

Interim Study Report for
European Commission Directorate-
General for Communications Networks,
Content and Technology



Next Generation Internet 2025

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NLnet as a public benefit organisation with well over two decades of unique experience in grant making for and supporting of bottom up internet infrastructure efforts. It has first-hand experience in deploying both 'open calls' and thematic funds to empower independent researchers and developers from around the world able to come up with unconventional solutions for the problems the internet is facing.

NLnet has funded essential work on important infrastructure parts of the internet, from the technologies with which the answers from the DNS root of the internet can now be trusted, all the way up to key standards for email security, transport layer security, email authenticity, and a lot more – on virtually every layer of the internet, from securing core routing protocols to browser security plugins, from firmware security to open source LTE networks.

NLnet is proud to be part of a global community in the technical and operational realm of the internet organically grown since NLnet's inception in 1982 when Teus Hagen launched the very first networking activities in Europe. Several NLnet alumni have been inducted into the global Internet Hall of Fame.

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1. Introduction

1.1 Aim of the document

This document is the *Interim Study Report* for the Next Generation Internet 2025, SMART 2016/0033. It aims at reporting on the first project steps and the initial results of the study after 4,5 months of activities.

The Interim Study Report delivers on the following topics¹:

“Initial steps taken”, describing the **activities** and most relevant steps taken during the first 4,5 months of the project. It is a summary of the progress of the project².

The initial work on the **Vision**,

The method for shaping the **NGI Programme**, input collected from stakeholders and desk search on **Research Topics**, and a **first focus on technology topics**

The **Mapping of Ongoing Relevant Initiatives**,

A description of **stakeholder mapping and** setting up of the **Community**, and organisation of the **Workshop**.

1.2 Reader

The document is structured along the following sections:

1. Introduction
2. Initial steps taken
3. Initial compelling vision
4. NGI Programme concept, first principles and intervention logic
5. Preliminary list of research topics and first focus on technological topics
6. Mapping of ongoing relevant initiatives and gap analysis toward Vision and targeted capabilities
7. Community activities
 - the details regarding the organisation of the Workshop, including the choice of the venue, the selection of the experts and the agenda.
 - setting up of the Community including a description of the tools used to collect input on the research topics from the stakeholders, the stakeholder contacts and the communication packages used

¹ The detailed scope as presented in the Inception Report in annex 1

² The detailed progress reports are presented in annex 2

2. Initial steps taken

This section describes the initial steps which have been taken to produce the first results of the study. The highlights of these results are presented in Sections 3 and 4, and background information is provided in the Annexes.

Various activities were carried out during the first 4.5 month of the project. Their goal was to focus on:

- **creating a community and communicating on the project, collecting input from the right communities, experts and Member States,**
- **shaping the initial thinking on the Vision, the Programme Concept and Research Topics,**
- **and preparing for the Workshop with the experts end of September.**

The following has been achieved:

- The team delivered an *Inception Report* and held an *Inception meeting* with the EC, confirming and fine-tuning the scope of the contract.
- The team created an online Information tool and questionnaire which was promoted to selected stakeholder communities at some of their conferences, via word of mouth, social media and/or sent directly to them.

This online tool and information can be found at <https://nlnet.nl/NGI>, screenshots and a walk-through are provided in Annex 7: Online Platform.

- Members of the team have attended a number of conferences organised by relevant stakeholder communities:

- 1) Annual GEANT conference TNC, Linz, May 29th - June 2nd 2017
- 2) Euro-ISPA, Brussels, June 21st 2017
- 3) EDRi Workshop in Vienna , June 24th-25th 2017
- 4) IETF in Prague , July 16th - 21st 2017
- 5) SHA2017 in Zeewolde, Aug 4th – Aug 8th 2017

Short reports of these conferences are provided in Annex 12: Conference and Workshop Reports and topics are included in section 5.2.

- Members of the team have attended a number of workshops organised or initiated by the European Commission.
- 6) NGI Summit, June 6th- 7nd 2017
 - 7) EuroDig, Talinn, June 7th 2017
 - 8) Net Futures, Brussels, June 28th - 29th 2017

9) NGI Workshop, Twente, July 6th 2017

10) COST-CONNECT, September 1th 2017

Short impressions of these conferences are provided in Annex 12: Conference and Workshop Reports and potential identified topics are included in section 5.1.

