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1. The Next Generation Internet Initiative

The Internet has transformed our world since its invention in 1965, becoming the fuse of an entire era, The Internet Revolution[1]. The global economy is undergoing a digital transformation as well, and it is happening at fast-moving speed, with billions of everyday online connections among people, businesses, devices, data, and processes. The backbone of such Digital Economy is hyper-connectivity, where the ever-growing consumer dependence on technology demands more, better and digital-centric products and services.

The explosion of emerging technologies such as the Internet of Things, 5G Communication Networks, Artificial Intelligence, Blockchain and Cybersecurity promise to meet -and exceed- the expectations at technical level in a wide spectrum of industries, including healthcare, public services, mobility or finance - to name just a few. Each technology alone can bring its own opportunities and challenges, but the biggest potential breakthrough lies in their combination within one digital technology ecosystem. Assessing the opportunities and challenges created by the use of each of these technologies alone and in combination is thus essential to developing policies well-suited to the digital age.

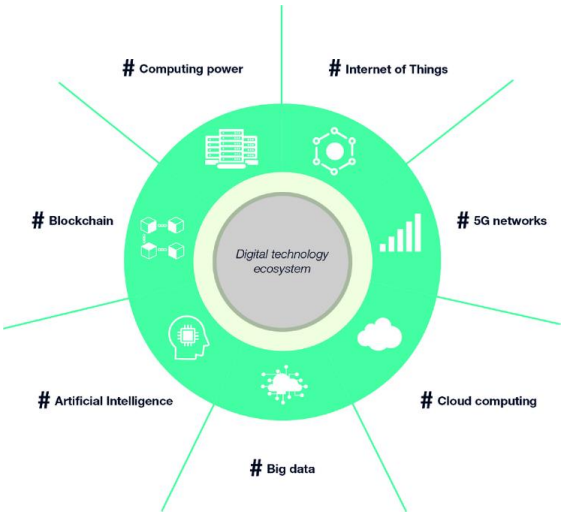

Figure 1 – The Digital Technology Ecosystem (Source: OECD)

Digital transformation is pushing all market sectors to level up their digital capabilities so as to better serve customers and increase the user experience. Having access to a deep level of insight about a consumer, and being able to interpret it rapidly, is the difference between a happy and loyal customer, and one that abandons the interaction.

Thus, **data is the 'fuel' of the digital technology ecosystem**. In contrast to natural resources, the volume of data increases with its collection and use. Digital data can be copied and re-used endlessly, enable economies of scale and scope. In the very near future, every company in the world will either buy or sell data as this asset continues to gain value, creating strategic unfair advantages in business models. Without access to hyper-relevant data for decision making, service providers will quickly become isolated and disconnected. Data is driving the customer experience, and analytics, machine learning and AI running on advanced hardware platforms are empowering companies to look at data as strategic enabler not an output product.

Yet, although digital technology is rapidly transforming the world's socio-economic fabric for good, the codes of ethics that rule algorithms-writing, access and exploitation of data will also have a determining impact on how the societies of the future evolve. Data-driven technology advancements carry significant risks, that include erosion of individual privacy, misinformation, misuse of data, increase of cybersecurity threats, and boost weapons capabilities in the hands of state as well as non-state actors. It is difficult to assess the value of data in itself, given that value is essentially created when data are contextualised and analysed to derive information. The benefits of storing, using, accessing and sharing

[1] O'Regan G. (2016) The Internet Revolution. Introduction to the History of Computing. Undergraduate Topics in Computer Science. Springer, Cham

data come with potential risks that may arise from any of these activities, and risks need to be managed well to maximise benefits. This balancing act involves costs and legitimate private, national, and public interests, in particular the rights and interests of the stakeholders involved in producing and using data.

"By creating a connected digital single market, we can generate up to EUR 250 billion of additional growth in Europe during the mandate of the next Commission, thereby creating hundreds of thousands of new jobs, notably for younger job-seekers, and a vibrant knowledge-based society". Jean-Claude Juncker, extract from the Political Guidelines for the next European Commission (EC)[2]. Since the beginning of its mandate in 2014, the EC has shown its strong commitment to open digital opportunities for people and business and to enhance Europe's position as a world leader in the digital economy[3]. As part of this priority and more than ever, the Internet is expected to play a major part in driving forward the growth of the European economy, but also **the growth of the European competences in terms of technological and social innovations, market and regulation**. By 2050, the world population is expected to have reached nine billion, 60% being older than 50. 75% of the population will live in cities, over 60% in small households. Thus, sustainable solutions to problems such as energy supply, logistics, health care, security, water and food supply need to be implemented world-wide.

The main objective of the Digital Single Market (DSM)[3] plan adopted in May 2015 is to generate smart, sustainable and inclusive growth in Europe. A DSM to create opportunities for new startups and allow existing companies to reach a market of over 500 million people, potentially contributing EUR 415 billion per year to Europe's economy. Since then, the Commission has delivered all the major proposals set out therein.

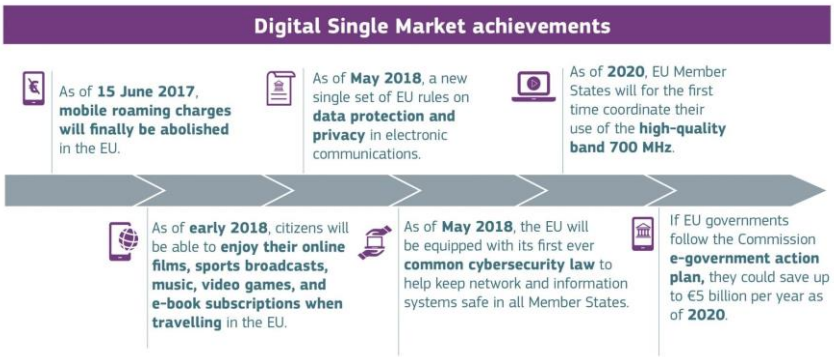

Figure 2 - Digital Single Market achievements (Source: Digital Single Market Mid-term Review)

The digital revolution, if well managed, offers the opportunity to **drive market competitiveness and technological leadership,** energizing the Research and Innovation capabilities of academia, industry, small and medium-sized enterprises and entrepreneurship. The European Commission estimates that **in 10-15 years from now the Internet will become an even more indispensable motor for any socio-economic activity worldwide.** For this reason, it is needed a forward-looking agenda to reshape the evolution of Internet, stimulating a human-centric vision. Europe shall take leadership in this revolution in line with its values such as openness, inclusion, protection of data and privacy thereby contributing to making the future internet more trustworthy. An Internet for the people, that contributes to a more sustainable and inclusive society.

With this vision, the EC launched in 2016 the **Next Generation Internet (NGI)** as part of the DSM Strategy. An initiative to implement "the Internet of the future, that should be more open, provide better services, more intelligence, greater involvement and participation. It needs to reflect the European social

[2] A New Start for Europe: My Agenda for Jobs, Growth, Fairness and democratic Change, Jean-Claude Juncker, 15 July 2014. http://ec.europa.eu/priorities/sites/beta-political/files/juncker-political-guidelines-speech_en_0.pdf
[3] Digital Single Market Strategy for Europe, European Commission, 6 May 2015. http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52015DC0192&from=EN

and ethical values: free, open and more interoperable". This ambition requires the involvement of the best Internet researchers and innovators to address technological opportunities arising from cross-links and advances in research fields ranging from network infrastructures to platforms and application domains to social innovation.

Figure 3 – The Next Generation Internet Initiative

The success of the NGI will be measured on its ability to allow Europeans to flourish both individually and collectively within this new era of enhanced connectivity, and, at the same time, to provide European industry with the tools to gain a competitive advantage within an interoperable technological global environment.

1.1. Technologies and applications for an Internet of Humans

The NGI initiative is radically different from historical efforts undertaken in the European ICT domain; rather than just stimulating Research and Development in a number of key 'stand-alone' technology areas, the NGI initiative aims to challenge the vision of the whole internet – and have a major impact at the system level. In order to enable ambitious social objectives, the NGI articulates a powerful vision for the Internet as the key enabling technology for any future innovation– anchoring the core European values and the spirit of democracy into the technology.

Thus, NGI includes a broad number of different -but always interrelated- emerging technologies into the following focus areas:

AI and Autonomous Machines, as defined in the Digital Innovation Networks (DIN) Forum 2017[4], are intelligent self-driven machines (robots) that are capable to sense their surrounding environment, reason intelligently about it, and take actions to perform tasks in cooperation with humans and other machines in a wide variety of situations on land, sea and air. With the development and proliferation of autonomous machines, a paradigm shift will occur within the industrial and societal domains. The field of Artificial Intelligence (AI) is perhaps the most characteristic example of such considerations. It is predicted that machines working on decision-making algorithms will take up a greater part of the production lines in industries, while other service areas have already started to incorporate AI to perform tedious tasks. Discussions on the ethical dilemmas and potential social impacts from the introduction of such technologies, balanced with the need for greater autonomy, have only started to emerge;

Blockchains & Distributed Ledgers advocate a decentralized, transparent, and more democratic version of the Internet[5]. Essentially being a trusted and decentralized database, blockchain finds its applications in fields as varied as the energy sector, forestry, fisheries, mining, material recycling, air pollution monitoring, supply chain management, and their associated operations. Smart contracts as implemented in blockchain technology enabling automatically enforced agreements. Blockchains have been considered to enforce trust in the voting process[6] and other government-related processes.

[4] "Digital Innovation Networks (DIN) Forum 2017". Brussels, Belgium. June 2017

[5] Hassan, F. U., Ali, A., Latif, S., Qadir, J., Kanhere, S., Singh, J., & Crowcroft, J. (2019). Blockchain And The Future of the Internet: A Comprehensive Review

[6] Osgood, R. (2016). The future of democracy: Blockchain voting. *COMP116: Information Security*, 1-21

However, distributed deployment faces the risk of different jurisdiction, lack of standards, potentially conflicting with the right to be forgotten and lack of anonymity.

Big Data is considered a critical part of NGI. As data has become a key asset for the economy and our societies similar to the classic categories of human and financial resources the need to make sense of "Big Data" is leading to innovations in technology, development of new tools and new skills[7];

Internet of Things (IoT) is marked as the top technology driver by the number of sources. From the results of a large-scale survey of European citizens[8], IoT is among the most promising technologies which may have larger impact not only on peoples' personal lives but also in the labour market. At the DIN Forum 2017, almost 80% of participants expressed IoT as the key technology driver for NGI;

5G is the next generation of telecommunication systems will be one of the most critical building blocks of our digital economy and society in the next decade. Europe has taken significant steps to lead global developments towards this strategic technology[9];

Cybersecurity and privacy technologies should become in the next decade complementary enablers of the EU digital economy, ensuring a trusted networked ICT environment for governments, businesses and individuals. The compliance of the European infrastructures, products and services with relevant directives/regulations (e.g. GDPR) and standards will promote trust and confidence to the European consumers and providers/suppliers, paving the way for a competitive, trustworthy Digital Single Market;

Cloud and Edge Computing are estimated to provide huge potential to empower the estimated 64 billion of Internet of Things devices being deployed globally by 2025[10]. Cloud/edge computing are crucial enablers to improve the performance and reduce operational costs in the following areas: i) autonomous driving, ii) healthcare monitoring, iii) industry 4.0. The reduced need for dedicated hardware, lowers de boundaries for the average consumer to benefit from services which previously were only available for parties wealthy enough to finance their own dedicated hardware resources. Nevertheless, storage and computation on other location than the original location induces potential wiretapping or man in the middle attacks, distributed datacentre deployment means different jurisdiction.

