D2.5 – Thematic Workshop #2 report

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement nº 825189. This document reflects only the author's view and the Commission is not responsible for any use that may be made of the information it contains.

Project Title	Think tank for the collaboration on NEXt generation internet between EU-US
Project Acronym	Think NEXUS
Grant Agreement No	825189
Instrument	Coordination & Support Action
Topic	Industrial Leadership / Next Generation Internet
Start Date of Project	1st November 2018
Duration of Project	30 Months

Name of the deliverable	Thematic Workshop #2 report
Number of the deliverable	D2.5
Related WP number and name	WP2 - Think Tank Operation
Related task number and name	Task 2.2 - Think NEXUS Thematic Workshops
Deliverable dissemination level	Public
Deliverable due date	31/10/2020 (initial date), 1/03/2021 (accepted new date)
Deliverable submission date	01/03/2021
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Abstract

This deliverable, 'Thematic Workshop #2 report' gathers the inputs linked to Think NEXUS technical workshop having taken place on Feb. 17th, 2021. This workshop was focusing on key NGI-related technologies and opportunities for collaborations between the EU and US.

Keywords

Next Generation Internet; EU-US collaboration; Workshop; Digital Policy; STEM

Revisions

Version	Submission date	Comments	Author
v0.1	19/02/21	Definition of the deliverable's contents	Fabrice Clari, Lisa Pourcher (GAC)
v0.2	21/02/21	Validation of the workshop transcript	Fabrice Clari, Lisa Pourcher (GAC)
v0.3	25/02/21	Inputs from IMEC, ATC	Maritini Kalogerini (ATC), Wouter Tavernier (IMEC),
v0.4	26/02/21	Inputs from AUSTRALO, SPI	Jose Gonzalez (AUSTRALO), Daniela Coutinho (SPI)
v0.5	01/03/21	Integration of inputs, conclusion	Fabrice Clari, Lisa Pourcher, Marc Pattinson, Hubert Santer (GAC)
v0.6	01/03/21	Internal review	Maritini Kalogerini (ATC)
v1.0	01/03/21	Integration of comments and submission	Hubert Santer (GAC)

Disclaimer

Acronyms and definitions

Acronym	Meaning
AI	Artificial Intelligence
BDVA	Big Data Value Association
dApps	Decentralized applications
DG CONNECT	European Commission's Directorate General for Communications Networks, Content and Technology
DL	Deep Learning
EC	European Commission
EDIH	European Digital Innovation Hub
EIT	European Institute of Innovation & Technology
EU	Europe/ European Union
GDP	Gross Domestic Product
GDPR	General Data Protection Regulation
GMF	German Marshall Fund of the United States
H2020	Horizon 2020 Programme
HetNets	Heterogeneous Networks
ICT	Information and Communications Technology
IoT	Internet of Things
NATO	North Atlantic Treaty Organization
NGI	Next Generation Internet
NSBE	National Society of Black Engineers
NSF	National Science Foundation
R&D	Research and Development
SDET	Strategic Dialogue for Emerging Technologies
SHPE	Society of Hispanic Professional Engineers
SME	Small and medium-sized enterprise
STEM	Science, technology, engineering, and mathematics
SWE	Society of Women Engineers
TTC	EU-US Trade and Technology Council
UK	United Kingdom
US/ U.S./ USA	United States of America
VC	Venture Capitalist

Think NEXUS project

The Internet of the future should be more open, provide better services, more intelligence, greater involvement and participation. It needs to reflect the European values. EU's Next Generation Internet initiative is a key opportunity to rethink the way the Internet works today and develop a vision involving voices from across Europe, the US, and beyond, an Internet that embodies the values Europe holds dear, such as openness, inclusivity, transparency, privacy and cooperation.

Thinking globally, the NGI will be successful only if a worldwide consensus is found, enabling the internet a Human-centric process. To that end, collaboration between the EU and the US is essential, both areas being strongly committed to develop the future of Internet, to shape a sustainable landscape for NGI developments. Indeed, the NGI initiative should design specific actions for policy collaboration, shared technology development and interaction between user-communities, with other initiatives in the world where parts of the NGI infrastructure are designed and deployed; and the US are one of the main places where such activities are held.

Think NEXUS aims to reinforce EU-US collaboration, through its dedicated think tank, involving major stakeholders (researchers, entrepreneurs, policy makers) from both sides of the Atlantic on NGI-related thematic 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. More specifically, Think NEXUS is expected to boost the strategic research, industrial partnerships and policy compliances among the respective communities of the NGI areas and thus, result in substantial socio-economic benefits in both the EU and US regions.

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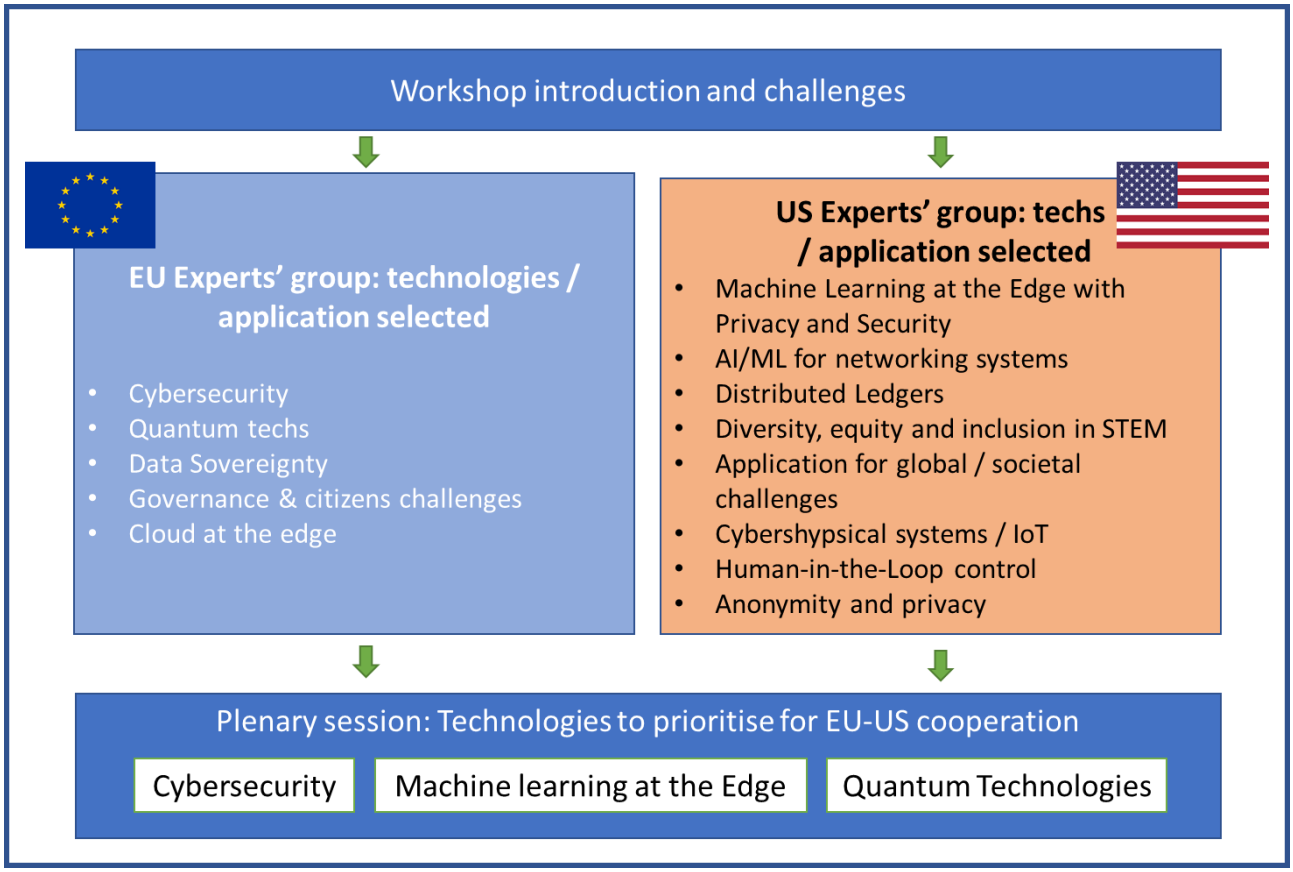
Executive summary