- The team selected a group of experts, willing and capable of providing feedback on the deliverables of the project, and also willing to attend the workshop end of September in Amsterdam. For this purpose, the team created a dedicated information package.

The list of selected/invited experts is provided in section 8.2 and the expert communication package is provided in Annex 11: Workshop Experts Information package.

- Organisation of a Workshop – a deliverable of this study – to be held at CWI in Amsterdam on Thursday September 28th.

The agenda and other details of this Workshop are provided in section 8.2.

- During all these activities, the team gathered a significant amount of stakeholder contacts, from many countries, a variety of backgrounds, different age groups and from both genders.

A list of all these contacts, including specifics, is provided in Annex 8: Stakeholders.

- The team created a draft framework for prioritizing research and development activities for the Next Generation Internet. It takes into account the users' perspective for defining the drivers for change for the Next Generation Internet. A first outline of the approach was presented to the EC. The team then "tested" the framework on the research topic "Discovery and identification technologies".

The framework and the key outcome of this assessment is provided in section 4.

- The team did a systematic quantitative text analysis of all existing and completed projects under H2020 to identify prevalent themes and issues. The same analysis was performed on research abstracts published in the last 10 years regarding the Internet.
- The team mapped the activities within the IETF by performing quantitative text analysis of around 8.000 published RFC's as well as analysing the charters for all active working groups under IETF.
- The team carried out an intensive desk-research, including the analysis of several earlier studies and parallel tracks, as listed below :

- *NEXT GENERATION INTERNET CORE (NGI), CONSULTATION ON METHODOLOGY (nov/dec 2016), FINAL REPORT - Rapporteur: Puja Abbassi, University of Cologne,*

Date: 30 January 2017

- *"Next Generation Internet" (Presentation), Fabrizio Sestini, Senior Expert (Advisor) in Digital Social Innovation, DG CONNECT,*

Date: End 2016

- *"NEXT GENERATION INTERNET INITIATIVE – CONSULTATION" (10 nov 16 – 9 jan 2017), David Overton,*

Date: March 2017

- *Consultation for a Next Generation Internet Initiative, Questionnaire David Overton*

Date March 2017

- ❑ Firestudy: The Next Generation Internet (NGI) white paper survey results
Date: March 2017
- ❑ Centre for Science and Policy, Cambridge Computer Laboratory, European Commission, Policy Report, Makoto Takahashi,
Date: Workshop March 1 and 2, 2017
- ❑ *Next Generation Internet Experimentation*, Michael Boniface/Monique Calisti/Martin Serrano
Date: June 2016
- ❑ Speech by Andrus Ansip, Commission Vice-President for the Digital Single Market, at the Next Generation Internet Summit
Date: 6 June 2017
- ❑ *Internet of Humans - How we would like the internet of the future to be*
'Bruno Kessler Lecture ' by Roberto Viola, Director-General for Communications Networks, Content & Technology at the EC
Date: June 30, 2017
- ❑ *Citizen Engagement And Media Campaign On The Next Generation Internet*,
Atomium European Institute / REI-search
May 31, 2017
- ❑ *Horizon 2020 Draft Work Programme 2018-2020*,
Date: June 22, 2017 (Draft)

The general outcome of this desk-research effort is outlined in Annex 13: Desk Research.

- The team did a mapping of ongoing relevant initiatives in Member States and gap analysis. Specifically for this purpose, the team liaised with the National Horizon 2020 contact point in the Netherlands and obtained the 'Horizon 2020, Draft Work Programme 2018 - 2020'. The team also liaised with the Commission to contact the FIF network to request input from the Member States on the National Research Programmes related to the Future of the Internet.

The analysis on the Work Programme and the mapping are included in section 4 and in annex on The mapping of ongoing initiatives. The mapping results and gap analysis are presented in section 7.

- The team created a first compelling Vision, as outcome of a process to identify the compelling aspects, the communication style and the primary goal of this Vision, and the most added value for the Commission.

The Vision is outlined in Section 3. The draft versions and the background text provided in our tender response are provided in Annex 3: Background themes which shaped the Vision and in Annex 4: Draft Vision Texts

- The team provided a framework for conceptual thinking on the design of a work programme.

This conceptual thinking is detailed in Section 4.

- Based on desk search, input from stakeholders and use of the above mentioned framework, the team provided a first list of suggestions on Research and development technology Topics.

These suggestions and the technology topics are presented in Section 5.