Open Data has been always considered as critical by the Commission, especially for start-ups, as discoverable and easy to access and process data will boost the competitiveness of the EU IT industry. There is a need to develop and "open link" in order to overcome the challenges of format interoperability among data representation and data sources;

1.1.1. Key Application Areas

Since 2016 the **initiative has already defined some key application areas** which are expected to be greatly impacted by the emerging NGI technologies[11]:

Industry 4.0: Industry 4.0 is a name for the current trend of automation and data exchange in manufacturing technologies. It includes cyber-physical systems, the Internet of things, cloud computing and cognitive computing. Industry 4.0 is commonly referred to as the fourth industrial revolution. It is considered to be the next phase in the digitization of the manufacturing sector. It relies on Internet services and knowledge is largely shared across the network in order to exploit this available knowledge for faster and better robotic learning.

[7] Digital Single Market – Big Data. https://ec.europa.eu/digital-single-market/en/big-data
[8] "Key issues arising from multiple consultations concerning The Next Generation of the Internet". University of Southampton IT Innovation Centre. September 2017. https://zenodo.org/record/1284073/files/HUB4NGI%20White%20Paper%20-%20Next%20Generation%20Internet%20Key%20Issues%20-%20v6.pdf
[9] Digital Single Market – Big Data. https://ec.europa.eu/digital-single-market/en/towards-5g
[10] Internet of Things Statistics 2019. Web page: https://techjury.net/stats-about/internet-of-things-statistics/
[11] NGI 2016 workshop minutes

Immersive Environment: With the advancement in AI and learning algorithms, the immersive environments such as Virtual Reality (VR), Augmented Reality (AR) are also expected to be leveraged. However, these new forms of interactions and immersive environments might also face the challenges of data privacy, diversity and the concentration of data into proprietary platforms. Understanding the psychological & biological effects and threats and opportunities for industry and citizens is necessary in the VR world.

Collective User Experience: Decentralised, heterogeneous and distributed architectures are important in the next generation digital society. For an enhanced user experience, human-centric technologies need to be identified, propagated and managed.

Lifelong Learning: ICT lifelong learning is important in order to raise people's awareness of the significance of acquiring ICT skills throughout their lives.

Inclusiveness: Each citizen has the right to benefit from modern ICT services and technologies. And the services should be designed in simple and easy to use way so that everyone including persons with disabilities could get benefit. Ubiquitous access to Internet and other ICT services is the right of each citizen just like access to clean water or energy infrastructure. Inclusiveness and ubiquitous connection are the key themes for civil society. The important risk factor is the potential isolation of those behind general levels of connectivity. There is a need to take immediate actions in order to bridge the digital divides and to cope with the digital literacy challenges.

Protection from the dangers of the Internet: Ordinary Internet users are not fully aware how deep they are in the Internet. They sometimes disclose very personal information against social engineering attacks. This poses not only a data protection problem but also people themselves protection. It is important for emerging NGI technologies to protect people from dangers of the Internet.

1.2. Drivers and impediments for a Global Digital Single Market

Science and Technology are the backbone of the Internet, but their exploitation into tangible results is necessary to have an impact over the society. Innovation and Entrepreneurship are the drivers to transform the technological excellence of Internet into economic performance, competitiveness, growth and application to societal challenges and vertical domains. The Entrepreneurship 2020 Action Plan[12] - published by DG Internal Market, Industry, Entrepreneurship and SMEs- summarizes the action priorities identified by the European Commission in this regard.

According to EC's European Innovation Scoreboard 2019 [13] , EU's innovation performance has been improving for four years in a row, outperforming that of the United States for the first time. However, China is catching up at 3 times the EU's growth rate and Canada, Australia and Japan maintain a performance lead over the EU. This still reflects the tough environment for entrepreneurs in Europe: education does not offer the right foundation for an entrepreneurial career, difficulty in transferring businesses, the fear of punitive sanctions in case of failure and of course the difficult access to finance.

Figure 4 – Overview European Innovation Scoreboard 2019 (Source: European Commission)

Competitiveness - The tech giants dominating the European digital economy in 2018 hail from the US,

[12] European Commission's Entrepreneurship 2020 Action Plan. https://ec.europa.eu/growth/smes/promoting-entrepreneurship/action-plan_en

[13] European Innovation Scoreboard 2019. https://ec.europa.eu/growth/industry/innovation/facts-figures/scoreboards_en

and their main competitors are Chinese, not European companies. Google, Amazon, Facebook and Apple (GAFA) have now a higher market capitalization than the whole French index CAC40. Ensuring Europe's competitiveness within the digital revolution requires fundamental measures. Recent reports by Accenture/Frontier Economics, McKinsey and PWC conclude that AI will be a game changer for total factor productivity and growth, by gradually rising as a third pillar of production, together with labour and capital. Learning from success factors mainly from the US, Europe should focus its efforts on deepening the Digital Single Market through harmonisation. The Programme for the Competitiveness of Enterprises and Small and Medium-sized Enterprises (SMEs) -COSME- is the Union's programme to strengthen the competitiveness and sustainability of enterprises, to encourage an entrepreneurial culture and to promote the creation and growth of SMEs.

Digital Transformation - The modern global economy is increasingly driven by digitalization. The main challenge in the coming years remains the transformation of traditional industries and businesses. Improving the productivity and innovative potential in sectors like Energy, Agriculture, Media, Automotive and Industry (the manufacturing sector in the European Union accounts for 2 million enterprises, 33 million jobs and 60% of productivity growth) by successfully adopting new technologies will be crucial in order to maintain the competitiveness. Europe could gain an additional €2.5 trillion ($2.8 trillion) of GDP in 2025 through further digitisation. However, Europe underperforms on its digital potential relative to the United States. The European digital frontier, represented by the ICT sector and its digitisation of assets, uses, and labour, is only 60 percent as digitised as the US frontier. Overall Europe operates at only 12 percent of its digital potential exhibited by the digital frontier in the United States.

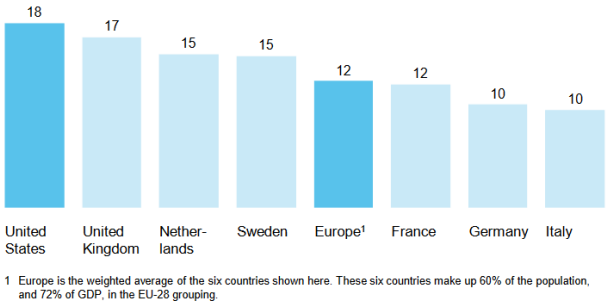

Figure 5 – Captured potential by country % (Source: McKinsey Global Institute analysis)

Innovation Ecosystems - There is less research on ground-breaking technologies like Artificial Intelligence in Europe than in China and the US. Companies in the EU are also less effective in turning research into profits. Different factors seem to have contributed to the success of giant American tech firms: risk-taking institutional frameworks for rapidly turning innovations into business; a wide access to private funding (average venture capital-backed US companies receive five times more VC than its EU counterparts); or counting on rapid internationalisation and diversification strategies. Support to Digital Innovation Hubs will help companies become more competitive by improving their business/production processes as well as products and services by means of digital technology, as well as giving them access to experimentation facilities to potential users.

Startup Acceleration - Accelerators are an increasingly popular approach to supporting the whole process from the entry of possible entrepreneurs to the continuous support during the lifecycle stages of enterprises. In Europe, policymakers have recognised the potential of acceleration schemes and have started to adopt and adapt them to their own policy objectives. As part of its Startup Europe initiative[14] the European Commission identified the following categories of support as fundamental: Providing training/advisory/mentoring services to young startups to prevent early failures; Supporting the creation of incubation centres, accelerator programmes and co-working spaces for startup projects; Enabling

[14] Digital Single Market – Startup Europe. https://ec.europa.eu/digital-single-market/en/startup-europe-building-ecosystem

links between source of knowledge and source of finance to facilitate access to finance for viable startup projects. The Accelerator Assembly[15] is a network for startup accelerator programmes in Europe. Such network offers dedicated events for startups and accelerators but also gathers and shares knowledge about trends and developments in the acceleration industry.

Access to finance - one of the main pitfalls faced by the European startups is the access to capital, while an important component of a successful entrepreneurial ecosystem consists of an array of early stage investors (venture capitals and business angels) that provide seed and first round equity investments. EU startups still have to rely more often on local banks and loan-based financing, as equity-financing is not as developed as in the US. Many European startups have been forced to seek US-based investors or to be bought by US firms. In both the euro-area crisis countries and in the EU11 the depth of local capital markets and the lack of investment opportunities seem to undermine private equity activity. Facilitating the financing of European companies through external equity should be a central ambition of European Union financial regulation, including in the European Commission's capital markets union agenda.

Internationalisation - Fostering efficiently the internationalisation remains a policy challenge and a crucial aspect of the competitiveness of European industry. Operating internationally has become an important business opportunity, mainly for SMEs, that have developed domestically a portfolio of valuable and rare resources. It will be critical to assess the interest and challenges for internationalisation capacity between Europe and the US, identifying facilitators and barriers, factors that might be influencing a better performance (geography, nature of business community, effective support mechanisms, appetite & capacity within companies etc.) and an evaluation of the effectiveness and efficiency of support mechanisms.

Mobility Schemes - Trends demonstrate an increasing interest in deploying staff exchange and mobility schemes to enhance innovation performance and accelerate learning and good practice as a way of knowledge exchange. Programmes such as ERASMUS[16] have demonstrated for many years the added value of such initiatives, supporting mobility and exchange programmes in the fields of education, training, youth and sport. The ERASMUS "brand" has also been deployed in support of young entrepreneurs through the Erasmus for Young Entrepreneurs programme[17]. In this context, the EU-US collaboration on NGI will drive a dedicated initiative to support missions of high-level European innovators in the US.

2. Transatlantic Cooperation on Next Generation Internet

As for cooperation in the field of Information and Communications Technology, Europe and the USA must seek a joint framework to expand efforts in new emerging technologies, while preserving common principles around a comprehensive EU-US digital economy dialogue. China aims to become the world leader in science and innovation by 2050, and in Artificial Intelligence by 2030 to lay the foundation for its economic dominance. With Digital authoritarianism pulling into the pole position in this race, **it is time for the United States and Europe to forge a digital governance alliance**.