The Think NEXUS workshop #2 was held on the 17th of February 2021. This event gathered 29 Experts on Internet-related domains from EU countries and the US for 2,5 hours. The objective of this workshop was to further prepare the EU-US research and development agenda for cooperation on future internet technologies.

After a short introduction to the remote tools used, Experts were divided in two groups, one for European Experts and the other one for US ones. After having selected the key technologies enabling the developments of the Next Generation Internet, a last session enabled Experts to gather and discuss the ones for which EU-US cooperative schemes should but an emphasis upon. The graph below details the different technologies discussed and prioritised during the workshop developments.



This deliverable provides an overview on the approach and methodology taken, before diving into the key technologies, domain and applications discussed. It also put these within the EU and US contexts for further identifying the path for enabling further exchanges and cooperative schemes.

Think NEXUS project will build upon these outcomes for further building the framework of cooperation, notably through its next white papers and workshops.

1. Introduction

This document presents the key information, contributions from the participants and key outputs from the Think NEXUS workshop, which was held on the 17th of February 2021. This was an invitation-only event, which included the participation of about 30 experts from EU countries and the US.

Figure 1 - Design prepared to announce the workshop

1.1. Context and objectives

In a changing world, facing a global sanitary crisis, it is essential to build bridges and provide decision makers with common views on the future of the Internet and the Digital Economy.

The European Commission (EC) recently published its new Digital Agenda for the next 5 years, that includes the Digital Services and Digital Market Acts. In parallel, the United States (US) has a new administration, that will undoubtedly pave the way for new Transatlantic cooperation opportunities.

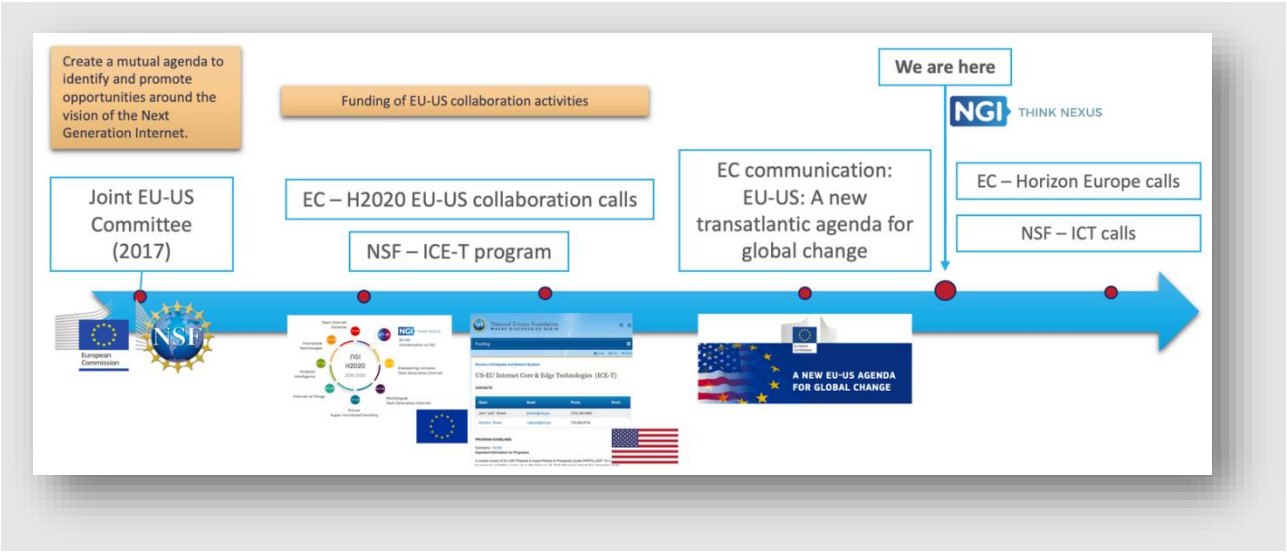


Figure 2 - High-level timeline of EU-US cooperation on NGI

Think NEXUS builds upon the insights and experiences of leading US and European Experts on *Next Generation Internet* for mapping key topics for upcoming EU-US cooperation. It is within this context that Think NEXUS organised an online international workshop to facilitate discussions and exchanges between the experts for identifying the main topics for future EU-US cooperation.

This workshop aimed at identifying the technical topics, which will enable the implementation of the Next Generation Internet technologies. The objective of this workshop was to further prepare the EU-US research and development agenda for cooperation on future internet technologies.

1.2. Agenda

The workshop agenda had been prepared and structured around two main slots: a preparatory session, during which EU and US experts would discuss their views on key technologies needed to foster EU-US collaboration on NGI topics in the next years, and a plenary session in which views from both sides of the Atlantic would be compared and merged.

TIME	SESSIONS
10 min.	**Welcome** Fabrice Clari – Think NEXUS project's coordinator
15 min.	**Introduction** Presented by a Think NEXUS' partner
50 min.	**Preparatory session: Defining NGI topics of high importance for EU-US cooperation for the next years** This session aims at fostering discussions between experts, with the moderation of a Think NEXUS partner. During this session, two parallel sessions will be organised: the EU track and the US track. The overall objective of this session will be to shortlist the key Internet technologies and services to be considered as priorities for the next 10 years. The following set of questions will be used to drive the discussion: • What are the technologies / solutions that are key for developing and deploying the next Internet developments? • What technologies should be prioritised for enabling these developments? • In which of these trends does the US/ the EU have a comparative advantage?
60 min.	**Plenary session: Merging views** The objective of this session is to merge outcomes of the previous discussions to get a common view of the main priorities in terms of key technologies for EU-USA cooperation. This session will promote an open discussion between EU and USA experts, which will be moderated by a Think NEXUS' partner.
15 min.	**Wrap up and conclusions** Presented by a Think NEXUS' partner

Figure 3 - Workshop agenda

More than 30 experts, both from the EU and the US have participated in this event.

2. Methodology

2.1. Topics' definition

Due to the sanitary situation and travel restrictions associated, this workshop was organised remotely (using Microsoft Teams). For enabling this event to provide Think NEXUS consortium with relevant outputs, despite the lack of 'physical interactions', this event was prepared in advance with partners involved in its design and dissemination towards Experts.