3. Initial Compelling Vision

One of the objectives of this study is to develop a vision for the Internet including the technological aspects, the service innovations expected, the socio-economic shifts, the point of views from the users (citizens, business, public sector, etc.) taking into account trends and other impacting factors.

This section presents the process to define a vision and in a second section, the outcome of this process: what we believe is the first compelling **NGI vision**.

3.1 Context and process for a first Compelling Vision for NGI

Context

The Next Generation Internet initiative is radically different from historical efforts undertaken in this area in Europe, because rather than just stimulate research and development in a number of interesting ‘stand-alone’ technology areas to see if anything useful comes out, the NGI initiative aims to look at the *whole of the internet* – and have a major impact at the system level. In order to enable the 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.

Background themes which shaped the vision

The following themes, as presented in Annex 3: Background themes which shaped the Vision have shaped the vision:

- The Internet is profoundly changing society and business
- The Internet needs to evolve technically
- Social and ethical values should be reflected
- It needs to cope with high demand versus technical debt
- The internet needs moving ahead strategically
- Technology operates in a complex and fast changing environment
- Next generation Internet should offer more at the service of Europe’s people, Europe’s communities and to European society as a whole

Drivers for change lead the Vision

The Vision is articulated around *drivers for change* for the NGI.

Existing work

Several approaches are possible regarding these drivers for change. The team research existing initiatives in this area in order to provide a novel approach which would complement the existing initiatives. ISOC is working on a similar initiative, and has defined drivers for change which take into account a technological and a “trends” point of view.

The **ISOC initiative** “Looking into the Internet’s future”¹ focuses on 6 drivers for change which are:

- The Internet Economy
- The role of government
- The Internet and the physical world
- Artificial Intelligence
- Cyber Threats
- Networks, standards and interoperability.

Drivers for change for an NGI

Together with DG CONNECT, the team has decided to bring a user’s perspective when defining the NGI Vision and programme. The detailed **framework used for providing a user’s perspective to the NGI** is presented in section 4. One of the outcomes of the exercise is the identification of the drivers for change.

The four drivers for change are used as key messages around which the vision is articulated. Three of these key messages defining the issues to solve::

- technology reliability and resilience
- trustworthiness and transparency
- sustainability and openness

A fourth transversal key message focuses on the NGI supporting human potential and creativity, which relates to innovation. The title relates to human values, referring to how the EC² would like the Internet to be in the future.

Identifying these drivers for change is the outcome of a long exercise carried out by the study team and the EC, and it synthesises the ideas put through by the Commission in various workshops and

¹ <https://www.internetsociety.org/future-internet>

² <https://ec.europa.eu/digital-single-market/en/news/internet-humans-how-we-would-internet-future-be>

speeches, the various feedback received from the study stakeholders during the data collection exercise, as well as trends identified by Gartner analysts.

Because of this extensive work of aligning various input, the process for defining an initial compelling vision presented in 3.2 was iterative, based on a series of drafts. We achieved a first agreement among the various study team members representing various communities and the project officer of the Commission.

Previous draft versions of the Vision

The team has designed a series of Vision texts and shared them with the Commission to collect feedback, leading to this initial compelling vision presented in the next section. The various versions are presented in Annex 4: Draft Vision Texts.

■ **Draft version sent 29/06:**

A first version which focuses on an Internet of values, and articulates around the reason for an NGI (why), how to achieve the NGI, and what to do.

■ **Draft version sent 14/07:**

A version which includes EC recommendations about exemplification and concision; it also articulates around a slogan and aims at inspiring momentum around the NGI initiative.

■ **Draft versions “B” and “C” sent 20/07**

Versions building on version from 14/07 and focusing on the global dimension of the initiative

■ **Draft version sent 28/07**

A version which includes EC recommendations and feedback on previous versions: the text addresses a vision message of human creativity and potential, and is articulated along three key messages – summarized in 3 words chosen for an R alliteration. It also reiterates some data points derived from our offer.

Structure and communication style of the Vision text

The Vision is structured around three key messages – the drivers for change - which are stated/ summarized in three words as subtitle to the title of the NGI.

These three key messages identify the problem and solutions needed. A fourth message is traversal and conveys a message related to the human aspect.

The text is kept short, about half a page, and the style is journalistic.

3.2 Initial Compelling Vision NGI

The process outlined above resulted in the following initial compelling vision of the NGI.

An internet of human values

Resilient. Transparent. Sustainable.