[15] Startup Europe's Accelerator Assembly. http://www.acceleratorassembly.eu/
[16] Erasmus+. https://ec.europa.eu/programmes/erasmus-plus/node_en
[17] Erasmus for Young Entrepreneurs. http://ec.europa.eu/growth/smes/promoting-entrepreneurship/support/erasmus-young-entrepreneurs_en

2.1. State of Collaboration

The partnership between Europe and the United States for Research and Innovation is governed by the "Agreement for Scientific and Technological Cooperation" that was originally signed in Washington on December 1997, being renewed four times, last one happening on October 2016[18]. “Bright ideas should know no boundaries, so European research and innovation is open to the world for collaboration. This agreement means that the best talent on both sides of the Atlantic will be able to work even closer together on tackling the global challenges that our societies are facing” - Carlos Moedas, European Commissioner for Research, Science and Innovation. As a result of this memorandum of understanding, up to October 2017, US entities have participated 1115 times to 845 signed grants of Horizon 2020, receiving EUR 36.7 million of direct EU contribution while EUR 107.0 million is the non-EU budget of U.S. beneficiaries[19].

The initial roadmap for cooperation between the US and the EU on research and innovation was developed in 2014 identifying the next future priorities by the Joint Consultative Group (JCG), among which interoperability of global data infrastructures and digital science policy framework; e-Infrastructures related to Open Access, Open Research Data and Digital Science. Several initiatives built further on this baseline and expanded cooperation including the protection of intellectual property rights as strong drivers for increased trade and future economic growth as of the EU-US Summit in March 2014. This triggered a **EU-US Cyber and Digital Economy dialogue** for which recently the 6th edition took place in June 2019[20]. This event focused on enhancing the cooperation on a number of cybersecurity foreign policy issues, resulting into the following outcomes:

- Commitment to a global, open, stable and secure cyberspace where the rule of law is fully respected, where the same rights that individuals have offline are also protected online, and where the security, economic growth, prosperity, and integrity of free and democratic societies is promoted and preserved;
- Engagement in increasing the international community’s awareness, adherence to and implementation of the recommendations contained in the existing consensus reports of the UN Group of Governmental Experts (GGE) on cyber-related issues;
- Development and implementation of Cyber confidence Building Measures (CBMs) to reduce misperceptions and the risk of escalation stemming from the use of information and communications technologies.

With the objective to keep reinforcing a mutual agenda on the Digital Economy and its impact on the society, the European Commission’s Directorate General for Communications Networks, Content and Technology (**DG CONNECT**) and the US National Science Foundation (**NSF**) established a joint EU-US committee in June 2017. The mission of such committee was oriented to identify and foster common priorities on research-focused networking testbeds, as well as research opportunities on the Next Generation of the Internet[21].

This committee identified several compelling drivers for joint EU-US research; i.e. cases for which joint research projects will be more effective than separate projects:

- **Many research challenges are inherently Internet-wide**: The Internet is a global infrastructure and many challenges cannot be partitioned into per-county or even per-continent challenges. Examples include internet-wide management of CDNs and clouds that must consider latency

[18] Implementing arrangement between the European Commission and the government of the United States of America for cooperation between researchers. 17 October 2016. http://ec.europa.eu/research/iscp/pdf/policy/eu-usa_implementing_arrangement_2016.pdf

[19] https://ec.europa.eu/research/iscp/pdf/policy/us_roadmap_2018.pdf#view=fit&pagemode=none

[20] Joint Elements Statement on the Sixth EU-U.S. Cyber Dialogue. Web page: https://eeas.europa.eu/headquarters/headquarters-homepage/64495/joint-elements-statement-sixth-eu-us-cyber-dialogue_en

[21] EU/US Future Networks Workshop. Brussels, Belgium. June 26-28, 2017

requirements and geo-diversity, and Internet control functions such as inter-domain routing, traffic engineering, and monitoring. Research in these areas can benefit both from shared research infrastructure and collaborative research.

- **Dealing with fundamentally different requirements or constraints**: Legal and regulatory requirements with respect to networking and cloud computing differ across countries. Examples include wiretapping laws and rules about user privacy both at the network and application level. Research in how both operators and users can be deal with this diversity naturally benefits from international collaboration.
- **Opportunities to learn from different research approaches or contexts**: Business models and network deployment models differ across countries, e.g., home networks and IXPs. This has led to different research approaches and opportunity to learn from each other. Along the same lines, the US and EU have focused on different types of future internet architectures (clean slate versus evolutionary), similarly creating opportunities for collaboration.
- **Enablers for future research**: There is an increasing interest in software-defined infrastructures, making interoperability an important challenge. Defining APIs and open source platforms that are shared between the US and the EU (and more broadly) is an important enabler for future collaborative research. Examples include APIs and platforms for sharing virtual network functions and common ontologies for resource specifications, data integration and Big Data analysis, and sensors and IoT services.

2.2. NGI in the USA

The term Next Generation Internet in the United States was the subject of US Public Law 105-305 – the Next Generation Research Act of 1998[22]. That Act of Congress authorized appropriations to support the US Next Generation Internet program and to have it be monitored and advised by the President's Information Technology Advisory Committee. Given this prior use of the term, NGI is not much used in 2019 in the US to refer to the next generation of Internet. In 2018, Jack Brassil of the National Science Foundation coined the term "Tomorrow's Internet"[23]; the term « advanced cyberinfrastructure » is also commonly used. For reasons discussed in the 5G chapter, the many differing meanings of « 5G » in the US have reduced the specificity and usefulness of this term, and the US policy and program is focused on « Advanced Wireless » communications[24]. For the purposes of this book, we will continue to use the terms NGI and 5G in their European meanings to avoid internal cognitive dissonance.

US Internet policy has varied depending upon the political party in power. Under Democrats and President Obama, the Federal Communications Commission issued the Open Internet Order in 2015[25] requiring so-called network neutrality in which carriers would not discriminate in their handling of various types of traffic. Blocking, throttling, and paid prioritization were not permitted. Network neutrality was intended to allow companies that depended upon the Internet for delivery of their services to be treated no worse than the carrier's own services. However, some interpreted the Open Internet Order to prevent carriers from prioritizing real-time traffic over backups and other time-insensitive traffic. The NBC-Comcast corporate merger was conditioned on the resulting company maintaining network neutrality for seven years [26]. During the recent Republican control of the Federal Communications Commission and under Chair Ajit Pai, the Open Internet Order and network neutrality was largely supplanted with the Restoring Internet Freedom Order[27] under which carriers do not have network neutrality obligations but must disclose how they choose to do their traffic engineering and prioritization.

[22] https://www.govinfo.gov/app/details/PLAW-105publ305
[23] https://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf17540
[24] https://www.advancedwireless.org/
[25] https://www.fcc.gov/document/fcc-releases-open-internet-order
[26] https://arstechnica.com/tech-policy/2018/01/a-comcast-net-neutrality-commitment-from-the-nbc-merger-just-expired/
[27] https://www.fcc.gov/document/fcc-releases-restoring-internet-freedom-order

Commercial home Internet speeds have been increasing dramatically since 2012 when Google Fiber connected its first customers in Kansas City[28]. Their symmetric gigabit speeds were an order of magnitude better than the best home services then available. Within just a few years, all major carriers were matching Google Fiber speeds and pricing in markets in which they were competing. In areas not receiving attention from the major carriers, municipal broadband, long outlawed in states with legislatures receiving significant donations from carriers, is now blossoming. States and municipalities seeing dense urban areas receiving cost-effective gigabit networks decided to insist that they be allowed to compete in the digital economy as well. Organizations such as Next Century Cities[29] spread the success stories.

Google Fiber slowed down its deployment beginning in 2016 but bought Webpass[30] to bring fiber-like speeds from wireless small cells to provide gigabit speeds to homes. Whether wireless will have large or small cells and operate as part of cellular carriers and new 5G standards or a new breed of carriers based on the Citizens Broadband Radio Service (CBRS)[31] or unlicensed 60Ghz frequencies, it's clear that a combination of fiber (where cost-effective) and advanced wireless technologies will be delivering the last mile of Next Generation Internet.

Attention has turned to the applications and services that will be available over this infrastructure. Congress has authorized a new, US national first-responder oriented Internet called FirstNet[32] which will initially be delivered using Verizon carrier assets[33]. Entertainment is clearly going "over-the-top" as so-called cord-cutting rapidly depletes the traditional cable television audience. New streaming services are dividing up the available entertainment content forcing consumers to decide how many services like Hulu, Disney+, Netflix, HBO Max, etc., will receive their paid subscriptions. The long-term stability of this market is in doubt as nearly all the streaming services have negative cash flows as they vie for customers.

US Ignite[34], a charitable non-profit public-private partnership is leading the quest for new gigabit applications in public benefit areas such as education, transportation, healthcare, and public safety. These new gigabit applications and services, which depend upon elements of Next Generation Internet, are "closing the loop" and proving the value of Next Generation gigabit, low-latency, and software-defined Internet.

The entire Smart Cities movement is also demanding not only more bandwidth, but much more deterministic network delivery from Next Generation Internet. For example, real-time vehicle-to-infrastructure communications requires highly-reliable, gigabit-class, low-latency exchange of vehicle location and speed information if we are to use intersections highly efficiently and without traffic lights. By not requiring vehicles to stop at intersections, travel times can be decreased, intersection utilization increased, and most importantly, greenhouse gas emissions can be greatly reduced. US Ignite is therefore focusing substantial effort in smart cities activities, and particularly those that require Next Generation Internet.

2.2.1. Digital policies in the US

By and large, competition sets digital policies. As already noted, the entrance of Google Fiber (2011-2019) triggered a generational upgrade in home access, and advanced wireless is expected to have similar impact a decade later (2021-2029). Research priorities are largely set by the private sector as well which out-invests organizations like the National Science Foundation (NSF) by orders of magnitude in delivering NGI services. However, the tip of that investment chain, the academic research leading to new discovery and new ideas, is still vitally dependent on the National Science Foundation.

[28] https://www.startlandnews.com/2016/03/five-years-later-google-fiber-celebrates-kansas-city-milestone/
[29] https://nextcenturycities.org/
[30] https://webpass.net/about_us
[31] https://en.wikipedia.org/wiki/Citizens_Broadband_Radio_Service
[32] https://en.wikipedia.org/wiki/First_Responder_Network_Authority
[33] https://www.govtech.com/public-safety/FirstNet-Verizon-Launch-Dedicated-Public-Safety-Networks.html
[34] https://www.us-ignite.org/

The Foundation has programs in both next-generation Internet technologies and services and in the fundamentals behind advances in fiber optics and advanced wireless solutions. The National Science Foundation also coordinates with other federal investments through Networking and Information Technology Research and Development[35] (NITRD) and its member agencies including Department of Defense, Department of Energy, Department of Commerce, and others. For a few cases of national importance, the White House Office of Science and Technology Policy[36] (OSTP) directly coordinates federal investments.