As a first step, a list of technologies currently 'trending' across the Atlantic was drafted with the inputs from previous Think NEXUS development as well as an update from US Ignite (Glenn Ricart) and validated with the European Commission's Projects' officer. This list is detailed below, the bold ones being favoured by the EC.

- Distributed and edge AI
- Massive MIMO for frequency re-use (to help multiply spectrum capabilities)
- Auto-resilient hosting
- **Green edge computing (green leaves)**
- UWB for smart things and IoT (Ultra WideBand)
- Environmental power for smart devices (powered by ambient RF, temperature changes, wind, human or natural motion, etc.)
- **Quantum Internet**
- Converging 6G and WiFi technical capabilities
- Reliable and fail-safe V2X infrastructure
- At-scale real-time and predictive digital twins
- **Quantum simulation and prediction**
- **Homomorphic encryption for privacy**

The project team further rationalised these topics, and prepared a dedicated questionnaire that was sent to the Expert database prior to the event.

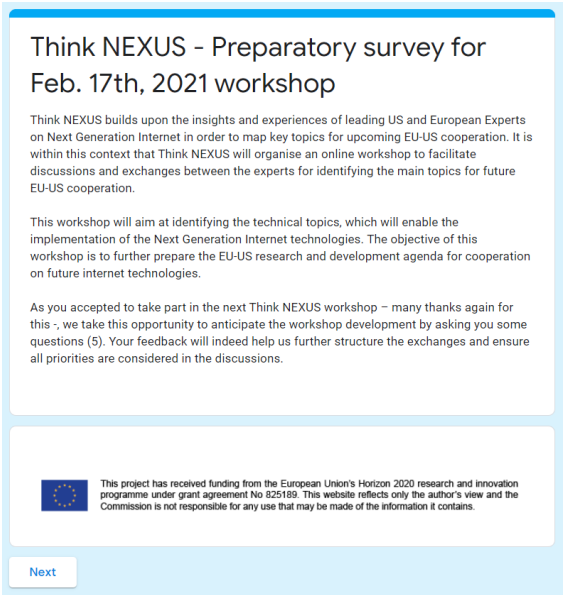


Figure 4: Think Nexus Workshop #2 preparatory survey

This survey was sent to all registered participants prior to the meeting, for enabling Think NEXUS to further refine the workshop outline and set the roll out of the Workshop.

2.2. Workshop outline and management

The workshop outline was discussed aside the list of topics with the European Commission' s Project Officers, for ensuring its added value to these stakeholders. Its objectives were thus set as follow:

- Identification of a list of key technologies for future EU-US cooperation on NGI
- Definition of the next steps to further define/study key topics (ex: preparation of white paper)
- Provision to the project with inputs to prepare recommendations to be proposed to the European Commission for key topics to be funded in the context of EU-US cooperation

The Think Nexus team designed a workshop format that would allow stakeholders to contribute along discussions in a collaborative manner. As such, the team opted for distributing EU and US Experts in two separated groups along 2 sessions. This format enabled Experts from both sides of the Atlantic to design and discuss applications of the technologies in their respective contexts.

These 2 sessions were aligned upon these thematics:

- **First / preparatory session**: propose key internet technologies for future EU-US cooperation. Two parallel tracks to get EU and US perspectives.
- **Second / plenary session**: merge idea, get a consolidated view, vote for most important technologies, prepare a roadmap for next steps.

The graphic Figure 5 below displays the approach taken for the workshop.

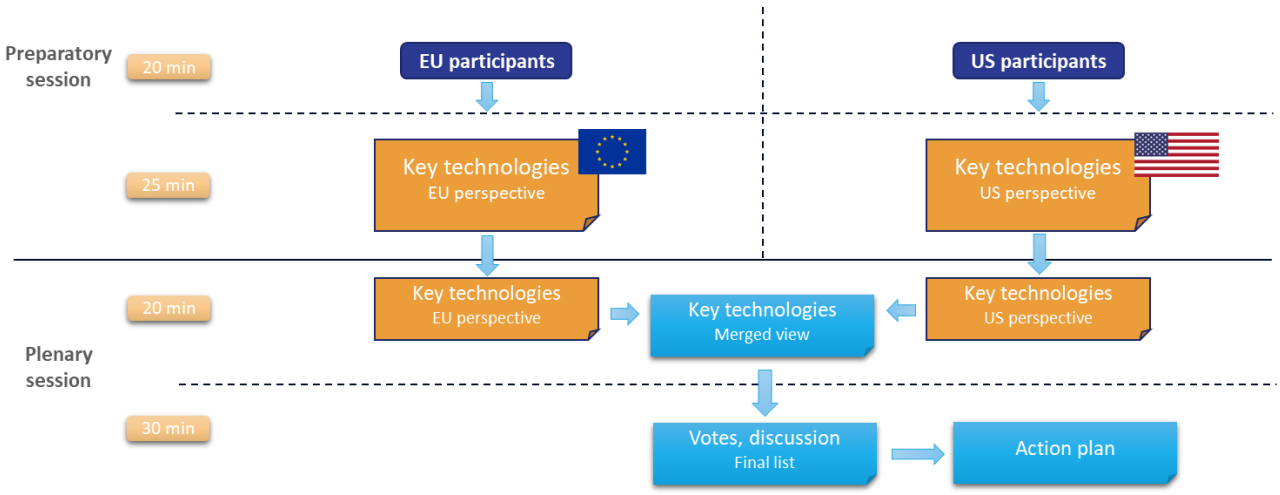


Figure 5: Workshop methodology and timeline

The project divided the animation of the workshop between 2 partners. 'Plenary sessions' were moderated by Fabrice Clari and Marc Pattinson, from GAC, while discussions within the 'Preparatory sessions' took place under the management of Jose Gonzalez and Vasilis Papanikolaou from AUSTRALO.

For enabling the participatory approach of these discussions, the team used a virtual board through the collaborative tool Klaxoon[1]. This tool enables participants to add 'post it' on the priorities and to rate the various 'post its' from other participants.

During this workshop, a Klaxoon background was set for each group, enabling participants to add and comment on technologies proposed, related use cases, and main obstacles to the implementation of the technology. Figure 6 presents the tool made available to participants for listing and detailing the contents of discussions.