The overall mission of the Next Generation Internet initiative is to re-imagine and re-engineer the Internet for the third millennium and beyond. We envision the information age will be an era that brings out the best in all of us. We want to enable human potential and creativity at the largest possible scale. In order to preserve and expand the European way of life, we shape a value-centric, human and inclusive Internet for all.

These ambitions need a solid foundation to build on. The legendary robustness of the Internet must become actual reality in the Next Generation Internet. A massive global fleet of connected devices is on its way to enhance and control our homes, factories, offices and vehicles. Technology is embedded in concrete, circling in space and is increasingly entering the intimacy of our human bodies. The Next Generation Internet has to be highly adaptive and **resilient**. Whatever companies or parts of the network go down by some natural or other disaster, the effects on the rest of us should be close to zero.

There is another important dimension to trust, which lies above physical availability. We need a **transparent** technological environment, that is trustworthy. The architecture, governance and policies structure how entire societies and economies interact. By design it should protect free speech and private enterprise and much more. The Next Generation Internet is to be designed to avoid any bias or systematic abuse of global trust in the Internet. It shall be a true global commons, rising above international politics and competition. It will guarantee the safety of citizens and strengthen the health and autonomy of our markets and societies.

The enduring success of the Internet lies in permission-free innovation, openness and interoperability. The Next Generation Internet is set up to create wider choice. It fosters diversity and decentralisation, and grows the potential for disruptive innovation. This extends far beyond the technical realm. The Next Generation Internet will achieve a **sustainably open** environment for our cultures and economies, celebrating our values and promoting creativity and well-being.

Let's re-invent Internet to reach the full human potential, for all generations.



A completely accessible (text) version can be found in Annex 4: Draft Vision Texts.

4. NGI Programme, concept, first principles and intervention logic

This section presents the approach developed to help form a viable and effective NGI programme. We consider the NGI to be a “**moonshot plus**” effort, both in effort and importance. The internet is the largest technological construct ever devised, and upgrading its technology and services to a next generation while continuing to carry the weight of the global economy and billions of critical users will probably be the single largest collaborative effort in the history of technology.

Like the famous technology race to put the first person on the moon, the NGI will require an enormous amount of coordination, very careful engineering at different levels of technology, rigid quality assurance and solid integration. Clearly, the scale of this operation requires a long term vision – and to be honest, a lot of persistence, adequate mechanisms to commit the right human talent, political stamina and even a streak of luck.

Unlike the content and data that flows through the network, the internet as an infrastructure is not a mere abstraction or narrative– it is also part of the physical world in a very tangible and concrete way. Electrons, radio waves and photons are sent by physical pieces of hardware equipment across physical media into physical hardware equipment elsewhere. It may not necessary to understand how the internet actually works in order to use it, and a user may not see wires coming out of his or her cell phone, but that does not make the underlying infrastructure less physical or operational. At the end of an invisible radio link, at some point the internet turns into boxes which connect to other boxes. The logic programmed in the overall system has the final say on the functionality, usage, robustness and trustworthiness of the entire internet. When users send something to or request something from the internet, all of the boxes that needs to be involved to make that happen should already have exactly the right logic on board.

The first generation of the internet showed great value to society could be already delivered through relatively simple mechanisms that allowed the army of devices that together comprise the internet to understand how to pass information along to each other, but the global community was knowingly kept ignorant of systemic insecurity which was cultivated to gain pervasive capabilities for manipulation and large scale espionage. The NGI will allow Europe and the rest of the world to cut off these capabilities, and upgrade into a better internet that can deliver even more value, which is easier to maintain (so new capabilities can easily be added in the future) and which can better handle the modern cybersecurity threats. The Next Generation Internet in the infrastructural sense is what makes a very complex chain of actions and events spanning across continents seem invisible.

The unique promise of the Next Generation Internet initiative is that for the first time in history, the ability would exist to implement a second and more trustworthy generation of core logic throughout the whole system. Such a leap into the future is the only way to transform today’s internet into the internet we expected in the first place: an internet that is safe to use and reflects our core values.

