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INTERNET OF THINGS & 5G REVOLUTION

THE HIGHWAY FOR THE FUTURE OF EU SERVICES AND INDUSTRY

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1. INTERNET OF THINGS: DEFINITION, EXPECTED BENEFITS IN EUROPE AND ACTIONS TO PROMOTE

The Internet of Things (IoT) has been defined in different ways but, generally speaking, it refers to a global, distributed network (or networks) of physical objects that are capable of sensing or acting on their environment, and able to communicate with each other, other machines or computers.

Already in 2014 – but even before – European Commission analyzed opportunities and critical issues connected to IoT's development. In the document "*Definition of a Research and Innovation Policy Leveraging Cloud Computing and IoT Combination*" (2014), entrusted by the European Commission DG CONNECT to IDC EMEA, IoT is described as a "disruptive innovation" because it radically changes business processes within and across sectors. This report foresaw an IoT market's expansion in Europe with yearly growth rates over 20% in value between 2013 and 2020, an increase of the number of IoT connections within the EU28 from approximately 1.8 billion in 2013 (the base year) to almost 6 billion in 2020 and an increase of IoT revenues in the EU28 to more than €1,181 billion in 2020, including hardware, software and services.

In the document *"Internet of Things Opportunities and challenges"* (May 2015) the EU Parliament also highlights the importance of IoT for Europe recalling Gartner Group's predictions, worldwide by 2020, that the IoT will connect 26 billion devices and IoT product and service suppliers will generate incremental revenues of more than $300 billion and IDC's more optimistic previsions that the worldwide IoT market will grow from $1.9 trillion in 2013 to $7.1 trillion by 2020.

The EU Commission's paper identified the sectors which are successfully exploiting IoT technologies: smart manufacturing, smart homes (home security, energy applications and household appliances), smart transport, smart Government/smart environment, personal wellness applications and wearable devices (for generic and health-specific purposes), innovations connected to smart customer experience (digital signage, in-store digital offers and Near Field Communication (NFC) payment solutions). Considering the IoT's revolution, the EU Commission concluded that there was a need for policy action in Europe to contribute to R&D investments, stimulate the growth of the stakeholder community and the development of a strong IoT supply industry, open the way for the user industry to adopt this disruptive innovation, and create the main framework conditions needed for the development of the market, including the provision of skills, the building of trust and the removal of regulatory barriers.

To meet these challenges, the EU Commission developed a comprehensive IoT and Cloud Research and Innovation Strategy for Europe articulated in some main pillars. This Strategy, in particular, was focused on the importance of investments in the development of technologies for the IoT, Cloud, and Big Data combination (able to manage complexity, provide scalability, guarantee usability and preserve privacy by design), on supply's development (building the EU industry competitiveness, improving IoT readiness, ensuring SMEs capability to enter the market), on the promotion of IoT's take up by user industries and finally on the creation of favourable framework conditions for the development of the IoT ecosystem (developing necessary skills, building trust in the emerging IoT economy, removing regulatory barriers, and encouraging international cooperation).

A working document of the Commission, *"Advancing the Internet of Things in Europe"* (April 2016), highlights the importance of IoT's development for European Union and the need to launch initiatives and actions to guarantee spectrum availability, network coverage and the introduction of mechanisms for the identification of physical and virtual/logical objects, to facilitate the flow and transfer of data, standardisation and interoperability and the creation of an ecosystem in which IoT technologies and their application are trusted, accepted, wanted, accessible and usable.

An awareness of the importance of the IoT spurred in March 2015 the establishment of the Alliance for the

Internet of Things (AIOTI), which is made up of the EU Commission and IoT industry players and which aims to give EU the lead in the IoT field creating a dynamic European IoT ecosystem.

The importance of IoT's development is also acknowledged in Horizon 2020, the European Union program created to promote the funding of research and innovation in Europe in 2014-2020. The fields of application of the projects, said "IoT Focus Areas", which benefit from funds (deadline notice on 12 April 2016) were smart city, smart life, industry 4.0, infrastructure security, food security, automated guided vehicles, smart home, wearable technologies, while a second call is scheduled in December 2016 (deadline in April 2017) for the development of IoT advanced architectures, artificial intelligence and smart networks.

2. 5G DEVELOPMENT IN EUROPE

We are living in a society where everything will be connected, video and data volumes will be paramount and technologies will face new challenges ensuring high performances. So the extraordinary diffusion of Internet and mobile devices and the prospects of development of the IoT call for a reflection on the need to promote technological progress and, in particular, 5G implementation.