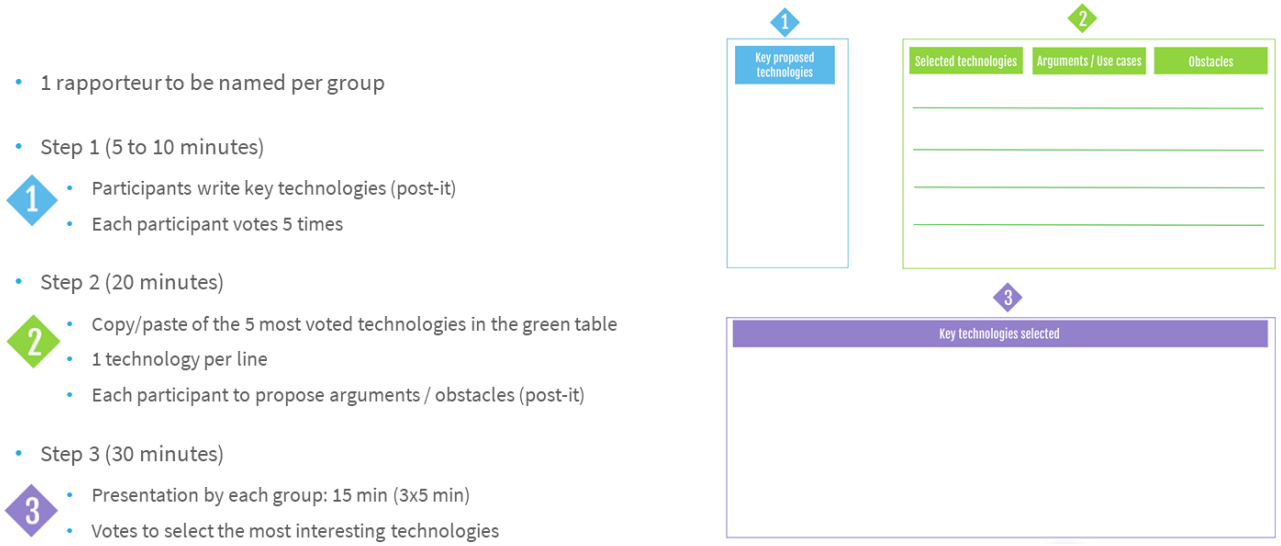


Figure 6: Collaborative tool Klaxoon - workshop setup

At the end of the first sessions, attendees were asked to vote for the technologies and themes they considered as the most important for the implementation of the future internet technologies, enabling the selection of key techs EU and US have the most common interest to collaborate about.

During the final / plenary session, the 'post-its' that were the most voted were gathered in a common table for enabling participants to discuss the techs selected and select the ones that need to be further scrutinized by the partnership in Think NEXUS endeavours.

Following sections detail:

- Responses to the preparatory survey;
- Key outcomes from the EU Experts session;
- Key outcomes from the US Experts session;
- Final outcomes from the merged groups upon the key techs to explore.

[1] https://app.klaxoon.com/

3. Preparatory questionnaire feedbacks

Workshop participants were invited to provide with their views on NGI technologies prior to the event for enabling a segmenting of discussions. Most of these feedbacks were provided by US experts (87%).

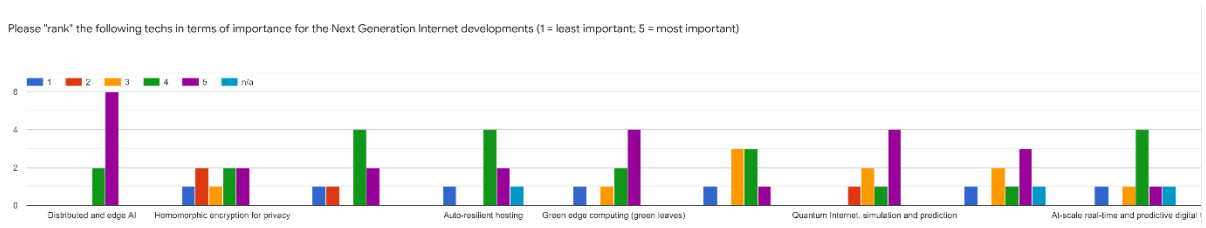


Figure 7 - Respondents ranking of techs for NGI

Distributed and Edge AI was considered as a key element for the development of the NGI paradigm, followed by 'Green edge' technologies and quantum techs development.

On the 'innovation aspects' of internet developments, the following question / answers lists the technologies that will drive the internet economy.

Which are the other most relevant technology breakthroughs that will shape the digital economy in the next 10 years?

6 responses

Secure computing environments (e.g., SGX) to reduce the opengings for cyber criminals

digital currencies, privacy preserving networks (e.g., Tor)

AI

Digital Currencies, Pervasive Cloud-edge Continuum, Compliance of GDPR and similar privacy laws, Machine Learning at the Network Edge.

Secure and Robust AI and ML

I won't think there be a single technology breakthrough in terms of novel hardware, a new software advance (e.g., AI), or a "killer app" -- with perhaps the exception of quantum computing, which is probably 10 years away). I believe it will more at the "grand scale" of how we leverage technology to tackle societal challenges. For example, decoupling and dis-aggregating data ownership, service providers and infrastructure providers to break the grip of "big tech" and the like to foster and enable new innovations.

Figure 8 - Respondents feedback on key internet innovations

The assessment of EU / US comparative advantages by respondents gave the following results:

Table 1: Comparative advantages / technologies

EU	US
• Green computing • GDPR • Reliable and fail-safe V2X infrastructure • Distributed and edge AI and Massive MIMO for frequency re-use • MIMO, Green edge computing, Environmental Powering of Smart Devices, Quantum Computing • Stronger government-industry supported research projects; consensus-driven approaches to tackle common problems of interest; better educated workforce	• Neutral-host or open access for competition • Funding opportunities • The US probably has an edge in Distributed and edge AI, Homomorphic encryption for privacy, and possibly Green edge computing • AI • Homomorphic encryption and auto-resilient hosting • Digital Twins, Distributed and Edge AI, Auto Resilient Hosting, V2X, Homomorphic Encryption • Diversity of talents, competitive spirits, ample (private) investment and funding, less unnecessary regulatory red tapes

These feedbacks to the preparatory survey helped GAC to further define the approach taken within the meeting, and essentially re-focus discussions within the preparatory sessions with this information in mind.

Unfortunately, not all respondents to the survey did take part in the workshop, leaving certain interesting entries out of the discussions during the workshop. The conclusions reached during the workshop thus differ from the ones of the questionnaire, along the exchanges' flows.

4. Preparatory sessions

4.1. EU Experts' outputs

Following the methodology defined for the session, participants were asked to identify openly technological research areas that they assess will be of paramount relevance for evolving the digital agenda in the next five years. To understand the rationale behind their suggestions, the experts needed to elaborate their opinions briefly with views to make a point and try to influence the rest of the audience. The objective was to consolidate a Top 5 list of topics, so the dynamic of the activity demanded to seek convergence.

The discussion brought some keystone research areas to the pipeline, such as Autonomous Vehicles, Nanonetworking, Data Block Matrix (data structure that supports the ongoing addition of hash-linked records while also allowing the deletion of arbitrary records, preserving hash-based integrity assurance that other blocks are unchanged), Unsupervised Machine Learning, Advanced Industrial IoT solutions, Crypto-currency Fraud Fight, 5G Stand Alone over IPV6, and the pan-European computing initiative 'GAIA-X'. However, as some of the suggestions implied very particular cases, the moderator curated and refined some of these categories into higher-level clusters, constituting the final list of topics from the European side. Most of the research areas are closely aligned to the European Commission's agenda in its Digital Strategy for the period 2020-2025, ***Shaping Europe's Digital Future***[2]. A thorough assessment can be found in *Think NEXUS D2.7 – Future Trends & Collaboration Roadmap*[3].

The discussions between the experts identified the following key NGI thematics and their underlying challenges.