The National Science Foundation is supporting not only that "tip of the arrow" research, but also supporting public-private research partnerships such as Platforms for Advanced Wireless Research (PAWR) and other midscale research platforms. In both cases, the NSF money is being leveraged by funding from industry and other federal agencies. In the PAWR case, the contributions from the NSF and industry are matched: 50% each. The resulting testing platforms can be used by both academic researchers and industry researchers with encouragement for composite teams with both academic and industry researchers.

In the public safety communications space, the operative agency is the National Institute of Stanrdards and Technology (NIST) which is responsible for the research efforts going into FirstNet through its Public Safety Communications Research Division[37]. As a result, NIST is chartering additional NGI research specifically targeted at public safety applications and is expected to develop some application-specific NGI testbeds.

The United States also has a robust academic advanced networking capability similar to Europe's GEANT, namely Internet2[38] and The Quilt[39] network of regional optical networks which provide local distribution within states or regions of the United States (also similar to the structure of national networks feeding GEANT). Both Internet2 and Quilt members are actively designing their next generation academic networks, and these networks are expected to be models for subsequent national NGI services. This pattern of proving advanced networking capabilities through academic networks and then active academic-industry collaborations on joint projects to translate those capabilities into industry-provided services is a pattern that has been recurring since 1982 in the United States.

The US telecommunications industry is generally open to collaborative research on ideas which are at least two to three years from commercial availability. Industry participation is at their own expense, and they often contribute additional amounts to joint efforts, sometimes directly and sometimes through the NSF. Once there is a demonstrated capability, industry will support it by helping staff open source projects except for those features and capabilities they think they can use to differentiate their products and services. These are developed quietly and often secretly within the company and then used as a competitive marketplace advantage. Unlike the EU, the US government rarely provides R&D money directly to industry partners.

US policy is also heavily influenced by global organizations like the Internet Society[40] which advocates for an open and accessible Internet. For example, the Internet Society has been advocating for better global routing by using MANRS[41]. The International Corporation for Assigned Names and Numbers[42] (ICANN) is also active in managing Internet identifiers, names, and numbers and the security of the Internet namespace.

Telecommunications policy statements are issued by a combination of the White House (including OSTP) and the Federal Communications Commission. Applicable policy statements bearing on NGI and 5G include:

[35] https://www.nitrd.gov
[36] https://www.whitehouse.gov/ostp/
[37] https://www.nist.gov/communications-technology-laboratory/pscr
[38] https://www.internet2.edu/
[39] https://www.thequilt.net/
[40] https://www.internetsociety.org/
[41] https://www.internetsociety.org/issues/manrs/
[42] https://www.icann.org/

- 5G Spectrum Management (White House)[43]
- Ensuring America Reaches Its 5G Potential (White House)[44]
- High Speed Broadband and Innovation for Rural America (White House)[45]
- The FCC and the Unregulation of the Internet (FCC)[46]
- A Giant Leap for 5G (FCC)[47]

In the US, Next Generation Internet is largely being driven by industry investments. For example, Google's Project Loon[48] and Facebook's, SpaceX's, OneWeb's and Amazon's low-earth-orbit satellite constellations for ubiquitous Internet are all uncoordinated free-market efforts[49].

The Ajit Pai Federal Communications Commission is relying on competition to provide NGI services. NITRD is coordinating federal agency investments, and NSF is setting up NGI technology testbeds described below.

US coordination with the EU on NGI technologies is the province of the National Science Foundation at present, and additional technical research coordination is expected.

2.3. Funding Mechanisms and Opportunities

2.3.1. Europe

Horizon 2020[50] is the biggest European Research and Innovation programme ever implemented, with nearly EUR 80 billion of public funding available over 7 years (2014 to 2020) dedicated to foster excellence in science, industrial leadership and tackling societal challenges – complemented by further measures to increase and further develop the European Research Area[51]. It is the financial instrument implementing the Innovation Union[52], a Europe 2020[53] flagship initiative aimed at securing Europe's global competitiveness. H2020 was designed to execute a simple structure that reduces red tape and time so beneficiaries can focus on making sure new projects get off the ground quickly – and achieve results from the lab to the market faster.

Seen as a means to drive economic growth and create jobs, H2020 has the political backing of Europe's leaders and the Members of the European Parliament. By coupling research and innovation, the programme is helping to achieve excellent science, industrial leadership and tackling societal challenges. The goal is to ensure European leadership in world-class science, removing barriers to innovation and making it easier for the public and private sectors to work together in delivering innovation.

International cooperation – This is a cross-cutting topic lying at the core of H2020, providing a range of opportunities to collaborate with non-EU Member States and Associated countries (Third Countries) in Research, Technology and Innovation (RTI). International cooperation is not only crucial to tackle global challenges, but also to strengthen Europe's excellence in science, increase its attractiveness towards becoming a global leader in innovation, and support the European Union's external policies through science diplomacy. In line with multiannual roadmaps to foster cooperation with key partner

[43] https://www.zdnet.com/article/trump-unveils-5g-spectrum-memorandum/
[44] https://www.whitehouse.gov/articles/ensuring-america-reaches-its-5g-potential/
[45] https://www.whitehouse.gov/articles/high-speed-broadband-fostering-new-era-innovation-rural-america/
[46] https://www.fcc.gov/reports-research/working-papers/fcc-and-unregulation-internet
[47] https://www.fcc.gov/news-events/blog/2019/06/18/giant-leap-5g
[48] https://x.company/projects/loon/
[49] https://techcrunch.com/2019/04/04/amazon-joins-spacex-oneweb-and-facebook-in-the-race-to-create-space-based-internet-services/
[50] H2020. https://ec.europa.eu/programmes/horizon2020/en
[51] European research area (ERA). http://ec.europa.eu/research/era/index_en.htm
[52] http://ec.europa.eu/research/innovation-union/index_en.cfm
[53] http://ec.europa.eu/europe2020/index_en.htm

countries/regions of Europe**, Horizon 2020 specifically encourages international cooperation through various instruments**. Such instruments can be **joint/coordinated calls**, **targeted calls for collaborative research and innovation projects with recommended or obligatory participation of Third Countries**, and **other specific horizontal activities** called Coordination and Support Actions.

In order to improve international participation within H2020, the EC has introduced various measures in alignment with their counterparts in third countries, as described below:

Participation in a H2020 Project as full partner with EU Funding - US entities and researchers can participate together with organizations from the 28 EU Member States and Associated Countries, and be eligible to receive funding in the following cases:

- Participation is foreseen/requested specifically in the relevant Work Programme or Call;
- Participation is decisive or essential for carrying out the project and for ensuring project success. Additionally, under the societal challenge in the area of Health, as a result of a bilateral agreement between the European Commission and the National Institute of Health (NIH), US partners participating in an H2020 project are eligible to receive EU funding.

Participation in a H2020 Project as full partner without EU funding - According to the EU-US Agreement signed on 2016 to enhance transatlantic cooperation on science, technology and innovation, **US researchers and/or entities with their own sources of funding are allowed to collaborate with a Horizon 2020 research project consortium without having to sign the Horizon 2020 Grant Agreement**. This arrangement is especially useful for those US researchers/entities that do not request European funding but wish to work together with European partners on a topic of their interest. The framework for a successful project implementation is set in the Consortium Agreement which is outlining the rights and obligations and signed by the beneficiaries, all having the same rights and obligations.

Participation in a H2020 Project as Implementing Certain Action Tasks without EU funding-Article 14a - US entities may be linked to a H2020 Project not as full research partner but as partner responsible for implementation of some activities within the Project. In this case, they do not get EU funding, neither directly nor indirectly. Costs of their participation are estimated but not included in the grant amount calculations by the Coordinator and not covered by the Grant. In this case, the US entity is considered as Third Party (rather than a beneficiary or a research partner) and a designated beneficiary from the consortium will be responsible for the Third Party's activities.

The US entity performs tasks directly (under the supervision of a beneficiary) without signing the Grant Agreement. The beneficiary remains responsible towards the Commission/Agency for the tasks performed by its US entity. No cost reporting is required. In line with the periodic reporting the explanation of the work carried out as well as an overview of the progress shall be reported to the linked beneficiary.

There are over 1000 projects funded under H2020 that include at least a partner from the USA in the consortium.

2.3.2. United States

In the United States, public resources invested in Research and Innovation are mainly financed by federal programs of applied technology, which have a significantly smaller influence compared to Europe. This is due to the strong leadership of corporations and VC investment. Funding is also available at the State level, but normally reflects local-specific needs, and are mostly normally open only to local applicants – meaning that neither entity from other US States nor foreign entities have access to these resources.

Federal priorities on research and development are decided based on three main sources of input: 1) the yearly Memorandum drafted by the Office of Science and Technology Policy (OSTP) of the White House – which provides policy advice and coordinate STI policies; 2) the Congress input; and 3) the State's Departments and relative funding agencies. Priorities and their corresponding allocated budget

are then yearly detailed by the Office of Science and Technology Policy of the President in the Multi-Agency Science and Technology Priorities for the Fiscal Year Budget.

Apart from specific areas - such as Security or Defence, which require a confidential approach, the policy for foreign participation and international partnerships are often allowed and valued, perceived as a benefit and a positive asset to strengthen credibility to research projects. However, funding is not always foreseen, and foreign participants and organisations are expected to cover their part of effort.

According to the research conducted by the project BILAT 2.0. "nearly one-quarter of individual organisations' policy measures provide funds to other countries as long as the leading organisation is a US-based university or other research institution. About 40% of the measures do not provide funding to non-US institutions. The remaining 40% have specific pre-requisites for allowing receipt of US funds by third countries"[54].

The Networking and Information Technology Research and Development (NITRD)[55] Program is the Nation's primary source of federally funded research and development in advanced information technologies in computing, networking and software. NITRD is among the oldest and largest of formal Federal programs that coordinate the activities of multiple agencies to tackle multidisciplinary, multi-technology, and multisector R&D needs. The 21 NITRD member agencies invest approximately USD 5 billion annually in programmes that identify, develop and transition to practical use the advanced networking and IT capabilities needed by the Federal Government and the Nation.

NITRD's Program Component Areas (PCAs) [56] are major subject areas for Federal priorities on R&D. PCAs are intended to facilitate budgetary comparisons from year to year in each area; FY2020 PCAs will be used in the *NITRD Supplement to the President's FY2020 Budget*, containing some significant NGI Areas such as Artificial Intelligence, CHuman - Computing-Enabled Human Interaction, Communication, and Augmentation and CSP - Cyber Security and Privacy.