In this revolutionary contest, 5G is the new generation of radio systems and network architecture that will revolutionize businesses and the lives of citizens/consumers. 5G, indeed, is the next chapter of telecom networks designed to meet a more advanced and more complex set of performance requirements, being able to support more users, more devices, more services and new use cases through more efficiency and speed. In particular, a wide range of opportunities from 5G can be identified:

- data rates up to 100 times faster (more than 10 Gbps);
- network latency lowered by a factor of five;
- mobile data volumes 1,000 times greater than today's;
- battery life of remote cellular devices stretched to 10 years or more;
- increase of the number of devices connected to the network (1 mln per 1 sq km);
- possibility of use of several bands from 400 MHz to 100 GHz.

European institutions underline the importance of 5G deployment. Indeed, on 17 December 2013 the EU Commission signed a landmark agreement with the "5G Infrastructure Association", representing major industry players, to establish a Public Private Partnership on 5G (5G PPP) and accelerate research developments in 5G technology.

With regards to the timeline, many operators have predicted 5G commercial availability starting from 2020.

Subsequently, the *"5G Manifesto for timely deployment of 5G in Europe"* (July 2016) highlighted that standards and coordination across European stakeholders for pre-commercial trials are very important for 5G development.

A two-phase trial roadmap, encompassing different use-cases, is being proposed.

- **Before 2018** (before the availability of the first 5G 3GPP release): Technology trials run by independent trial consortia in various countries, independent of the status of standardisation, demonstrate and validate new 5G capabilities as well as foster an ecosystem around new 5G capabilities. Vertical industries will already be involved in this phase.
- **Around 2018** (5G 3GPP first release close to being finalised – and additional frequency spectrum for 5G expected to be identified in WRC 2019 to enable the full performances capabilities of 5G in terms of capacity and speed): European stakeholders agree on trial specifications (use-cases, scenarios, interfaces, agreement to transfer use-cases across trial networks) valid for pan-European trials, based as much as possible on standard-compliant systems. These trials aim to demonstrate wider interoperability and support for vertical use-cases in order to claim global public attention.

This document highlights the importance of spectrum aspects of the Digital Single Market – namely, harmonisation and predictability of spectrum policy across Member States (including spectrum availability, licensing procedures and costs, licence terms, and liberalisation and renewal of existing spectrum) to promote investment into the mobile sector and in 5G and, in general, the need to encourage 5G deployment synchronised across Europe to achieve homogenous availability both in terms of location and time (by 2020). 5G Manifesto identifies the actions to promote 5G development and in particular: reduction and simplification of the rules on access to key infrastructure, deployment barriers' removal, prevision of incentives for all players and, where access regulation remains, promotion – wherever possible – of long-term commercial agreements that enable competitive outcomes as an alternative to regulation. The same document underlines the importance of the creation of a level playing field with equivalent and proportionate privacy requirements to innovate in data-driven markets and the danger of restrictive net neutrality rules, in the context of 5G technologies, business applications and beyond.

Finally the documents *"5G Global Developments"* and *"5G for Europe: an Action Plan"* (14.9.2016) underline the importance and the benefits for several economic and industrial sectors and identify eight actions to promote 5G deployment: 1) promoting preliminary trials from 2017 onwards and pre-commercial trials with a clear cross-border dimension from 2018, encouraging the adoption by Member States of national 5G deployment roadmaps and the identification at least one major city to be "5G enabled" by the end of 2020; 2) identifying – in accordanced with Member States – by the end of 2016 a list of pioneer spectrum bands for the initial launch of 5G services; 3) adopting an agreement around the full set of spectrum bands (below and above 6GHz) to be harmonised for deployment of commercial 5G networks in Europe; 4) setting roll-out and quality objectives for the monitoring of the progress of key fibres and cell deployment scenarios identifying actionable best practice to facilitate – also incrementing administrative conditions – denser cell deployment; 5) promoting by the end of 2019 the availability of the initial global 5G standard, the standardisation on radio access and core network challenges and the conclusion of cross-industry partnerships; 6) planning technological experiments to realize as early as in 2017 and presenting detailed roadmaps by March 2017 for the implementation of advanced pre-commercial trials; 7) encouraging Member States to consider 5G infrastructure's usage to improve the performance of communication services used for public safety and security; 8) identifying assumptions and modalities for a venture financing facility.