Table 2: Key European technologies / challenges (*extracted from Klaxoon page*)

Selected technologies	Opportunities and use cases	Collaboration drivers
Cybersecurity	Sensitive information exchanges and protection	• 5G for Cooperative Connected and Automated Mobility • Digital Innovation Hubs as drivers for cooperation • Common strategy aside Chinese plans
Quantum techs	• Security frameworks powered by Quantum techs • Sped up responses to crises	• Chinese as frontrunner / competitor • Market uptake of Quantum powered solutions
Data Sovereignty	Multi sector impacts	

[2] "Shaping Europe's Digital Future". European Commission Communication, February 2020. https://ec.europa.eu/info/sites/info/files/communication-shaping-europes-digital-future-feb2020_en_4.pdf

[3] "D2.7 - Future Trends & Collaboration Roadmap". Think NEXUS, January 2021. https://thinknexus.ngi.eu/wp-content/uploads/2018/10/Think-NEXUS-D2.7-Future-Trends-Collaboration-Roadmap-v1.0.pdf

Governance & citizens challenges	Implication of citizens in the development of solutions	Securing developments that share common EU-US democratic values and principles
Cloud at the edge	Investment and infrastructures	Building upon the shared facilities and access between both areas

Cybersecurity

Cybersecurity is identified as the most critical subject upon which developments are expected to enforce the Next Generation Internet's trustworthy vision. Vast amounts of sensitive data are currently stored in controversial cloud services, with the possibility of being exposed to a myriad of cybersecurity threats. Many initiatives provide strategic direction for making improvements to cybersecurity, while budget for relevant R&D fields has been increased. This domain covers a wide array of technologies and principles that are currently at the centre of the European Single Market, having the General Data Protection Regulation (GDPR) and top referent, and gaining momentum as the shield protecting sensitive information, enforcing citizens' digital rights and enabling prevention / treatment of cyber-attacks and spying on next generation communication networks. This tendency is well reflected in the agreement to establish a **European Cybersecurity Competence Network and Centre**[4], leveraging the operations of over 660 cybersecurity expertise centres from all Member States, to help Europe retain and develop the industrial capacities and assets necessary to create an inter-connected, Europe-wide cybersecurity industrial and research ecosystem. The new network of European Digital Innovation Hubs (EDIHs)[5] shall represent a significant driver in this mission.

Margrethe **Vestager**, Executive Vice-President for a Europe Fit for the Digital Age, said: "*If we want people and businesses to make the most of digital services, they need to trust them. We are increasingly dependent on digital infrastructures and applications. And their security is critical for the entire European society and economy. We need to make sure we have all elements in place, including a robust cybersecurity industry, to create a safe online environment, where EU citizens can exercise their fundamental rights and freedoms, and where businesses can prosper.*"

Quantum technologies and networks

Quantum computer is a new way of computing that uses elements from theoretical physics to provide order of magnitude performance increase, and qubits is the fundamental building block of quantum computers that is used for processing and storing quantum data. It is the equivalent of a classical bit.

[4] "Commission welcomes political agreement on the CybersecurityCompetence Centre and Network". European Commission Press release, December 2020. https://ec.europa.eu/commission/presscorner/api/files/document/print/en/ip_20_2384/IP_20_2384_EN.pdf

[5] "European Digital Innovation Hubs in Digital Europe Programme". Draft working document. European Commission, January 2021. https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=70324

Despite the early state of the art in development, quantum computing, quantum networks, and related applications need to be considered one of the leading technological drivers in the medium term. The critical aspect here is that the EU is relatively well advanced compared to its 'competitors' globally, with China being at the forefront. This is in fact a key aspect that can represent a driving motivation for collaboration with the United States. If both powerhouses can define and pursue a joint roadmap, the Transatlantic alliance will be catch up with -and overtake- China to define a global model. Large quantum-computing initiatives are investing in qubit research, giving researchers access to commercial cloud services. But extensive research is needed between these extremes. The industry will ultimately mass-produce quantum computers, but the early 'killer apps' might well come from scientific discovery. Unleashing 'full stack' quantum computers into the research community will hasten that search.

There are two clear-cut use case scenarios where this could represent an absolute competitive advantage: 1) Quantum cryptography -which is highly related to the previous sector- can protect hyper-connected mission-critical scenarios. BT is joining forces with a group of UK-based quantum technology startups and research bodies seeking to make a leap in developing secure communications for 5G and connected cars[6]; 2) The response plan against the Covid-19 -and future- pandemics. Diagnose the infected patient as soon as possible in the coronavirus outbreak is extremely important. Machine learning process in classical computers requiring more processors and time than quantum computers can be realized in a very short time with a very small quantum processor such as 4 qubits in quantum computers. According to research, by using a small number of data sets such as 126 COVID-19 and 100 Normal CT images, a positive or negative classification of Covid-19 can be obtained with 90% success in classical computers, while it is achieved a high success rate of 94-100% in quantum computers[7]. Within high performance computing, quantum is anticipated to be a game-changer in the field of quantum chemistry, because of its ability to provide exponential speed-up to crucial calculations. The creation of a vaccine for COVID-19 has an expected timeline of 12 to 18 months. The question raised here, is if quantum computing has the potential to reduce these timelines. Methods of developing vaccines, deal with complex computing during the design phase, where molecular simulations often have to be accomplished to comprehend the protein structure of the virus. The ability to run more complex simulations, could decrease the chance of vaccines being ruled out in the second testing phase (testing if the vaccine works consistently) - or even third testing phase (testing the vaccine's efficiency). Most of physics, and all of chemistry are based on a single equation – the Schrödinger equation. Quantum computers can deal with the Schrödinger equation, because instead of truncating the equation, or simplifying the problem, they can simulate systems with much higher accuracy[8]. In conclusion, looking at the impact that COVID-19 is having in

[6] "BT backs quantum computing for 5G security". Mobile World Live, November 2020. https://www.mobileworldlive.com/featured-content/top-three/bt-backs-quantum-computing-for-5g-security

[7] "COVID-19 detection on IBM quantum computer with classical-quantum transfer learning". E. Acar, I. Yilmaz, medRxiv 2020.11.07.20227306; doi: https://doi.org/10.1101/2020.11.07.20227306

[8] https://www.capgemini.com/2020/07/can-quantum-technology-assist-in-the-next-covid-crisis-part-1/

healthcare, we can envision future use cases for the role of quantum computing in vaccine development thanks to its ability tackle larger problems with higher accuracy[9].

Quantum technology however also poses a risk, which might be exploited in cybersecurity fields, as current security mechanisms considered intractable for some attacks might become prone and feasible to attack using quantum computing.

Data sovereignty, internet governance and citizen challenges

Whilst at the core of the GDPR principles, data sovereignty applied to the internet remains a technical challenge for European stakeholders. On the 'non-technical' aspects, the questions of ethics, data anonymisation, and empowerment of users are key for a democratic development of the internet infrastructure. On governmental level, the security of servers, the hosting of sensible personal data (and data as a whole), are key elements they have to consider for enforcing the European policy.

Figure 9 – Projected data impact in 2025 (Source: European Commission)

On technical level, the implementation of technical solutions empowering citizens to access, control and protect their data in the upcoming years remain the key challenge upon which European stakeholders need to focus. Interestingly, this work on technical solutions for enabling GDPR applications could confer these stakeholders with a comparative advantage on a market burgeoning in certain parts of the US.

The European Commission aims to define a framework for cross-sectoral governance of common European data spaces, that will be reinforced by common European data spaces in strategic sectors and domains of public interest, naming manufacturing, Green Deal, space or health.