It is important for such an effort to understand that there are different phases:

- The first phase is conceptual and inspirational thinking (dream phase), effectively gathering requirements and constraints.
- The second phase (engineering phase) is about developing actual technology and tools based on those requirements, as well as the mechanisms and knowledge how these should be introduced.
- The third phase is actual usage based on the new characteristics of the new internet. This will allow the new internet to behave the way we need and want it to. This can only be the case if (enough of) the legacy core logic of the internet has been replaced by more versatile, robust and trustworthy logic. In addition to more reliable behaviour that makes the new internet more predictable, entirely new classes of services can come into being as a result of new capabilities and behaviours introduced in the NGI.

We believe the Next Generation Internet initiative is predominantly about the first two phases. The subsequent usage of the new internet is only limited by what the engineering technically allows for, and it is certainly not limited to the (quickly ageing) conceptual thinking that inspired the whole effort. The Next Generation Internet will result in very concrete bundles of technologies that need to work together in an orchestrated and reliable way, creating powerful generic means to fulfil a plethora of societal needs and wishes in a way the current internet is incapable of doing.

The first generation internet was not created to serve the needs of a global society, but to create remote access for the users of expensive computers in the context of academic researchers under contract by the US military. It drew on military contractors to deliver much of the technology. We live in a completely different world now, and today's requirements for the internet are different as well. Yet the internet has stayed pretty much the same over the course of a number of decades, every attempt to upgrade so far failing. Human ingenuity however not only has found creative workarounds, but more importantly has made an immense leap of thinking possible. We have meanwhile accumulated a vast set of new requirements waiting for an opportunity to fulfil them. The next generation internet initiative is about significantly broadening our the possibilities, hopefully including solving the most problematic aspect of the internet: its inability to actually upgrade itself

Use of the first generation of internet has already injected it across every realm of human activity, and the same legacy technologies were already able to empower completely different usage from doctors, factory owners and school children. The NGI will make important new additions to those capabilities. The new logic of the internet will establish a new digital reality, with new ground rules that are more human-centric, fair and reliable. The vastly improvements in the overall characteristics of the new system are the key aspect of the NGI. Taking an example from another realm: it would not have been possible to build a complex construction like the Eiffel Tower that could withstand the centuries without the prior availability of metal bolts. Yet the person that invented the metal bolt only worried about adding the capability of making a strong connection between two metal parts.

The outcome of the NGI programme is actually about delivering a new and better system. The technology that will be developed is designed as a building block to fit within a larger system, and is

validated by adoption . A warehouse plant filled to the ceiling with boxes containing ion engines, meticulously crafted heat shields, leak-proof waste management systems, sensor components that withstand extreme temperatures, oxygen systems and endless amounts of boxes of cogs, springs and screws does not automatically self-assemble into a rocket with the right characteristics that can successfully exit and re-enter the stratosphere while keeping its human cargo alive– and the same need for a coherent approach applies to the NGI initiative if it wants to actually become the Next Generation Internet.

Whatever the intervention logic of the NGI will turn out to be, the blueprint of the NGI should probably early on allocate the overall responsibility to a ‘mission control’ to take care of the overall technical coordinating, planning and quality assurance – equivalent to the pivotal role in space programmes fulfilled by the ESOC in Darmstadt or NASA Control in Houston. Without such oversight, coordination and planning beyond short term projects, the risk is the NGI would result in the creation of a ‘cargo cult’-like mimicry of technology development. Given the urgency of the NGI vision, clearly that cannot be the desired outcome.

4.1 Introduction

The overall approach developed to help form a Commission NGI programme follows five steps:

- The **first step** aims at defining a **baseline** for the NGI programme. This baseline is the current H2020 NGI programme, this allows to build on existing work of the Commission and keep the focus on the core goals of the NGI.
- The **second step** is **aligning the baseline** with strategic and disruptive technology trends. The aim is to check if the topics of the calls can include the technology trends, as a way of “future proofing” the NGI baseline.
- The **third step** defines the **sources for additional research and development ideas** which will fuel the topics complementing the NGI baseline.
- The **fourth step** provides a **framework** for identifying the drivers for change for the NGI which also fuel the Vision
- The **fifth step** provides a framework for **analysing** the various research and development ideas and topics to select them into a final NGI work programme and **assessing** the responses to the calls.

4.2 Step 1: Defining the baseline: the current NGI Programme

This first step aims at defining a baseline for the NGI programme. We identified the baseline as the current H2020 NGI programme, this allows to build on existing work of the Commission while keeping the focus on the core goals of the NGI.

Summary of the current Work programme

A summary of the currently defined calls (draft June 22, 2017) relating to the NGI themes in this programme is presented in the table below and a copy of the complete programme is provided in [Annex 5: Complete H2020 Work programme NGI initiative](#).