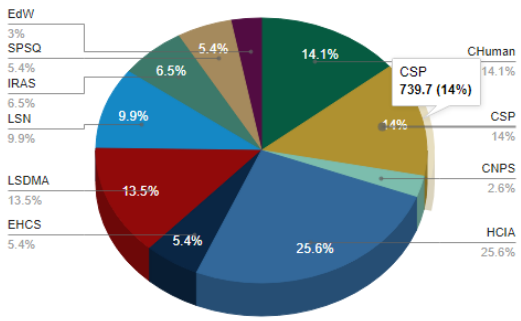

Figure 6 - NITRD FY2019 Budget (in $ Million) (Source: NITRD)

Eligibility criteria are provided in the Announcement of Federal Funding Opportunity (FFO) and are specific to each announcement. Some opportunities are limited to entities located in the United States or its territories, but others are opened to foreign public entities, foreign governments, organisations under the jurisdiction of foreign governments; international organisations.

Other announcements, in presence of limitations linked to majority domestic ownership or control of applicants, may specify that "organisations that are ineligible to apply because they are majority foreign-owned or foreign-controlled may be included in a team or consortium as an unfunded collaborator, provided that they are organized and operated in the United States.

[54] Deliverable D3.1, "Report on the EU and US innovation policy framework and relevant initiatives". http://www.euussciencetechnology.eu/documents-and-publications
[55] The Networking and Information Technology Research and Development (NITRD) Program. https://www.nitrd.gov/about/index.aspx
[56] NITRD Program Component Areas (PCAs). https://www.nitrd.gov/subcommittee/NITRD-PCAs.aspx

However, a European partner has to follow the following rules[57]:

- The authorizing legislation and agency policies will determine whether a foreign individual or organization may apply for the grant. Foreign applicants need to complete the same registration process as domestic applicants, but there are additional steps to this registration process.
- Depending on the intended usage of the grant applied for, you may need to file filing a US tax return which requires a Taxpayer Identification Number (TIN), also referred to as an employer Identification Number (EIN) may be required. If a non-resident alien is awarded funding to perform activities outside the United States, then this likely does not constitute US source income and a TIN/EIN is not necessary. Examples of such funding include scholarships, fellowship grants, targeted grants, and achievement awards.

Before applying, foreign applicants should thoroughly review the IRS website[58] and search for their most recent guidance for Aliens and International Taxpayers.

2.4. Initiatives supporting EU-US collaboration on NGI

Collaboration in ICT research and innovation between the US and the EU isn't anything new. However, the breadth and depth of the collaboration can be improved considerably, and NGI could find a stronger and more visible place among the key areas for EU-US collaboration. Both economic competition and differences in approaches and policies between the EU and the US have contributed to this situation. Economic competition exists between European companies in the same way as between US and European companies, but pre-competitive research and innovation collaboration can lead to faster development, opportunities to market new technologies, and better understanding of cultures and markets. Collaborative efforts will lead to better shape the future of the Internet, whatever name is given to it and could at the end create market opportunities in the US and world-wide for European companies, who will also have advantages from new open innovation opportunities at a greater scale. In the other direction, EU citizens will profit from open competition.

A number of initiatives are currently active with the ambition to reinforce the partnership between Europe and the USA on a shared roadmap for the Next Generation Internet. These actions include funding instruments from the EC (through H2020) and NSF, and are either technology oriented (by tackling specific research and innovation challenges) or supporting a more fluent knowledge exchange between the two regions on the policy level.

2.4.1. Transatlantic NGI projects

There are multiple research infrastructures and efforts that have been closely interacting and collaborating between regions. These efforts are expected to continue to evolve the research infrastructure in support of the new research agendas. It is critical to mention that these initiatives do not provide funding to organisations, but offer their infrastructures for testing.

H2020 Think NEXUS (EU)[59] – The European Think Tank on EU-US collaboration towards Next Generation Internet. The mission of Think NEXUS is to become an important instrument in the arsenal of EU and US policymakers, supporting them towards a collaborative approach for tackling NGI challenges for the benefit of the society. For that, the initiative underpins the interaction and synergies with the most relevant initiatives and key actors from Internet in both regions through a comprehensive manner. Its Expert Groups involve key actors (researchers, entrepreneurs, policymakers) from both sides of the Atlantic on NGI-related thematics in three Focus Areas: Science and Technology, Innovation and Entrepreneurship and Policy. Its mission is to become an important and lasting entity, involving stakeholders and disseminating NGI visions in a collaborative approach for tackling NGI challenges, and benefit society at large.

[57] https://www.grants.gov/learn-grants/grant-eligibility.html
[58] http://www.irs.gov/
[59] Think NEXUS. https://thinknexus.ngi.eu

Further details will be outlined in the next section.

H2020 NGI Explorers Programme (EU)[60] - NGI Explorers is the programme that sponsors immersive missions to the United States for Top European Internet researchers and innovators, providing them with the skills, the network and the resources to accelerate their ambitious ideas. The program seeks to empower these change-makers to position Europe into the powerhouse of the Next Generation Internet, benefiting from multiple partnerships with US-based organizations acting as hosts.

NGI Explorers Program goal is to empower Europe's most powerful network of Internet leaders into a transformative journey to catalyse the success of their ambitious ideas fuelled by disruptive technology.

US-EU Internet Core & Edge Technologies (ICE-T) (US)[61] - The Division of Computer and Network Systems (CNS) within the National Science Foundation's Directorate for Computer and Information Science and Engineering (CISE) supports research and education activities that seek to develop a better understanding of the fundamental properties of computer and network systems. The Networking Technology and Systems (NeTS) program in the CNS division supports transformative research on fundamental scientific and technological advances leading to the development of Next Generation Internet (NGI) and Advanced Wireless Networking (AWN) systems and technologies.

NSF/CISE seek to enable US and EU researchers to collaborate to address compelling research challenges in NGI and AWN. Topics of interest include, but are not limited to, software-defined infrastructures; network function virtualization; resource management in support of content delivery; open data architectures for shared, federated research infrastructures; advanced wireless technologies; and research software tools to support advanced wireless and smart city/community testbeds.

This NSF solicitation is expected to align with a related effort in the EC's Horizon 2020's Work Programme for 2018-2020. For funding under this solicitation, US investigators must describe: 1) collaborative research, 2) research collaboration initiation activities, or 3) research fellowships with counterpart EU investigators who have received, or are requesting funding separately under the EC Horizon 2020 Programme area on ICT.

H2020 FED4FIRE+ (EU)[62] - FED4FIRE+ is offering the largest federation worldwide of Next Generation Internet testbeds, which provide open, accessible and reliable facilities supporting a wide variety of different research and innovation communities and initiatives in Europe. The project, that will run until the end of September 2021, has established a close cooperation with GENI.

GENI (US)[63] - GENI (Global Environment for Network Innovations) provides a virtual laboratory for networking and distributed systems research and education. It is well suited for exploring networks at scale, thereby promoting innovations in network science, security, services and applications.

[60] NGI Explorers. https://explorers.ngi.eu/
[61] US-EU Internet Core & Edge Technologies. https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505516
[62] FED4FIRE+. https://www.fed4fire.eu/
[63] GENI. https://www.geni.net/

Figure 7 - GENI compute and network resources (Source: GENI)

GENI allows experimenters to:

- Obtain compute resources from locations around the United States;
- Connect compute resources using Layer 2 networks in topologies best suited to their experiments;
- Install custom software or even custom operating systems on these compute resources;
- Control how network switches in their experiment handle traffic flows;
- Run their own Layer 3 and above protocols by installing protocol software in their compute resources and by providing flow controllers for their switches.

GEANT (EU)[64] - ESnet, Internet2, Indiana University and the NASA Integrated Services Network (NISN) (US) - There is a long–standing relationship between pan-European research and education networking and North American research networks, which has led to diverse transatlantic links being established in reciprocal arrangements between the two continents.

In this collaborative environment, GÉANT provides links to North American partners to ensure that there is abundant capacity and no single points of failure, enabling research and education traffic between the two regions to flow seamlessly. These connections are key in enabling research collaboration on intercontinental projects, and are particularly significant for the Large Hadron Collider (LHC) at CERN, a number of the data-processing centres of which are located in North America.

Where projects and researchers need to exchange large amounts of data with their project counterparts in North America or have high-performance requirements, GÉANT Plus point-to-point circuits can be provisioned to the CANARIE, Internet2 and ESnet networks.

In the USA the key national organisations are ESnet, Internet2, Indiana University and the NASA Integrated Services Network (NISN), each of which caters for a subset of the US research and education community.

OneLab (EU)[65] **-** Through OneLab, it is possible to test software systems in any of the following networked communication environments: IoT networks with mobility and sensing capabilities; ad-hoc wireless and wireless broadband access networks; a global, public, fixed-line Internet; and Cloud and SDN networks. Our platforms offer both wireless and fixed-line emulated environments and reproducibility of experimentation. OneLab is a consortium consisting of five different higher education and research institutions. These institutions are devoted to making testbeds used for network computer communications available to enterprises, scientific researchers, and educators.

CloudLab (US)[66] **-** CloudLab provides researchers with control and visibility all the way down to the bare metal. Provisioning an entire cloud inside of CloudLab takes only minutes. Most CloudLab resources provide hard isolation from other users, so it can support hundreds of simultaneous "slices", with each getting an artefact-free environment suitable for scientific experimentation with new cloud architectures. Run standard cloud software stacks such as OpenStack and Hadoop. CloudLab is built from the software technologies that make up Emulab and parts of GENI, so it provides a familiar, consistent interface for researchers. This NSF-sponsored facility at U. Utah, Clemson U., and U. Wisconsin allows researchers to explore the clouds of the future. Untethered to current commercial clouds, experimenters can use this testbed to create new kinds of clouds that might be useful for edges, for hybrid clouds, and for other cloud concepts that may be useful in NGI.

TIPOFF (US)[67] **-** In order to leverage, advance and strengthen its investments in mid-scale computing research infrastructure, the National Science Foundation's (NSF) Directorate for Computer and

[64] GEANT. https://www.geant.org/
[65] OneLab. https://onelab.eu/
[66] CloudLab. https://www.cloudlab.us/
[67] Tomorrow's Internet Project Office (TIPOFF).
https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505384&WT.mc_id=USNSF_180&WT.mc_ev=click

Information Science and Engineering (CISE) will support the work of Tomorrow's Internet Project Office (TIPOFF). Working closely with the US academic and industrial computer networking research community, TIPOFF will provide leadership and administrative oversight in developing, deploying and operating innovative mid-scale computing research infrastructure to meet evolving research community needs and align with emerging national priorities.

To initiate this activity, TIPOFF will assume responsibility for the operation and future evolution of the Global Environment for Network Innovations (GENI) platform. TIPOFF will then lead the research community in developing an expanded and enriched experimental platform ("Platform") that leverages the existing GENI infrastructure to support exploration of robust new networking and distributed systems architectures, services and applications. This Platform will serve as a virtual laboratory for research and education, with the goal of advancing understanding of computing and communication systems and sustaining US technology leadership and competitiveness in information technology (IT) and Internet-based services.