Considering the importance of 5G development and EU investment in 5G research and standards, the European Commission has earmarked a public funding of 700 million euro through the Horizon 2020 Programme.

3. INDUSTRY 4.0

European manufacturing is largely losing ground on a global level: in 1990 the manufacturing value added produced in Western Europe was 35% of global value added; in 2014, this share collapsed to 23%, largely in favor of Asian countries. This is the most important reason why European Union cannot continue to ignore the challenge posed by the fourth industrial revolution, better known as Industry 4.0.

Industry 4.0 is "the comprehensive transformation of the whole sphere of industrial production through the merging of digital technology and the Internet with conventional industry". In short, everything in and around a manufacturing operation (suppliers, the plant, distributors, even the product itself) is digitally connected, providing a highly integrated value chain.

Digitization is finding its way into horizontal as well as vertical value chains to an equal extent. It thus optimizes and generates a huge flow of information and data.

The data market value in the manufacturing industry amounted to almost 12 billion euro in 2015 and is

expected to grow by 54% to over 18 billion euro in 2020.

The manufacturing industry is also the lead industry as to spending on data market – with a value of over 132.000 euro in 2015 (7% of total ICT spending in 2014) – and the second vertical market that accounts for the largest number of data users – about 111.000, expected to reach 123.450 units by 2020, a growth of 11%, approximately in line with the other sectors.

Digitalized manufacturing will result in a wide range of changes to manufacturing processes, outcomes and business models. Smart factories allow increased flexibility in production and mass customization, encouraging innovation, since prototypes or new products can be produced quickly without complicated retooling or the setup of new production lines. Industry 4.0 also improves the speed and efficiency with which a product can be produced, thanks to a reduction of redundancies, the minimization of quality losses and the increased flexibility discussed above, which altogether increases productivity.

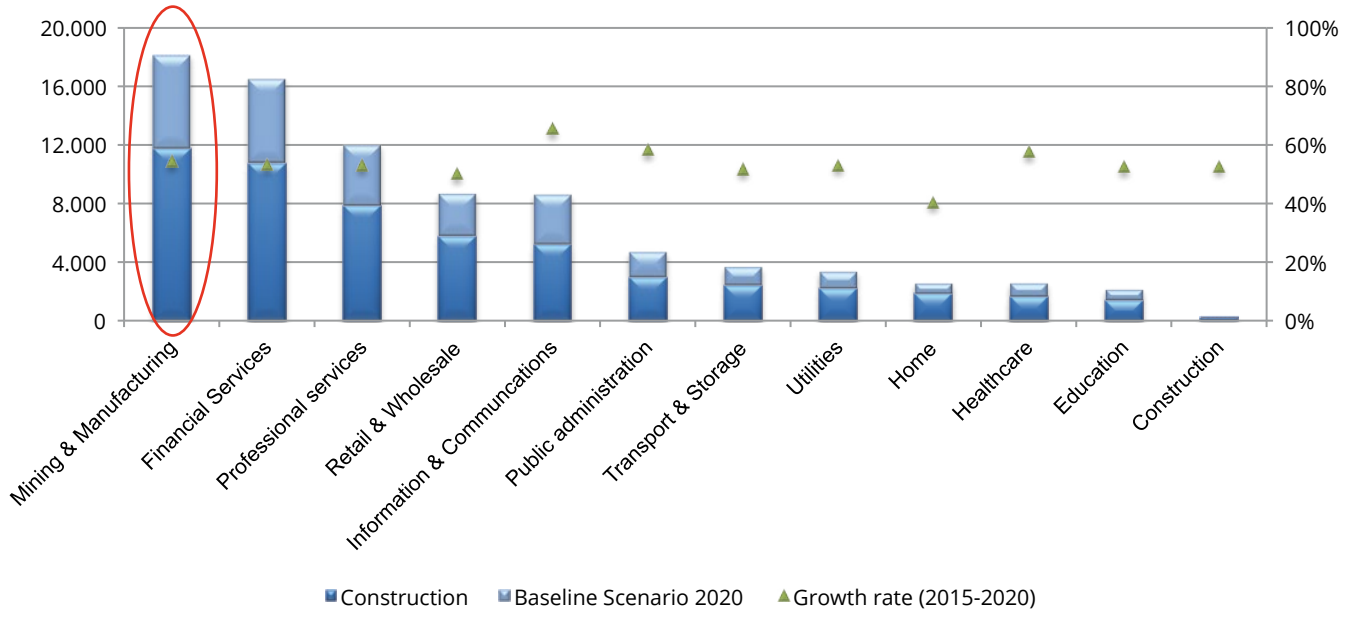
Investing on IoT initiatives may largely impact a manufacturing company's revenues: in the industrial manufacturing industry, according to Tata Consultancy data, revenues grew on average by 29% between 2013 and 2014 thanks to IoT investments.

