing on key technologies and their integration** including through large scale federating projects;
- **Focus a significant part of the PPPs and national investments on cross-sectoral and integrated digital platforms and ecosystems** including reference implementation and experimentation environments in real setting.

The Commission will monitor the commitment by the private sector to invest, on average, at least four times as much as the EU investments in the PPPs and the use of the opportunities offered by financial instruments under EFSI and ESIF.

4.2.3 Standardisation: Prioritisation and intensified efforts on reference architectures and experimentation

An effective standardisation environment for digital technologies is crucial for Digitising European Industry, and is key for the Digital Single Market. ICT standards allow devices and services to connect seamlessly across borders and technologies. In the future, billions of connected devices - including appliances, industrial equipment, and sensors – depend on such seamless communication, regardless of manufacturer, technical details, or country of origin. ICT is rapidly moving into all economic sectors. Yet in many industrial domains, the traditional cycle of development, testing and standardisation is no longer adequate for the fast evolving and complex converged technologies. Furthermore, the multiplicity of 'ad-hoc' global standard setting bodies significantly challenges conventional approaches.

The accompanying Communication on Priority ICT Standards for the Digital Single Market contains a series of measures that aim to streamline standard setting for ICT technologies through two

[32] Details can be found at www.imi.europa.eu/content/imi-2-call-6-launch

interlinked pillars – firstly by providing strategic focus on core set of key technology building blocks, and secondly by a robust delivery mechanism. This approach is in line with the foreseen broader Joint Initiative on Standardisation, announced in the Single Market Strategy.

In order to provide strategic focus to standardisation, the Communication identifies five priority areas for standardisation efforts - 5G, Cloud Computing, the Internet of Things, Data technologies and Cybersecurity. Focusing efforts in these areas and integrating them along industry value chains shows where our strategic interests lie in realising the DSM and helps concentrating resources, bring researchers, innovators and standard setters together more effectively, develop reference architectures and test infrastructure[33]. Streamlined cross-domain approaches to standardisation in these areas will also help progressing in eHealth, smart energy systems, intelligent transport systems and connected vehicles, advanced manufacturing, smart homes and cities.

This strategic focus is supported by a robust delivery mechanism, building on regular monitoring by the Commission, a sustained political dialogue of the Commission with all stakeholders, reinforced cooperation with standardisation organisations, and strengthened international engagement. In addition, ICT standardisation needs to rely on a balanced intellectual property rights policy for access to standard essential patents (SEPs), based on FRAND licensing terms. The policy measures outlined in the accompanying Communication on Priority ICT standards for the Digital Single Market aim at ensuring a fair return on investment to incentivise global R&D and innovation, and for a sustainable standardisation process, whilst ensuring wide availability of technologies in an open and competitive market.

4.3 Providing the appropriate regulatory framework conditions

From data protection and security to the availability of world class networking and cloud infrastructure, the Digital Single Market strategy includes essential actions for digital innovations in industry.

The fast development and wider use of digital technologies may however also require further modernisation of the current regulatory framework. Clarifying and possibly adjusting the legislative framework is important to establish the necessary trust and legal certainty for industry in Europe and will be taken forward as part of the Commission's Better Regulation REFIT programme[34]. The REFIT platform will focus on barriers to innovation and discuss how they can be removed or reduced through innovative regulatory approaches as set out in the Single Market Strategy[35] or through innovation deals[36].

[33] Reference architectures and shared test environments are of particular importance as they provide a common language and test infrastructure for the development of solutions by multiple actors. They also allow for cooperation across value chains, across industrial sectors and across functional layers. They are particularly important for SMEs and start-ups.

[34] The Commission already considers a digital assessment for each initiative. This can be part of retrospective evaluations and Fitness checks of existing legislation under the Regulatory Fitness and Performance Programme (REFIT) or part of forward-looking impact assessment in order to ensure that legislation is digitally fit for purpose.

[35] Upgrading the Single Market: more opportunities for people and business, COM(2015)550

[36] "Better regulations for innovation-driven investment at EU level". SWD of the EC, 2016

In fact, digital technologies are developing so fast that the legal framework needs to be monitored constantly to make sure it remains in line with the technological development. Some Member States have started adapting national legislation to allow for testing and experimentation such as the ATLAS dedicated testing and training airspace for drones in Spain and the Italian RoboTown city in which service robots can be tested in real-life environments. The need for action at European level is to be explored.

As regards personal data and privacy, the General Data Protection Regulation already provides a framework to increase trust in digital services, as individuals, public administrations and businesses will profit from clear data protection rules that are fit for the digital age, that give strong protection and at the same time create opportunities and encourage innovation in a Digital Single Market. 'Data protection by design and by default' will become an essential principle to incentivise businesses to innovate and develop new ideas, methods, and technologies for security and protection of personal data. In particular, techniques such as anonymised or pseudonymised data will encourage the use of "big data" analytics.