Another main theme, that was discussed, is the need for EU-US collaboration on the data protection laws. Indeed, since the invalidation of the Privacy Shield, many companies have to use standard contractual clauses which implies heavy administrative burdens. More than 5300 companies in the US and most of them are small and medium-sized companies are scrambling to find a basis under EU law for transferring personal data. This

9 [Kreuder Johnson, C., Hitchens, P., Smiley Evans, T. et al. Spillover and pandemic properties of zoonotic viruses with high host plasticity. Sci Rep 5, 14830 (2015)].

legally complicated situation has to be solved through a political arrangement that streamlines the relationship again between the EU and the US (as the Safe Harbour Agreement and the Privacy Shield Agreement did).

Cloud at the Edge, infrastructure and platforms

Technology sovereignty is one of the main priorities set out for Europe for the next 5-year period, and the dependency on Hyperscalers like Google, Facebook, Microsoft and Amazon represents an obstacle for that ambition. Hyperscale companies have a broad, ambitious vision for their future. In most cases, that vision requires a substantial investment in infrastructure, concentrating the majority of cloud infrastructure and services.

It is expected that European-flavoured federated, open data infrastructure '**GAIA-X**' can act as an alternative to the US hyperscale model, whose first iteration is expected in early 2021. With GAIA-X, representatives from 22 Franco-German founding members from business, science, and politics create a proposal for the next generation of a European data infrastructure: a secure, federated system that meets the highest digital sovereignty standards promoting innovation. This project is the cradle of an open, transparent digital ecosystem, where data and services can be made available, collated and shared in an environment of trust.

GAIA-X targets 8 critical sectors, including Industry 4.0, Smart Living, Finance, Health, Public Sector, Mobility, Agriculture and Energy.

To enforce a European data Strategy, the European Commission is also putting the spotlight on the liability of platforms with the Digital Services Act. The accumulation of vast amounts of data by Big Tech companies, the role of data in creating or reinforcing imbalances in bargaining power, and how these companies use and share the data across sectors is being analysed by the Observatory of the Online Platforms Economy. The issue will not be addressed as part of the Data Act, but under the broader fact-finding around the high degree of market power of certain platforms and also in the context of the Commission's work on the Digital Services Act package. Based on this fact-finding, the Commission will consider how best to address more systemic issues related to platforms and data to ensure that markets stay open and fair[10].

4.2. US stakeholders' outputs

The US session focused on opportunities and use cases linked to the technologies driving the future of internet as shown in figure 10. The most voted technologies / use cases validated by the US experts were the following ones:

[10] "A European strategy for data". European Commission, February 2020. https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1593073685620&uri=CELEX%3A52020DC0066

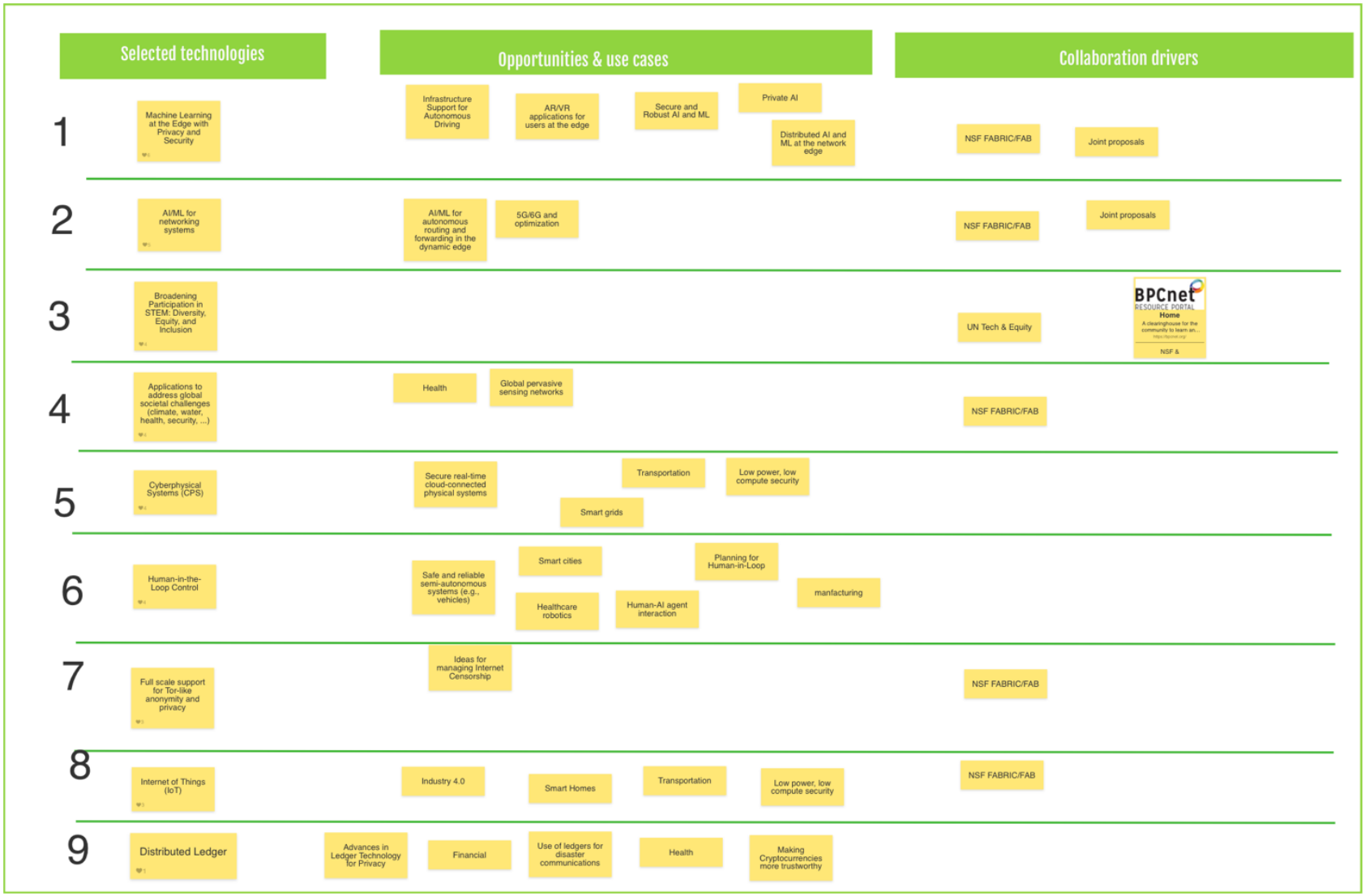


Figure 10 - US session whiteboard

Machine Learning at the Edge with Privacy and Security

Machine learning at the edge is quickly moving from prototypes to commercial deployments across a wide range of use cases. Benefits of edge computing include reduced latency and bandwidth savings, privacy-by-default and by-design in compliance with new privacy regulations that encourage sharing only the minimal amount of data. This creates a need for processing data locally rather than sending everything to a cloud environment and performing machine learning there. Even though machine learning deployments in datacentres can be protected using conventional cybersecurity measures, running neural networks in edge and endpoint devices brings new security challenges to system designers. This challenge is common for both sides of the Atlantic. Collaborative efforts could lead to better, faster and more efficient results stemming from joint research initiatives between leaders on this field.