PlanetLab (EU/US)[68] **-** Planetlab Europe is the European arm of the global PlanetLab system, the world's largest research networking facility, which gives experimenters access to Internet-connected Linux virtual machines on over 1000 networked servers located in the United States, Europe, Asia, and elsewhere. Researchers use PLE for experiments on overlays, distributed systems, peer-to-peer systems, content distribution networks, network security, and network measurements, among many other topics.

2.4.2. US clusters & innovation hubs

Commented [J1]: Does this sub-section add real value? I propose to delete it

There are multiple efforts in the USA around Research and Innovation platforms and innovation hubs with focus on advanced technologies. All are driven by the needs of demanding leading-edge applications that are poorly served by current commercial networks. All have at least a degree of partnership between academic researchers and industry researchers. In all of them, industry pays at least its own way and often covers other costs as well.

Platforms for Advanced Wireless Research (PAWR) – A $100 million effort (half industry, half-NSF) to create up to four advanced wireless testbed facilities to explore what comes after current 5G standards. Specific efforts are being put into software-defined-everything, massive MIMO, millimetre-wave, and autonomous mobility communications. PAWR [69] is administered by US Ignite and Northeastern University.

The Future of CISE Distributed Research Infrastructure – Twenty-eight leading US NGI researchers have proposed a future Internet testbed cyberinfrastructure based on workshops and bold research ideas as documented in this paper endorsed by all of them[70]. CISE stands for Computing and Information Sciences and Engineering. A proposal based on this paper is pending before the National Science Foundation and may result in a significant new NGI research infrastructure if awarded.

DETERLab – USC/ISI's DETERLab (cyber DEfense Technology Experimental Research Laboratory)[71] is a state-of-the-art scientific computing facility for cybersecurity researchers engaged in research, development, discovery, experimentation, and testing of innovative cybersecurity technology that may be of use in NGI.

Starlight[72] – This Chicago-based software-defined interchange facility is a model for NGI interchange points, implementing both extreme data rates (stress-tested by such events as SuperComputing 2019[73]) and software-defined switching and management. The University of Illinois at Chicago, Northwestern University, and Argonne National Laboratory operate Starlight. At a US national level, Internet2 provides similar services but using their national network to provide them in a distributed way.

[68] PlanetLab. https://www.planet-lab.org/
[69] https://www.advancedwireless.org/
[70] https://arxiv.org/abs/1803.09886
[71] https://deter-project.org/
[72] http://www.startap.net/starlight/
[73] https://sc19.supercomputing.org/

Complementing Internet2, members of The Quilt are providing regional NGI interchange facilities. All of them are rapidly evolving to better serve NGI.

Digital Town Squares – Local community data and traffic exchange points designed to keep local NGI traffic local. Keeping traffic local helps minimize application latency and makes the resulting system more resilient to outages or natural disasters that may affect the larger NGI. They are also models for NGI community-based edge computing and DTS implementations are purposefully designed to support both current Internet traffic and future software-defined NGI traffic. Digital Town Squares are being deployed now by US Ignite. Some are in full production for all local traffic; others are in various stages of development. Digital Town Squares are expected to play a role in future Internet testbeds to provide local connectivity[74].

Smart Gigabit Communities[75] (SGC) – This programme is piloting NGI applications and services in communities which already have advanced networks. Depending on the community, these advanced networks are at least gigabit but often include edge clouds, software-defined cyberinfrastructure, and Digital Town Squares. The Smart Gigabit Communities effort provides demonstrations of the new applications and services to be made available more widely by NGI. US Ignite manages the SGC effort which now includes 28 communities.

Chameleon Cloud[76] – This sister facility of CloudLab allows researchers to create their own clouds involving some of the fastest supercomputer cyberinfrastructure available to researchers. The emphasis is on high performance. It's located at the U. Texas Advanced Computing Center and Argonne National Laboratory. Both CloudLab and Chameleon Cloud can be accessed through Internet connections.

Pacific Research Platform[77] (PRP) – This cyberinfrastructure is providing early-NGI services to US West Coast Universities and their Asian partners. It operates using multiple redundant 100 Gbps links and facilitates the movement of ultra-large data files using Data Transfer Nodes (DTNs) which are small edge devices optimized for data transfer over high bandwidth-delay-product links. The PRP is supported by the National Science Foundation and headquartered at University of California San Diego.

National Research Platform[78] (NRP) – Now in its third year of discussion, this initiative would take the advantages of PRP and apply them throughout the United States. This initiative is working closely with Internet2. There may well be a convergence between NRP, edge clouds, DTNs, Digital Town Squares, Starlight, and the Future of CISE distributed infrastructure over time.

Global Research Platform (GRP) – The Global Lambda Integrated Facility[79] (GLIF) is forming a global research platform group to extend PRP and NRP NGI concepts globally. It held its first meeting in September 2019.

EdgeNet[80] – A populist, do-it-yourself distributed NGI computing infrastructure allows anyone to download EdgeNet software and join a global NGI cyberinfrastructure.

2.4.3. Initiatives developing NGI technologies

Commented [J2]: I propose to delete this section as it's not EU-US collaboration

The European Next Generation Internet Initiative includes a pool of initiatives specifically designed to provide cascade funding to small and medium-sized enterprises and/or startups developing solutions on the Focus Areas. Although these instruments do not explicitly exclude US organisations from participation, matching funds will be required from the US side.

[74] https://meetings.internet2.edu/media/medialibrary/2016/09/28/20160928-ricart-configuring-managing-digital-town-square.pdf
[75] https://www.us-ignite.org/program/smart-gigabit-communities/]
[76] https://www.chameleoncloud.org/
[77] http://pacificresearchplatform.org
[78] https://meetings.internet2.edu/2019-924-third-national-research-platform-workshop/
[79] https://www.glif.is/
[80] http://edge-net.org/

H2020 NGI TRUST (EU)[81] **-** This project supports the development of a human-centric Internet by developing a stronger European ecosystem of researchers, innovators and technology developers in the field of privacy and trust enhancing technologies. Three types of third-party projects will be awarded funding:

Type 1 (viability): up to EUR 100,000 from NGI TRUST, no matching funds required. The objective is to explore and assess the technical feasibility and/or commercial potential of a breakthrough innovation that aims at enhancing privacy and trust for the NGI. Activities can include conceptual development, risk assessment, market study or intellectual property management of a new technology or service, or a new application of existing technologies.

Type 2 (execution): up to EUR 180,000 from NGI TRUST and matching funds of up to EUR 90,000 (2/3 – 1/3 model). The objective is to fund R&D or technology development projects underpinned by a strategic plan and feasibility assessment (which can be, but need not be, developed through a Type 1 project funded by NGI Trust).

Type 3 (transition to commercialisation): up to EUR 200,000 from NGI TRUST and the equivalent in matching funds (50/50). These projects should pursue the commercialisation of a privacy and trust enhancing innovation for the NGI.

H2020 NGI Zero (EU)[82] **-** NGI Zero is a idea-driven coalition of not-for-profit organisations from across Europe. It was set up to provide the Next Generation Internet initiative with an agile, effective and low-threshold funding mechanism. With funding from the European Commission, NGI Zero provides grants to individual researchers and developers as well as small teams to work on important new ideas and technologies that contribute to the establishment of the Next Generation Internet.

NGI Zero will launch two different calls:

NGI Zero PET[83]: Funding available: project proposals between EUR 5,000 and 50,000 – with the potential to scale them up if there is proven

NGI Zero Discovery[84]: Funding available: project proposals between EUR 5,000 and 50,000 – with the potential to scale them up if there is proven potential.

H2020 LEDGER (EU)[85] **-** LEDGER, is a EU funded project, that empowers people to solve problems using decentralised technologies such as blockchain, peer to peer or distributed ledger technologies. LEDGER offers to the selected projects:

- Up to EUR 200,000 equity free;
- A venture builder programme for up to 12 months with business mentors, camps, technological vouchers, training and demo days;
- An expert researcher in residence to support the selected teams along the full programme;
- Access to market and support to raise further investment for the best projects in class.

3. Think NEXUS to support the Transatlantic NGI Alliance

Think NEXUS is a joint Transatlantic mission built for gathering and combining the knowledge of Top researchers, entrepreneurs, thinkers and influencers from Europe and the USA committed to envision and re-shape the future of the Internet. A "pathfinder" which should not only be focused on the trends related to emerging technology, but also on the services provided across the multiple value chains, and its societal impact and implications. It is crucial to understand that the work and the activities conducted needs to follow a multidisciplinary approach including market, society and societal dimensions. The

[81] NGI TRUST. https://www.ngi.eu/about/ngi-trust/
[82] NGI Zero. https://www.ngi.eu/about/ngi-zero/
[83] NGI Zero PET Open Calls. https://nlnet.nl/PET/
[84] NGI Zero Discovery Open Calls. https://nlnet.nl/discovery/
[85] LEDGER. https://www.ngi.eu/about/ledger/

Next Generation Internet must be technologically disruptive while benefitting the overall society, clearly considering the barriers and the means to overcome the challenges. The NGI Initiative is an important opportunity to radically rethink the way the Internet works today, and more human-focused narratives are needed more than ever.

This vision will be successful only if a worldwide consensus is found. We are on a crossroads, with rapidly evolving technologies like Artificial Intelligence and Cybersecurity expected to radically reshape our societies, while growing geopolitical tensions threaten to rewrite the rules governing the internet itself. The NGI Initiative must design and implement specific actions for international policy collaboration, sharing technology development and interaction between Research and Innovation communities at global scale; the United States must become a leading partner in this endeavour.

The objective of Think NEXUS as a project is to become an important tool in the arsenal of EU and US policymakers, supporting them towards a cooperative a collaborative approach for tackling NGI challenges for the benefit of the society. For that, the initiative will underpin the foundation of a Think Tank to interact and collaborate with the most relevant initiatives and key actors from Internet in both regions through a comprehensive manner. An open framework that shall operate smoothly and flexible to steer and promote the cooperation across EU-US communities, encompassing the various aspects of NGI towards the correlated values they carry: technology, openness, diversity, inclusion, ethics, among others.

Think NEXUS requires assessing and strengthening such vision from different but complementary standpoints, understanding the diverse nuances of the EU-US joint cooperation and all its potential impacts. For that, the Think Tank is structured in **three** interdependent and symbiotic **Expert Groups: 1) Science and Technology, 2) Innovation and Entrepreneurship** and **3) Policy**.