Industry 4.0 will finally cause changes in business models. Rather than exclusively competing on costs, European companies can compete on the basis of innovation – meant as the ability to deliver a new product rapidly, on the ability to produce customer-driven customized designs (through configurable factories), or on quality (primarily associated with the reduction of faults due to automation and control). Some companies may finally take advantage of the data created as smart products are created and used, and adopt business models based on selling services not products: this "servitisation" can help to expand business opportunities and further increase revenues.

The ongoing digital transformation also has profound implications for employment in the manufacturing sector, affecting everything from the size of the workforce, required skill-sets, and the location of factories. Human workers will have to learn to work side-by-side and in conjunction with robots. There will be certainly job redundancies for low-skilled jobs and the need to shift towards more high-skilled complex jobs that require a generally more intense focus on continuous learning and education. Although some jobs will be lost, the level of cooperation between

Data market value, by sector (2015 vs. 2020)

Source: European Data Market Monitoring Tool (2016)



humans and machines will increase significantly. By adopting Industry 4.0, manufacturers will be able to increase their competitiveness, which will enable them to expand their industrial workforce at the same time that productivity increases. The higher demand resulting from the growth of existing markets and the introduction of new products and services will allow manufacturers to create new jobs.

Two types of new roles arising from Industry 4.0 will be: robot coordinator, overseeing robots on the shop floor and respond to malfunctions or error signals, and industrial data scientist, extracting and preparing data, conducting advanced analytics and applying their findings to improve products or production.

Six European countries (UK, Germany, France, Italy, Poland, and Spain) account for 72% of the total data workers in 2015. Nevertheless, the share of data workers on total employment is still too low in the manufacturing industry (2%, comparing with 10.4% in ICT or 9.2% in finance).

According to current data and estimates for the future, there is (and there will be) a substantial skill gap. According to IDC, in 2015, the gap between total demand and supply of data workers was equal to 396,000 unfilled data worker positions in EU (corresponding to 5.9% of total demand) and is expected to grow to 486,000 (6.6% of total demand). However, the forecast demand to 2020 of Big Data analysts – a specific category of highly qualified data workers with sophisticated technical skills – is expected to grow much faster than the demand for data workers, at a CAGR of 14.3%. This would lead to a potential supply-demand gap of 66,000 unfilled positions for Big Data analysts, corresponding to approximately 17% demand for them. This gap needs to be urgently addressed both by policy action and by the industry.

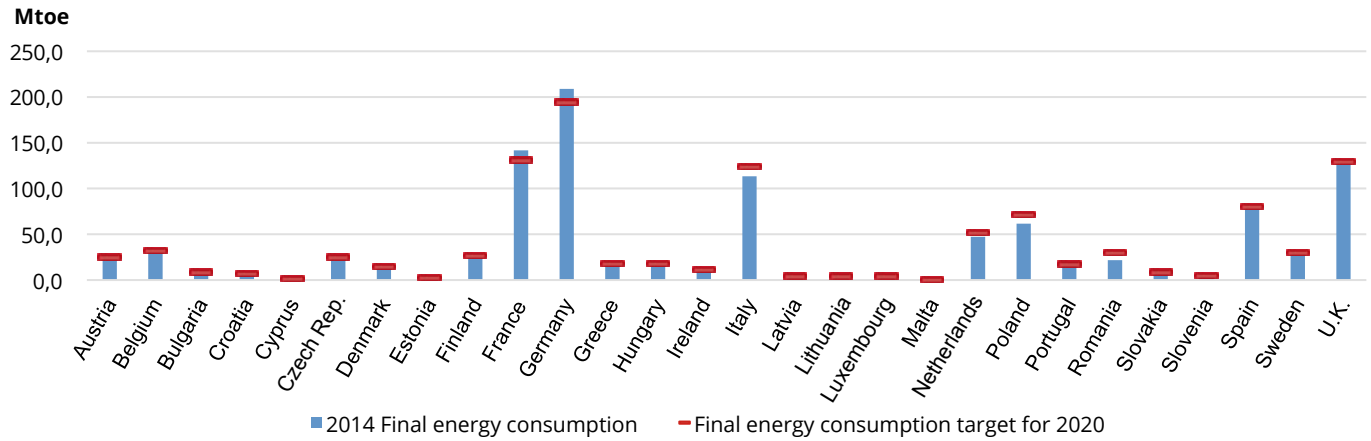
Another paramount question for the success of a EU strategy on digital manufacturing is ensuring an adequate level of harmonization and/or interoperability in terms of standards and protocols, based on open source models. National and sectoral barriers may significantly decrease the impact of the digital revolution in the manufacturing sector so coordination between Member States initiatives appears necessary and urgent.