AI/ML for networking systems

From physical to virtual to cloud infrastructures, networks are getting more diverse. For network teams, managing across hybrid environments is a growing challenge. On top of that, increasing adoption of SDN and SD-WAN technologies are adding new virtual, overlay, and underlay constructs and elements, all making the network stack even more difficult to holistically understand. These factors make accurate network visibility and effective network management harder than ever to achieve. Humans and manual processes can no longer keep pace with network innovation, evolution, complexity, and change. That's why we're hearing more about "self-driving networks," "self-healing networks," "intent-based networking," and other concepts which aim to apply artificial intelligence (AI), machine learning (ML), and automation to support modern network operations, as the amount of data traversing over networks is so astronomical that it has become impossible for humans to process, analyze and act on it.

Broadening Participation in STEM: Diversity, Equity, and Inclusion

Even if this is not a directly technological topic, it has been identified as a key aspect for transatlantic collaboration. The need for a robust and diverse STEM workforce has been reiterated for decades, and it should be one of the top priorities in order to maintain America's and Europe's historical pre-eminence in the STEM fields. Broadening participation aims to strengthen the STEM fields and STEM literacy by engaging and building capacity in all people in STEM learning and professional training, particularly those from groups that have been traditionally underrepresented in STEM fields. Although several initiatives exist, a close collaboration between the two regions is needed allowing to benefit from each other.

Applications to address global societal challenges (climate, water, health, security, ...)

As in the case of Broadening Participation in STEM, this is not a technological subject. However, it has been highlighted several times as a key element for further collaboration and cooperation among the two regions. A challenge-based approach will bring together resources and knowledge across different fields, technologies and disciplines, including social sciences and the humanities, from both regions to tackle common challenges that affect the way their citizens live. This should cover activities from research to market with a new focus on

innovation-related activities, such as piloting, demonstration, test-beds, and support for public procurement and market uptake.

Cyber-physical Systems (CPS)

It is well accepted that Cyber-physical systems (CPS) will provide the foundation of our critical infrastructure, form the basis of emerging and future smart services, and improve our quality of life in many areas. Cyber-physical systems (CPS) will bring advances in personalized health care, emergency response, traffic flow management, and electric power generation and delivery, as well as in many other areas now just being envisioned. Therefore, transatlantic collaboration on technologies, applications and testbeds is vital. Being able to join forces among leading institutions and key end-user, will boost the market uptake of related technologies to real life applications for the benefit of all citizens.

Human-in-the-Loop Control

Human-in-the-loop (HITL) is a branch of artificial intelligence that leverages both human and machine intelligence to create machine learning models. In a traditional human-in-the-loop approach, people are involved in a virtuous circle where they train, tune, and test a particular algorithm. Several control systems in safety-critical applications involve the interaction of an autonomous controller with one or more human operators.

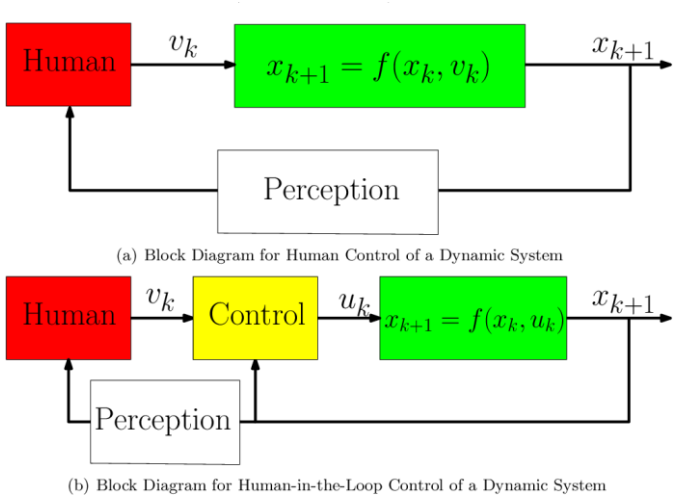


Figure 11: Figure 2: Control philosophy for human-in-the-loop control of a dynamic system: The proposed controller will stay close to the human input signal while completing a lower-level task[11] (source: Human-in-the-loop control for cooperative human-robot tasks)

Examples include pilots interacting with an autopilot system in an aircraft, and a driver interacting with automated driver-assistance features in an automobile. The correctness of such systems depends not only on the autonomous controller, but also on the actions of the human controller. As this is a critical and vital element for the future of almost any technology, international collaboration and agreement is needed.

Full scale support for Tor-like anonymity and privacy

[11] Chipalkatty, R.. “Human-in-the-loop control for cooperative human-robot tasks.” (2012).

Anonymity and privacy for internet users sits in the centre of discussion in both regions. Solutions such as Tor already exist but the boundaries between ethical or unethical usage are vague. Even though similar technologies have been – and are still being – used by limited internet users such as journalist, law enforcement officials and corporate IT professional, simple everyday users are increasing and demand of keeping their anonymity while they are just browsing the internet. This is an essential freedom that any internet user should have. To this end, transatlantic collaboration is needed for developing innovative solutions that will give the opportunity to the user to keep his/her privacy while online.

Internet of Things (IoT)

The IoT is commonly recognised as a fundamental game changing technology across many industrial sectors and social solutions. Many experts and studies agree that the biggest challenge for the IoT is to overcome market fragmentation and to achieve interoperability between many established silos and global IoT platforms. In this context, transatlantic collaboration and cooperation is critical both on the governmental/federal level and on the project level. It is also critical to enhance and strengthen cooperation between key initiatives such as the Industrial Internet Consortium (IIC) and the Alliance for the IoT Innovation (AIOTI).

Distributed Ledger

Distributed Ledger Technologies (DLTs), such as blockchain, have the potential to fundamentally transform a wide range of industries and markets. As the databases are shared between multiple sites, participants or even regions, transatlantic cooperation is essential to address the challenges raised by DLTs and seize the opportunities they offer. Sharing experiences between countries and regions regarding use cases and applications will allow a faster and more efficient adaptation of this technology while it will create a fertile ground for joint discussions, decisions and policies related to possible regulatory schemes needed.

5. Plenary session

After the two parallel preparatory sessions, experts were invited to discuss all together in order to merge EU and US views. As a first step, the project team prepared a dedicated area on the shared whiteboard to show technologies with bigger interest from both sides of the Atlantic; then the audience was invited to vote up to 5 times, for selecting the most needed technologies to foster EU-US cooperation in the field of NGI.

The figure below shows topics selected by EU and US experts along with respective votes (hearts in bottom-left corner of each box). Green boxes were proposed by EU experts while yellow ones were selected by US experts.