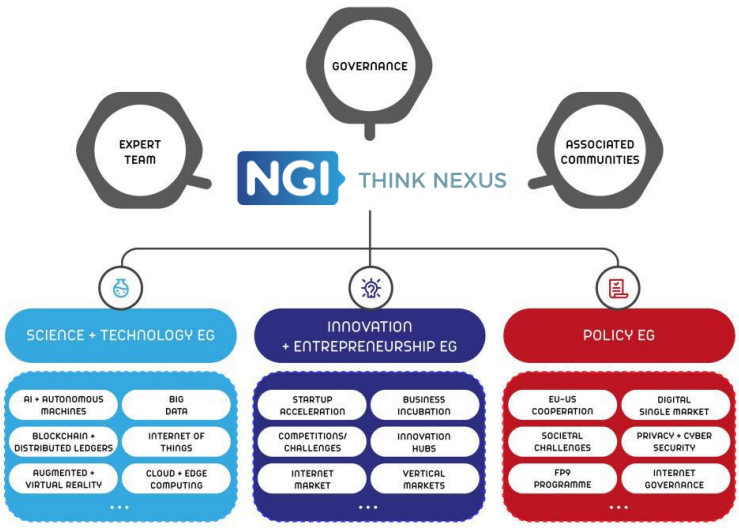

Figure 8 - Think NEXUS Structure

Science + Technology. This area focuses on pure technical aspects of common priorities for both regions, such as AI, Big Data, Blockchain, Internet of Things and more;

Innovation + Entrepreneurship. This area covers the Go-To-Market approach of NGI, identifying trends and means to foster and speed up the exploitation of the technology;

Policy. This area pinpoints crucial policy cooperation between regions, including Internet governance, cyber security, standards and interoperability, data privacy, and ethics.

Each Expert Group will notably support Think NEXUS on following activities:

- Set a consistent conceptual framework for NGI-related developments, by analysing potentials and challenges for EU-US collaboration in the fields covered by NGI concepts and the needs for policy and actions to improve such conditions for upcoming collaborations;
- Identify research and innovation collaboration opportunities and potential projects supporting the setup of a sustainable human-centric architecture, infrastructure and governance;
- Contribute to the barriers and opportunities reports, to develop common views on the priorities and EU-US collaboration will provide improved competitiveness, performance and reinforced rights to Internet users;
- Propose new schemes for developing and co-developing strategic initiatives and actions that will foster the uptake of human centric considerations within technological hard & software developments;
- Help in linking EU and US networks for mobilising the relevant stakeholders upon given topics.

Each of the expert groups will be using a sprint-type dialogue by which specific subtopics will be defined, leading to specific recommendations and suggestions as input to thematic webinars and workshops.

3.1. Think NEXUS US Workshop 2019

Think NEXUS organised its first thematic workshop in the USA in July 2019[86], bringing experts from both regions around the 3 Expert groups for a first round of face-to-face discussions and presentations. The workshop run in parallel with the GCTC Smart and Secure Cities and Communities Challenge Expo 2019[87], hosted by the US National Institute of Standards and Technology, gathering a total amount of 41 attendees, 28 from the US and 13 from the EU, representing research and innovation, academia, policy and the industry.

Each Expert Group was structured to count on a mix of EU and US experts in the defined topics, leaving the following key messages and outcomes.

3.1.1. Science + Technology Expert Group

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One of the main agreements by all Expert Group members was the fact that overall Science and Tech polices need to synchronize with real developments as in many cases public administration is considered to lag behind. The need for a joint funding scheme between EU and US should be of high priority as both regions need to collaborate and not to compete to each other; there is a communication/coordination bottleneck between policymakers from both regions and funding agencies. Standardisation bodies, industry and user representatives should also be included in the NGI discussion.

Adding to the above, most members raised that testbeds and networks are struggling to support NGI related research experiments because their commercial focus. Nonetheless, the interaction with big digital players (platforms such as Google, Amazon and Facebook) to offer infrastructure for research is vital.

[86] Think NEXUS US Workshop 2019. July 10, 2019. Washington DC, USA. https://thinknexus.ngi.eu/news/think-nexus-us-workshop-2019/
[87] GCTC Smart and Secure Cities and Communities Challenge Expo 2019. https://pages.nist.gov/GCTC/event/gctc-expo-2019/

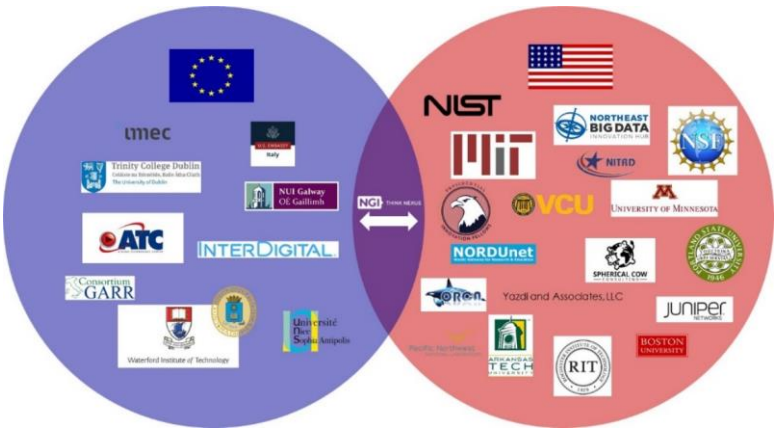

Figure 9 - Think NEXUS Science + Technology Network of Actors

There are many options for transatlantic collaboration, having topics that are not too reliant on the involvement of competing companies (e.g. that address world-wide societal challenges, or that focus on low-TRL fundamental research) as promising candidates.

Key Technologies: IoT, Digital ledger technology, Big Data, Trust & Identity, Cloud computing, Edge, AI, Real time control, Smart Infrastructures, 5G, Cloud to Edge, Edge to Edge Communication Technologies, Intelligent Operating Systems.

Characteristics of Technologies: Enable mobility, more visual, less complex, more secure, autonomous deployment systems, data-centric services, distribution of computation elements (decentralised), distributing computation.

Key Action Points:

- Working towards defining the characteristics of a possible joint funding scheme on NGI, between the EU-US in order to facilitate collaboration instead of competing, on mutual applications domains of interest and communicate this to policy makers from both regions.
- Coordinating with the Policy Expert Group in order to provide input for tackling the communication/coordination bottleneck between policy makers and funding agencies from both regions.
- Interacting with the NGI community emphasizing on engaging standardisation bodies, industrial stakeholder groups and user representative's groups, into its activities. Additional S&T members that could bring value into the Expert Group will b also considered.
- Interacting with policy makers from both regions for lobbying towards the establishment of a formal NGI collaboration scheme between the two regions.
- Support Think NEXUS goals and activities by participating in events and workshops, providing input into official documents (i.e. publications, white papers, deliverables) and disseminating the project into the community as a whole.

3.1.2. Innovation + Entrepreneurship Expert Group

Today, digital economy is already transforming the very nature of work and society as a whole. Hence, it is important to monitor and assess some of the crucial aspects the Next Generation Internet shall pay attention to throughout the next 15 years, not only as a European vision, but towards an alliance for a global digital market. Think NEXUS proposes a number of priorities for Innovation and Entrepreneurship.

Digital Transformation

The main challenge in the coming years remains the transformation of traditional industries and businesses, as well as the integration of emerging technology. Improving the productivity and innovative potential in sectors like Energy, Agriculture, Media, Automotive and Industry by successfully adopting new digital assets will be crucial in order to maintain their competitiveness. However, Europe has been comparatively a slow adopter – both in terms of integrating digital into existing industrial processes, and even more so in terms of understanding the transformative nature of digital technologies. Europe could gain an additional €2.5 trillion of GDP in 2025 through further digitisation. Late 2017, only 24% of enterprises had integrated Big Data analytics, 16% had took on robotics and automated machinery, and only 5% were working with Artificial Intelligence or 3D printing[88].

While the US already works as a unified market removing key differences between online and offline worlds, breaking down the barriers to cross-border online activity, the digitisation of Europe is progressing at a different pace, hampered partially by the readiness level of the European 'Digital Single Market'. Finland and Denmark are the only countries in the EU where the percentage of firms with a very high Digital Intensity Index is above 10%, followed by Sweden with 8%, while in some countries such as Bulgaria, Romania, Greece, Latvia, Spain, Poland, Hungary and Italy the majority of businesses (55+%) have low investments in digital technologies. The European digital economy will never be able to thrive if it continues to consist of 27 different consumer markets.

Data Economy

A key purpose of creating value from data is to improve decision making and drive innovation. Data has become essential for economic growth, job creation and societal progress, but at the same time it remains a resource that is relatively little understood and conceptualised from both an economic and regulatory perspective. For this reason, public and private players must work towards a data market more open and safer.

The raise in the density and fluidity of data can increase consumer welfare (through a wider choice and decreased lock-in effects), stimulate new business models and render markets more competitive (through a reduction in network effects and lower switching costs), and ultimately also contribute to more innovation in Artificial Intelligence (in making data available to a broader pool of players). The introduction of data as a key digital asset stimulates the presence of electronic marketplaces where data is traded as a commodity. These marketplaces can make it easier for parties to share data and to promote innovation in the Digital Single Market, provided they preserve European values with respect to data protection.

The General Data Protection Regulation (GDPR) regulation has positioned Europe as a global reference in the enhancement of privacy rights and consumer protection. At the same time, GDPR is a mechinism with the potential to create more dynamic data markets. The European Data Protection Supervisor considers that portability could release synergies in data protection and competition law in preventing exclusionary or exploitative abuses of dominance and consumer lock-in in addition to empowering consumers 'to take advantage of value-added services from third parties while facilitating greater access to the market by competitors'[89]. Nonetheless, GDPR must evolve towards a view that paves the way for European leadership in privacy-preserving AI, especially with respect to data minimisation, purpose limitation and the distinction between sensitive vs. non-sensitive data as well as personal vs. non-personal data.

Such is the reaching influence of GDPR that California's legislation has been inspired by this measure to implement its California Consumer Privacy Act (CCPA), that will become effective on January 2021. The value of personal information used for advertising in the state tops $12 billion each year, and could be $20 billion or more if you add in the value of that information to data brokers. The CCPA will fundamentally force companies to provide more information to consumers about what is being done

[88] European Commission, 2018 Digital Transformation Scoreboard

[89] Preliminary Opinion of the European Data Protection Supervisor, 'Privacy and Competitiveness in the Age of Big Data: The Interplay between Data Protection, Competition Law and Consumer Protection in the Digital Economy' (2014) 36 https://edps.europa.eu/sites/edp/files/publication/14-03-26_competitition_law_big_data_en.pdf

with their data and gives them more control over the sharing of their data. Some industries will be forced to completely revise their business models to incorporate the newly required data protections.

Eastern Digital Challengers

For decades, Europe has benefited enormously from being one of the world's most open markets to trade and foreign direct investment, becoming not only the number one trader of goods and services, but also the largest destination for foreign investment. In 2005, the size of the European economy at current market prices was more than six times larger than China's (€11.6 trillion for the EU28 versus China's €1.8 trillion). Today, China has an economy worth €11.4 trillion euro, against €15.9 trillion for the EU28[90]. These trends are directly linked to the fact that over the next 30 years, 1.8 billion people will move into cities, mostly in Africa and Asia, creating one of the most important new opportunities for financial institutions[91]. A rapidly growing middle class tends to drive higher consumption

Although the global economy's shift to the East entails outstanding new market openings for European companies, it is also clear that part of this position is owed to generous state subsidies, significant market protection and a track record of unfair trade practices, commercial espionage and intellectual property right infringements[92].