Horizon 2020, Summary of the Work programme 2018 – 2020

| Programme name: | Ref nr: | Specific Topics raised: |
|---|------------------|---------------------------------|
| Next Generation Internet - An Open Internet Initiative | ICT-29-2018-2019 | ■ A more human-centric Internet |

Excerpts from Description:

Specific Challenge: This initiative aims at developing a more human-centric Internet supporting values of openness, cooperation across borders, decentralisation, inclusiveness and protection of privacy; giving the control back to the users in order to increase trust in the Internet. It should provide more transparent services, more intelligence, greater involvement and participation, leading towards an Internet that is more open, robust and dependable, more interoperable and more supportive of social innovation..

Scope: Involving today's best Internet innovators to address technological opportunities arising from cross-links and advances in various research fields ranging from network infrastructures to platforms, from application domains to social innovation. Beyond research, the scope includes validation and testing of market traction with minimum viable products and services, of new economic, mobility and social models, and involves users and market actors at an early stage. Multi-disciplinary approaches are encouraged when relevant. Eventually this initiative should influence Internet governance and related policies..

| Programme name: | Ref nr: | Specific Topics raised: |
|----------------------------|------------------|--|
| Interactive Technologies * | ICT-30-2018-2020 | ■ Interactive community building ■ Future interaction |

Excerpts from the description:

Specific Challenge: Interactive technologies such as Augmented (AR) and Virtual Reality (VR) are set to transform the ways in which people communicate, interact and share information on the internet and beyond. The challenge is to forge a competitive and sustainable ecosystem of European technology providers in interactive technologies.

Scope: The scope includes: 1/ support a pan-European coordination effort to strengthen the collaboration among the constituency; 2/ increase the European innovation capacity through the development of new authoring tools and the access to a broader community;

a) Interactive Community Building (CSA)

b) Future interaction (RIA)

| Programme name: | Ref nr: | Specific Topics raised: |
|---------------------------|------------------|---------------------------|
| Artificial Intelligence * | ICT-31-2018-2020 | ■ Artificial Intelligence |

Excerpts from the description:

Specific Challenge: Artificial Intelligence (AI) is a key technology for the further development of the Internet and all future digital devices and applications. Driven by the wider availability of large amounts of data and increasingly higher performance computing and networking, AI brings additional autonomy to all types of physical and virtual artefacts and opens the door to a wave of innovations and opportunities.

Scope: The ultimate goal is a European AI-on-demand platform mobilising the European AI community to support businesses and sectors in accessing expertise, knowledge, algorithms and tools to successfully apply AI thereby generating market impact:

serve as a central point to gather and provide access to AI-related knowledge, algorithms and tools;

support potential users of AI in order to facilitate the integration of AI into applications;

facilitate the interaction with existing data portals needed for AI algorithms, and resources, such as HPC or cloud computing, and support interoperability.

| Programme name: | Ref nr: | Specific Topics raised: |
|----------------------|------------------|-------------------------|
| Internet of Things * | ICT-32-2018-2020 | ■ Internet Of Things |

Excerpts from the description :

Specific Challenge: Internet of Things (IoT) technologies and applications are bringing fundamental changes to all sectors of activity and are therefore an essential element of the Next Generation Internet. The challenge is to leverage EU technological strength to develop the next generation of IoT devices and systems that build on enhanced sensing/actuating, reasoning capabilities and computational power to the edges, but also new capabilities on the backend, such as artificial intelligence, deep semantic interoperability and novel contractual arrangements like Blockchains.

Scope: Coordination and Support Actions

A support action which will support IoT policies under the Digitising European Industry strategy especially in the context of human-centered IoT. In particular, it should analyse and evaluate security and privacy concepts across on-going and new European projects and initiatives in the IoT Focus Area and carry out trend scouting for future research and innovation policy through liaising with academic, industrial and policy stakeholders. The approach should include to build and sustain a vibrant network of IoT technology providers in Europe as well as ensuring the end-user trust in the security concerns as well respect for privacy.

| Programme name: | Ref nr: | Specific Topics: |
|----------------------------------|-------------|--|
| Future Hyper-connected Sociality | ICT-33-2018 | ■ Next generation Social Media platforms |

Excerpts from the description:

Specific Challenge: Future social networks, media and platforms will become the way our societies operate for communication, exchange, business, creation, learning and knowledge acquisition. The challenge is to mobilise a positive vision as to the role that Social Media will increasingly play in all these areas, and to overcome today's critical issues about trust and governance through democratic reputation mechanisms, and user experience.