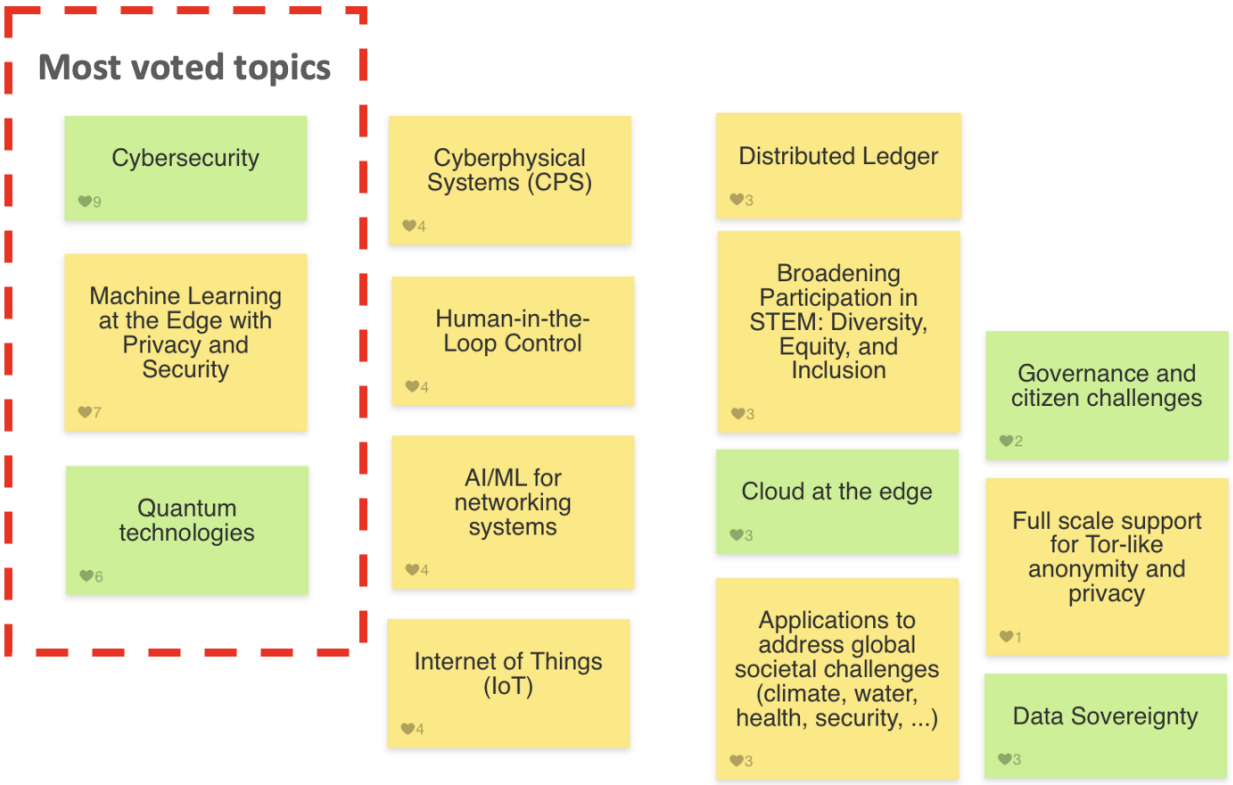


Figure 12 - EU-US selected topics

Level #1 – key fields for cooperation

It is not surprising, given the current context in which important data leaks are regularly announced by big companies and public administrations, that **Cybersecurity comes first**. The extent of potential cooperation ranges from co-development of technical solutions, such as the R&D of homomorphic encryption, to the development of shared learning tools through potential collaboration between the US and European standards and capacity building centres. On the latter, the combination of know how between existing (ENISA) and upcoming Competence Centre for Cybersecurity.

- Cooperation between competence centres
- Malwares identification and threat control

- Data safety & encryption
- Internet systems, CPS systems robustness and securing
- 5G for Cooperative Connected and Automated Mobility

AI, through its application of **Machine Learning / at the Edge** was identified as a key driver of potential cooperation. European initiatives (both regulatory and applicative) and US research and developments on Distributed Ledger Techs need to be considered in an 'holistic' approach, sharing developments but most notably for ensuring safety, compatibility, interoperability of systems. EU-US would benefit to setup research and development common goals, as proposed within the EU-US tech agenda of the European Commission[12], through the Transatlantic AI agreement.

Notable "use cases" for cooperation are listed below:

- Autonomous Routing and forwarding in the dynamic edge
- Infrastructure support for autonomous driving
- Shared facilities and infrastructure for machine learning
- 5G/6G and optimisation
- AR / VR applications for users at the edge
- Secure and Robust AI and machine learning, private AI

In a rather unexpected result of discussions, **Quantum technologies** (gathering, after discussions, Quantum chips, Quantum-powered systems, as well as Quantum-powered applications) were listed as main topic of potential technical cooperation. While the technology is still in its early stage, and the R&D developments remain very competitive, this domain is however considered as having a strong potential for future internet architectures and powered solutions. As another driver of EU-US cooperation, it is important to note that frontrunners for Quantum techs are based in China, which could gain an important comparative advantage in these fields. Combining research efforts could thus hinder the PRC's supremacy in these fields.

The types and "levels" of Quantum technologies and related applications need to be further explored, for identifying key drivers for cooperation.

Level #2 – Other / related domains for cooperation

While meeting less success than the 3 topics detailed above, following 'post-its' were selected by Experts as important domains to cover within EU-US cooperative frameworks:

- Cyberphysical systems & IoT
- AI for networking systems
- Human-in-the-loop control
- Data Sovereignty

[12] See Think Nexus Deliverable "D2.7 – Future Trends & Collaboration Roadmap" for more info on the contents proposed by the EC

- Diversity, inclusiveness and equity in STEM

These domains should be further explored and rationalised upond developments.

Also, it is interesting to note that in terms of sectorial applications, "**Health**" comes first as field for technological developments' applications, followed by "**Climate and energy**" and "**Mobility**".

6. Conclusions

The Thematic Workshop #2 enabled Experts and Think NEXUS partners to exchange upon the technological focus of potential EU-US cooperation. This 2,5 hours-event served as a platform for identifying the technologies the project shall focus upon in its endeavours. Most of the participants were from the research fields from various US universities, enabling participants to have a balanced view over the technical developments to prioritise.

It is important to note that the context is of very much important. The global pandemic, the new US administration and the new EU multiannual framework are key factors in the definition of collaborative themes and schemes. The themes discussed within this workshop reflects on the particular context it took place in. More interestingly, this workshop also highlights the fact that it inscribed itself within the key priorities identified in the US research environment. The outcomes of the workshop are indeed aligned with the Computing Research Association Quadrennial Papers[13], which serve as guidance for US government research funding efforts, as identified in Table 3 below.

Table 3: CRA Quadrennial Papers

Core Computer Science • Post Quantum Cryptography: Readiness Challenges and the Approaching Storm • Foundations for an Algorithmic World • Computing Research Challenges in Next Generation Wireless Networking • Advancing Computing's Foundation of US Industry & Society	**Broad Computer Science** • Pandemic Informatics: Preparation, Robustness and Resilience • A Research Ecosystem for Secure Computing • Infrastructure for AI/Quantum/HPC • Robotics Enabling the Workforce
Socio-Technical Computing • An Agenda for Disinformation Research • Modernizing Data Control: Making Personal Digital Data Mutually Beneficial for Citizens and Industry • New Pathways for Workforce Diversification	**Artificial Intelligence** • Artificial Intelligence at the Edge • Artificial Intelligence and Cooperation • The Rise of AI-Driven Simulators: Building a New Crystal Ball • Next Wave Artificial Intelligence: Robust, Explainable, Adaptable, Ethical, and Accountable • Interdisciplinary Approaches to Understanding AI's Impact on Society

[13] https://cra.org/cra-quadrennial-papers/

It is now up to the project partner to define the strategy, in line with the EC, for further exploring the potential papers to draft and cooperation schemes to design before the next Think NEXUS technical workshop, in Q2 2021.