Future of work

Europe and the USA often have a different interpretation of the objectives that fall behind the market impact of digital transformation. One good example is the discussion around the 'Future of Work' – creating new and better employment opportunities, should it be a top priority for policy makers when promoting measures in their digital agendas, or this should represent a major outcome of its efficient performance?

The 'Fourth Industrial Revolution' has significantly accelerated the change of the nature of work, transforming what people do for a living; how they do it, what skills they need; where they perform their work; how work relations are structured, and how work is organised, distributed and rewarded. Digitisation and automation are rapidly reshaping labour market needs across all sectors, in some cases, creating a dynamic environment with temporary positions, represented in the form of on-person micro-providers.

The challenge is twofold – 1) provide the instruments to upskill the workforce, concentrating on essential horizontal skills for the digital age, which must include new and stronger capabilities on emerging technologies, but also softer ones such as adaptability, entrepreneurship and multidisciplinary; while 2) responding to the risks that accompany these non-standard forms of work.

Another factor to be highly taken into consideration is the creation versus destruction of jobs and tasks due to automatization of processes. The estimates of the share of jobs that could be automated in the future vary widely across studies; e.g., globally, between loss of some 2 billion, to creation of 375 million by 2025/30. About 50% of current jobs globally[93], theoretically could be automated, where rapid advances in Artificial Intelligence imply that machines are becoming capable of outperforming humans in a range of work duties requiring cognitive capabilities. In any case, the risk of automation also differs significantly across occupations.

Nevertheless, these reports remain silent on the number of jobs that will be created in the future. As these tasks are replaced, new ones are emerging, such as those related to managing and troubleshooting automated systems – requiring the worker's skills profile to adapt accordingly. Assuming that current employment trends will not be entirely disrupted by new technologies in the next 10 years, occupations

[90] European Commission and International Monetary Fund, World Economic Outlook.

[91] PwC's Retail Banking 2020: Evolution or revoluton

[92] S. Hoffman, 'Engineering global consent. The Chinese Communist Party's data-driven power expansion', Australian Strategic Policy Institute Policy Brief, October 2019

[93] 'Jobs lost, jobs gained: Workforce transitions in a time of automation', McKinsey Global Institute Report, 2017

that are predicted to grow most in the EU-28 by 2030 appear to be disproportionately high-education, intensive in social and interpretative tasks, and requiring at least a basic knowledge of ICT[94].

Human capital

Despite digitisation covers all areas of the economy and society, there is a general shortage of highly-skilled tech professionals in emerging technology– hardly surprising when one considers that in 2017, 43% of the EU population had an insufficient (less than basic) level of digital skills, while those with low overall digital skills had actually increased from 23% in 2015 to 26% in 2017[95].

Over 70% of European firms report that lack of skills is hampering their investment strategies[96]. Europe needs to invest in specialist, high-end technical skills if it wishes to become a global leader in future technologies that build on digital, such as AI or quantum computing. Through its Digital Skills and Jobs Coalition[97], the Commission seeks to further reduce digital skills gaps by fostering the sharing, replication and upscaling of best practices in areas such as training and matching for digital jobs, certification and awareness raising.

Another main challenge the Next Generation Internet must confront is the position and empowerment of Women in Digital. Increased participation of women in the tech sector would boost the economy and allow for their full participation in society. However, despite the fact that more girls are now completing higher education than boys, not enough of them are entering fields of education that result in higher-paying, future-oriented occupations, such as science, technology or engineering. The Commission's study Women in the digital age[98] confirms this trend with only 24 out of every 1000 female tertiary graduates having an ICT related subject - of which only six go on to work in the digital sector. This is reinforced by the Women in Digital Scoreboard 2019, that underlines that only 17% of ICT specialists are women, having a gender gap of 11% in digital skills – even higher for those above 55 years[99].

Stimulating digital innovation for growth and inclusiveness

Larger companies have tended to lead in the exploitation of big data and digital technology, given the related investment requirements – e.g. skills, infrastructure and technology. However, Internet technology is significantly increasing SMEs' capabilities to grow and compete in the market. Access to data brings customer intelligence, which is the most important predictor of revenue growth and profitability. AI, machine learning, and customer analytics are expected to become the driver of client engagement over the next decade. The analytics layers will be in charge of the thinking, using advanced AI techniques to profile and predict behaviour, detect anomalies and discover hidden relationships. Meanwhile, data lakes will form the key layer of the solution, acquiring data rapidly from disparate sources and ingesting it so it can be used productively.

[94] A. Pabollet, et al., 'The changing nature of work and skills in the digital age', Publications Office of the European Union, Luxembourg, 2019

[95] Eurostat, Digital Skills, Data for the year 2017. Fortune 100 database.

[96] European Investment Bank (2018). 'Investing in Europe's future: the role of education and skills'

[97] The Digital Skills and Jobs Coalition. https://ec.europa.eu/digital-single-market/en/digital-skills-jobs-coalition

[98] 'Women in the Digital Age', European Commission DG-CONNECT, 2018

[99] Women in Digital Scoreboard 2019. https://ec.europa.eu/digital-single-market/en/news/women-digital-scoreboard-2019-country-reports

To achieve a robust digital economic fabric, the EU innovation policy framework must provide instruments to support disruptive or breakthrough innovation. The European Innovation Council (EIC) pilot[100] is a good approach to this challenge, combining grant and equity investments to fill market gaps for fast-growing, technology-based companies, and for targeted support to next-generation technologies. With a budget of €2.7 billion in funding for the period 2018-2020, the European Commission has proposed to scale this up to 10 billion euro under the next budgetary cycle.

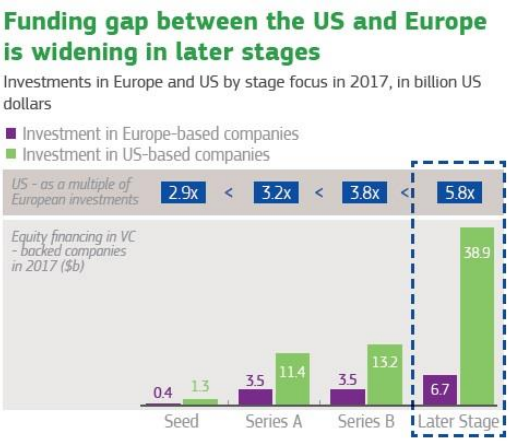

Figure 10 - Funding gap between the US and Europe (Source: Dow Jones VentureSource)

Nonetheless, a particular effort is needed to incentivise private venture capital investments. One of the main components – and main challenges – of technology transfer is its financing. While Europe has made real advances in narrowing the gap to the US with regards to seed and early-stage funding for start-ups, it lags behind on later-stage funding of companies. In 2017, growth capital still represented less than 7.5% of overall funding in Europe – at 6.7 billion euro, against 92 billion euro of total private equity raised. This is one of the key reasons why Europe's most successful companies often end up in the hands of third country firms or investment funds.

3.1.3. Policy Expert Group

Commented [J4]: To be updated by Fabrice. Maybe we can add the top priorities already shared by Peter

The first exchanges within the policy group tackled the identification of the main challenges the Internet will have to face in the next 5 to 10 years, including notions essential to EU-US cooperation and wider considerations.

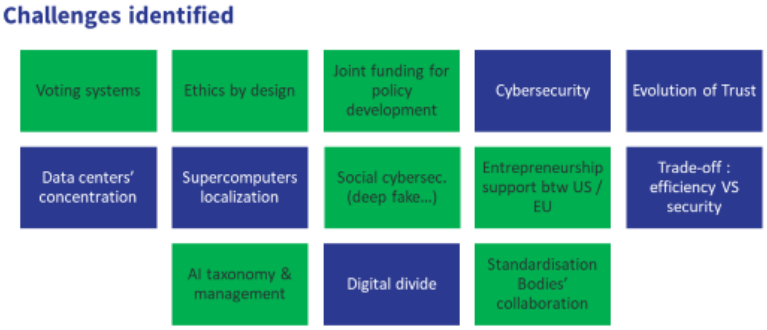

Figure 11 - Policy-related challenges identified

This meeting enabled Experts to identify a first set of key challenges that are to be further explored within the next developments.

NGI cooperation support schemes. As a first observation, Experts noted that EU and US innovation support schemes were intrinsically different when considering the Next Generation Internet. Transversal

[100] European Innovation Council (EIC) pilot. https://ec.europa.eu/research/eic

cooperation between research, industries and policymakers has no equivalent in the US. Moreover, most bilateral cooperation schemes do not provide funding for the other part, the European Commission financing EU stakeholders and US agencies their nationals. Joint or coordinated funding schemes are lacking for allowing EU/US cooperation, notably concerning entrepreneurship support.

- Policies Trust management in complexified environments
- Security intelligent trade-off (efficiency / security)
- Pilot Project in the field of Distributed Ledger Technologies (DLTs)

US and EU standardization bodies' collaboration across NGI technologies. As Next Generation Internet initiative explores new fields and technologies that are creating new international standards. These NGI-related technologies could confer with the opportunities to EU and US standardization bodies to set cooperation mechanisms breaking out silos and thus fostering the fast-tracking of standards, benefiting both sides in the international competition.

- IoT developments and NGI principles integration
- Standardization bodies cooperation mechanisms

Developing a common language on Artificial Intelligence. AI is a major technology the Next Generation Internet builds upon. As such, the development of solutions generate a new field of ruling for policymakers. However, the semantics behind AI-technologies and applications are not shared between both sides of the Atlantic (and event within each region itself). Cooperation on AI taxonomy could confer the opportunity to better tie EU and US developments and mutual understanding, thus fostering this technology's growth.

- Translating AI developments in understandable terms for policymakers
- Algorithm fairness & transparency
- Identifying the data per AI applications

Building cooperation upon shared values. NGI thematic covers a wide range of parameters linked to citizens' rights (data privacy, security, trust etc.). These themes are of concern for both EU and US authorities, which are facing similar and growing challenges on these questions – essential for their democracies.

The questions of trust and security in online voting systems as well as the 'social cybersecurity' (tackling aspects such as misinformation, etc.) of citizens were notably deemed as relevant within EU/US collaboration schemes, in line with the values these regions share.
In conclusion, the Expert Group agreed that there are many options for transatlantic collaboration, and it was discussed which topics and areas are most suitable for collaboration initiatives.

- Trust management in complexified environments
- GDPR / Californian policy
- Security intelligent trade-off (efficiency / security)
- Pilot Project in the field of Distributed Ledger Technologies (DLTs)[101]
- Digital divide

[101] https://ec.europa.eu/digital-single-market/en/news/pilot-project-co-creating-european-ecosystem-distributed-ledger-technologies-social-and-public