Scope: Analysing and building the foundation of **next generation Social Media platforms** towards a "Global Social Sphere", based on peer-to-peer/decentralised, community approaches and free/open source principles. This foundation shall enhance the role of prosumers, communities and small businesses, mastering technological barriers, introducing innovative and participatory forms of quality journalism, and using various data in a secure manner. These activities should contribute to overcome the current accumulation of power by central intermediaries often located outside Europe.

| Programme name: | Ref nr: | Specific Topics raised: |
|---|-------------|--------------------------------|
| A multilingual Next Generation Internet | ICT-35-2018 | ■ Interoperable language tools |

Excerpts from the description:

Specific Challenge: The activities under this topic will support technology-enabled multilingualism for an inclusive Digital Single Market. Every European should be able to access content and engage in written and spoken communication activities without language being a barrier. Content and services, such as those provided by public administrations, are not available in multiple languages. Linguistic fragmentation means that many citizens and businesses cannot fully engage in online activities and benefit from online content and services. The sheer volume of content, the diversity of content types and modalities as well as the diversity of languages in Europe makes the effective roll-out and provision of multilingual solutions challenging.

Scope: The actions will address technological challenges (for language resources and interoperable language tools) and support coordination and networking by exploiting excellences and synergies with activities carried out in the Member States. They will push research results to those who need them and support technology transfer and breakthroughs.

| Programme name: | Ref nr: | Specific Topics raised: |
|---|------------------|-------------------------|
| An empowering, inclusive Next Generation Internet * | ICT-36-2019-2020 | ■ Digital Learning |

Excerpts from the description :

Specific Challenge: Every citizen, from all walks of life, should be able to fully take part in the Digital Single Market. This means that the Next Generation Internet will have to empower users, including its most vulnerable or disabled one, to have access to the same digital learning opportunities, in forms that are accessible, perceivable and understandable by everybody.

Scope: The objective is to support actions on smarter, open, trusted and personalised learning solutions to optimise digital learning and to allow learners to engage and interact with content and with peers.

| Programme name: | Ref nr: | Specific Topics raised: |
|----------------------------|------------------|------------------------------|
| EU-US collaboration on NGI | ICT-43-2018-2019 | ■ EU-US collaboration on NGI |

Excerpts from the description :

Specific Challenge: Building upon the EU-US collaboration in previous work programmes in the area of research experimentation, the aim is to reinforce cooperation and strategic partnerships in the area of Next Generation Internet, to establish a continuous dialogue among the key actors in the US and European programmes and to implement focused projects for joint developments.

**= considered to proceed after 2020*

This list is the baseline from which we start for defining the NGI work programme.

4.3 Step 2: Aligning the baseline with strategic and disruptive technology trends

This step aims at **aligning the baseline** with strategic and disruptive technology trends. The aim is to check if the topics of the calls can include the technology trends, this is a way of “future proofing” the NGI baseline.

Top 10 Strategic Technology Trends¹ and relation with disruption

Gartner has been using its Research for this section.

The world is becoming an intelligent, digitally enabled mesh of people, things and services. Gartner analysts trust that most people will experience a digitally enabled world where the lines between what's real and what's digital truly blur. AI and machine learning will be used to enhance analytics, actions and interfaces of nearly every technology-enabled system. New digital business models are emerging, and new ecosystems are forming to realign business and customer relationships.

This chapter is also discussing disruption as the acceleration of technology introduction and adoption is accelerating and the impact of these changes on society are increasing.

Disruption versus Disruptor

When considering how digital transformation is changing the world, it is useful to point out differences associated with both disruptions that are happening and the disruptors causing them. While the notion of being a disruptor hinges on the notion of how we define disruption implicitly, it does not guarantee that a digital disruptor will be successful living with the disruption it causes. That is because disruption can have consequences — many of which a disruptor may not be in the best position to take advantage. First to market does not guarantee first to money, a lesson taught by the disruptive manufacturers in China. In addition, digital transformation itself can be quite disruptive, but not lead to the status of disruptor.