Stakeholders expressed a need to examine the regulatory framework for digital innovations with a view to provide further clarity on the following:

- Ownership and use of data generated in an industrial context are major areas of concern. When it is personal data, protection is dealt with in the General Data Protection Regulation, together with the ePrivacy Directive. The already foreseen initiative on "free flow of data" under the DSM will examine issues of ownership, interoperability, exploitation and access to data, including industrial data.

- Autonomously acting systems such as self-driving cars or drones[37] pose a challenge to current safety and liability rules where a legal person is ultimately responsible. Legal implications of the roll-out of IoT are wider than the allocation of liability as recognised in the DSM strategy and also need to be addressed.

- Apps and other non-embedded software (not contained in a tangible medium) might also raise potential safety risks and are currently not fully addressed by the EU legal framework.

With the support of industry and Member States, the Commission will:

- Propose in 2016 the initiative on **free flow of data** within the EU in order to remove or prevent unjustified localisation requirements in national legislation or regulation as well as to examine in greater detail the emerging issues of **data ownership**, access and re-use rules, including as regards data in an industrial context and especially data generated by sensors and other collecting devices.
- Explore the legal frameworks for **autonomous systems and IoT** applications in particular safety and liability rules and the legal conditions to allow large scale testing in real life environments.
- Initiate work on the **safety of apps and other non-embedded software** not covered by sectoral legislation, assessing a possible need for further action at the EU level.

[37] In December 2015, the Commission proposed a basic legal framework for the safe development of drone operations in the EU as part of the new Aviation Strategy for Europe, COM(2015) 613 final of 7.12.2015

4.4 A human capital ready for the digital transformation with the necessary skills

The digital transformation is structurally changing the labour market and the nature of work. There are concerns that these changes may affect employment conditions, levels and income distribution. Addressing these challenges requires **a comprehensive dialogue** on the social aspects of digitisation that engages all stakeholders involved in all aspects of work, education and training. The European social partners have recognised that digitisation is not just a technological issue, but it has wider social, work and economic implications. It is also a question of economic development and social cohesion. In line with the recognition of their fundamental role, the Commission invited the social partners to include the Digital Single Market in their social dialogue at European level and they have responded positively.
Work in industry at all levels from operators to engineers and administrative staff will increasingly consist of designing, maintaining and supervising intelligent machines that assist in the performance of tasks. This will require **different skill sets**.

In addition to digital skills and competences, there is an increasing demand for other complementary skills, such as entrepreneurial, leadership and engineering skills. Future jobs will require an appropriate mix of basic, soft and technical skills, notably the digital and business-specific skills, that education and training systems are not yet fully addressing. Industry has an active role to play in the definition and training of the key skill sets and competences[38].

While this is on the one hand clearly a cross-European issue, most relevant competences lie in the hands of Member States and Regions, and it is at national and regional level that specific issues should be identified and addressed. Moreover, the retraining of the existing workforce needs to take place in companies and therefore a strong involvement of businesses and social partners is necessary.

Starting in 2013, the Commission initiated the Grand Coalition for digital jobs[39] as a cross-European, multi-stakeholder initiative to increase the provision of digital skills through stakeholder pledges offering ICT training, apprenticeships, placements, actions to facilitate mobility and/or carrying out awareness raising activities to encourage young people to study and pursue careers in ICT. The initiative has been successful in attracting over 60 pledges from more than 100 stakeholders, largely from the ICT sector, to train hundreds of thousands of people in new digital skills. It has also led to the development of 13 national and local coalitions, with more being planned. Going forward, the forthcoming New Skills Agenda will build upon the success of these Coalitions and set out specific actions to increase digital skills in Europe.

Close links of DIH with education and training providers at all levels would ensure capitalisation of local innovation by business actors as well as graduates' skills and competences in the local employment context and the availability of locally relevant and cutting-edge training and retraining offers.

The forthcoming New Skills Agenda for Europe will provide a comprehensive framework for employability, including the need for digital and complementary skills.

[38] Recommendation of the European Parliament and of the Council of 18 December 2006 on key competences for lifelong learning

[39] https://ec.europa.eu/digital-single-market/en/grand-coalition-digital-jobs

Together with all stakeholders, such as Member States, industry, social partners and education and training providers, the Commission will:

- Address these challenges as part of the **dialogue** with social partners on the impact of digitisation on work.
- Reinforce the role of industry and research organisations in the Grand Coalition and stimulate further commitment from industry to take action.
- Improve the understanding of skills requirements for new technologies, including within H2020, and promote the development of digital skills and stimulate partnerships for skills within the framework of the **New Skills Agenda for Europe**.
- Engage Digital Innovation Hubs (DIH) in skills for mid-caps and SME.

5 Conclusion

Less than a year ago, the strategy for a Digital Single Market proposed transformational actions for the European economy and society. This Communication presents measures to reinforce the industrial and innovation pillar of the DSM strategy. It invites to mobilise significant investments from Member States, regions and industry and calls on industry to join forces across the value chains and across sectors. The Commission invites the European Parliament and the Council to endorse this Communication and its accompanying Communications with a view to completing the Digital Single Market as soon as possible and to actively engage in its implementation, in close cooperation with all relevant stakeholders.