4. ENERGY EFFICIENCY

Energy efficiency has a fundamental role to play in the transition towards a more competitive and sustainable energy system with the internal energy market at its core. The Energy Union Strategy confirmed the energy efficiency target of 20% by 2020, which means less than 1086 Mtoe of final energy consumption or less than 1483 Mtoe of primary energy consumption. This is the basis for moving forward to a reduction of

EU progress in 2014 towards indicative national energy efficiency targets for 2020

Source: European Data Market Monitoring Tool (2016)



at least 27% by 2030, having in mind a figure of 30%.
The graph shows progress toward energy efficiency target for 2020. EU-28 is expected to achieve energy savings of 18%-19% in 2020, missing the 20% target by 1%-2%. It should be noted that about one third of the progress towards the 2020 target will be due to the lower than expected growth during the financial crisis.
Between 2005 and 2014, final energy consumption decreased by 11% in the EU28. It was a result of decreases in industry, transport and household sectors, where final energy consumption dropped by 15.4%, 5.7% and 3.2%, respectively. In contrast, the services sector was the only one with an increase, by a figure of 5.7%, but the economic output of this sector increased by 11% which resulted in an improved energy intensity. More than 40% share of the European energy end-use is consumed by building sector, carried in the most part by gas, followed by electricity and oil. Household consumption per dwelling has been decreasing 1.5%/year at EU level, thanks to the energy efficiency improvement for space heating and the diffusion of new electrical appliances (A++).
With regards to digitalization in the energy efficiency, there are two main issues to consider, the first is the European framework to low carbon economy, the latter is the on-going revolution in the power sector.
In particular, the European huge effort in the transition to low carbon economy needs to be shared between Government and companies. Specifically, Governments should be ready to embrace the new trends and create the market conditions in order to make new technologies flourish; companies would have to completely reconsider their business model and the way they relate with customers.
Moreover, the energy industry is evolving from large centralized power plants owned by utilities to a new generation model, different in terms of ownership of the assets and the integration of new distributed energy resources into the grids.
The Internet of Things offers new potential to develop interconnected systems that can help to improve everyday life (e.g. smart grid, smart home, smart buildings) and promotes the process of empowering end customers. Although varying depending on estimates, the number of daily connected devices every day to 2020 will exceed 30 billion (and some estimates put the figure at 50 billion).
Currently, thanks to technological progress and distributed generation, the final consumer can produce, store and consume (or shift in time consumption) their own energy under fair conditions in order to save money, help the environment, and ensure security of supply. The 'prosumer' (consumers who also produce) could represent the first step towards the exchange of energy between users through digital platforms, in real time.
Regulation should encourage the use of new digital applications (and of new innovative services), ensuring the security of transmissions and adequate data protection. Although still unattractive for end users because of their costs or complexity, such digital applications and related services could bring many benefits to the system as a whole. In their long-term interaction, intelligent applications, smart grids and management platforms will lead to a new model of consumption, automatically and remotely managed.
The Internet of Things in the energy sector can enable a large variety of services. For example, thanks to smart meters, consumers can have access to a huge quantity of information and companies should help them in understanding how to improve their consumption. The roll-out of smart meters in the Union is occurring more slowly than expected due to different results of the CBA across EU member states, as well as concerns linked to the transmission of data security and privacy. The Third Energy Package sets a specific target for the electricity sector – 80% of consumers with a successful cost/benefit analysis by 2020 – but not for gas, for which "a reasonable period of time" is recommended.
Estimates predict that in Europe the market value of the Advance Metering Infrastructure (AMI) in 2020 will be approximately $9.2 billion compared to the $28.6 billion global market.
Italy, after the first mass deployment starting in 2001, will proceed with the replacement of first-generation

smart meters with those of the second (2G) in the electricity sector and AEEGSI (the National Regulatory Authority) has established a gas target as 50% of delivery points in 2018. Italy is also proceeding with the trial of multiservice smart meters (power, gas, water and "other" services).

5. DIGITAL HEALTHCARE

5.1. eHealth

The use of digital applications and solutions is becoming increasingly present in our daily lives, offering opportunities to take on several of the challenges of health systems (chronic disease and multi-morbidity, sustainability and efficiency of health systems, cross-border healthcare).

The European Commission's eHealth Action Plan 2012-2020 "Innovative healthcare for the 21st century" defines eHealth as "the use of ICT in health products, services and processes combined with organisational change in healthcare systems and new skills, in order to improve health of citizens, efficiency and productivity in healthcare delivery, and the economic and social value of health. eHealth covers the interaction between patients and health-service providers, institution-to-institution transmission of data, or peer-to-peer communication between patients and health professionals".

eHealth offers a broad range of advantages and benefits:

- helps patients manage their own health thanks to a better flow of information and interactions with health professionals (teleconsultations);
- through a greater access to personal health data for patients and health professionals, enables faster diagnosis, improved monitoring, more effective treatment and better health outcomes;
- improves healthcare efficiency and thus contributes to alleviating the burden on European health budgets. Some solutions for patient self-management could contribute to reducing the number and length of the hospital stays of chronically ill patients;
- facilitates access to healthcare services across Europe. Indeed, the use of eHealth might also support patient mobility and facilitate cross-border healthcare, as laid down in the Directive on patients' right in cross-border healthcare;
- offers to hospitals the possibility to improve care process, for instance via patient flow management systems. It could help hospitals and health professionals reduce medical errors.

However, there are some barriers that need to be addressed in order to reap the benefits of a fully mature and interoperable eHealth system in Europe:

- lack of awareness of and confidence in eHealth solutions among patients, citizens and healthcare professionals;
- lack of interoperability between eHealth solutions;
- lack of legal clarity for health and wellbeing mobile applications and the lack of transparency regarding the utilisation of data collected by such applications;
- regional differences in accessing ICT services, limited access in deprived areas;
- lack of IT literacy.

The eHealth Action Plan 2012-2020 establishes operational objectives to remove these barriers to the development of eHealth, enhancing quality, access and safety in healthcare across Europe. These objectives include:

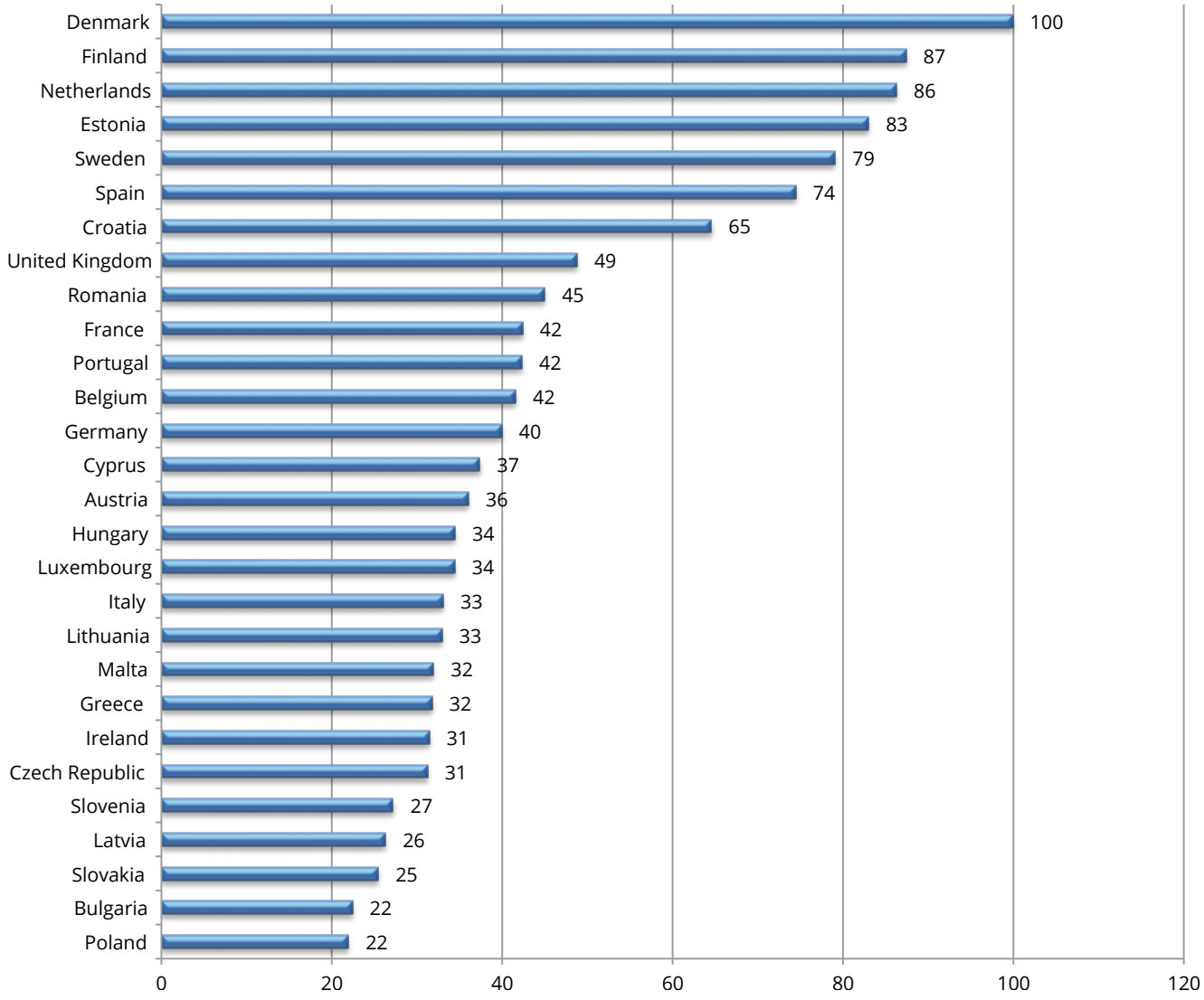
- achieving wider interoperability of eHealth services;
- supporting research, development and innovation in eHealth and wellbeing to address the lack of availability of user-friendly tools and services;
- facilitating uptake and ensuring wider deployment;
- promoting policy dialogue and international cooperation on eHealth at global level;
- addressing the organisational layer and legal issues.

Furthermore, the Action Plan includes actions to increase digital health literacy of health professionals and patients.

The European Commission selected four key indicators (seeking online information about health; making an appointment with a practitioner via a

Level of eHealth in European countries

Source: I-Com on the EU Commission data



website; GPs (General practitioners) using electronic networks to transfer prescriptions to pharmacists; GPs (General practitioners) exchanging medical patient data with other healthcare providers and professionals), which illustrate the performance of European countries in terms of eHealth, allow a comparison of progress across European countries as well as over time and illustrate how doctors and patients use internet to communicate, inform and exchange information about health.

According to the synthetic index, which is based on the four key indicators of the EU Commission and describes the level of eHealth in European countries, the most advanced country is Denmark, followed by Finland, Netherlands, Estonia and Sweden. These countries have in common a high level of digitalization in doctor's offices and an high number of patients who use mobile and internet technologies for searching health information and making appointments online with doctors.

5.2. mHealth

The Internet of Things has a compelling impact on the global economy, through the transformation of various sectors, including health. This technology – known as mHealth as regards healthcare – is transforming the

medical industry and is improving care system and cost efficiencies.

According to the Green Paper of the EU Commission and the definition by the WHO, mobile Health (or mHealth) is a component of eHealth and refers to medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices. It also includes applications (apps) such as lifestyle and wellbeing apps that may connect to medical devices or sensors (bracelets or watches) as well as personal guidance systems, health information and medication reminders provided by sms and telemedicine provided wirelessly.

Mobile technology integration within the health sector has great potential to promote effective communication in health care settings, supporting health professionals and patients in improving decision-making.

The market for mobile apps has developed very rapidly in recent years to become a key driver of mHealth deployment, facilitated by smartphone penetration. According to estimations of IMS Institute, the number of mHealth apps available to consumers now exceeds 165,000.

The demand for mHealth apps is increasing every year. According to Research2guidance, 2015 was another extraordinary year for mHealth: the total number of mHealth app downloads worldwide reached 3 billion.

According to Allied Market Research, the global mHealth market was valued at $10.5 billion in 2014 and it is expected to reach $59 billion in 2020.

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