Technology disruption definition

An effect that changes the fundamental expectations and behaviours in a culture, market, industry or process that is caused by, or expressed through technology, digital capabilities, channels or assets. Disruption causes a fundamental shift in behaviours and expectations, no matter what is being disrupted. Disruptors do not always lead in capturing market share after a disruption has taken hold.

It is important to note that digital disruption is largely non-linear, meaning it is not an incremental progression of capability. Disruption acts like a step function on a graph, where change is seen as a leap from the norm. That change will affect the structure of an entire ecosystem and is frequently associated with introduction of digital technologies or capabilities.

Disruptions and fads are not the same. Fads normally do not lead to long-term leadership, while disruptions open the door to multiple opportunities. Fundamental shifts alter the very core of value generation in a system, while a fad is a temporary and peripheral shift in behaviour.

Disruption is an effect that must be nurtured and tracked through specific elements of disruption.

Disruption in one area does not imply disruption in all areas.

¹ These trends will be refreshed in November and updated here if needed.

From an economical point of view, study of the IT and digital market shows that the technology leaders in one wave rarely survive to become the technology leaders in the next and that the leaders that define each wave frequently did not exist in any significant way in the previous wave.

Simple technologies widely adopted (search and Google massive searched content) can have a disruptive economical effect.

So, in the end, the key success criterion of digital disruptors is not their ability to simply introduce a disruption. Instead, it lies in the disruptors' ability to benefit from the disruption. That benefit can be in many forms, including revenue and profit, but also other strategic goals (for example, competition).

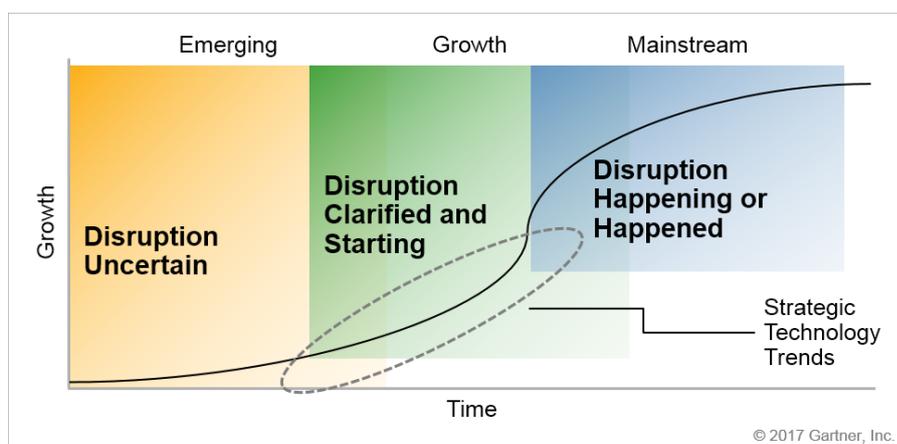
The status quo won't hold.

Rich digital services will be delivered to everything, and intelligence will be embedded in everything, creating an intelligent digital experience for people and organizations. Underneath these changes, big shifts in the enabling technologies and IT best practices create a mesh of technology building blocks to support the intelligent digital experience and resulting digital business ecosystems.

Gartner analysts call this disruptive set of strategic technology trends the intelligent digital mesh, and this forms the basis for Gartner **top 10 strategic technology trends for 2017**.

Strategic trends are those with broad and potentially disruptive impacts that are reaching key tipping points and demand a fresh look as part of strategic business and technology planning.

Gartner uses insights from analysts across Gartner and key research projects to identify and evaluate candidate trends. The top 10 is not a ranked list, with one trend being more important than the others. Rather, it is a list of interconnected trends, with their relative importance shifting by industry, business need and maturity of the enterprise. Organizations must examine the potential impact of these trends, factor them into their strategic planning for 2017, and adjust business models and operations appropriately. The ability to identify trends that are poised to break out of the emerging state and navigate the rapid pace of change with growth trends leads directly to competitive advantage (see figure below).



As depicted in the figure below, we identify three main evolution trends:

- **Artificial intelligence (AI)** and advanced machine-learning techniques are opening up a new frontier for digital business, as virtually every application, service and digitalized thing incorporates an intelligent aspect.
- The merging of, and interaction between, the **physical and digital worlds** provides a digital business revenue opportunity and sets the stage for digital business ecosystem development.
- An expanding **mesh** of rich connections between devices, things, services, people and businesses demands systems that are more adaptable and responsive to changing needs.

Figure: The Evolution of Strategic Technology Trends

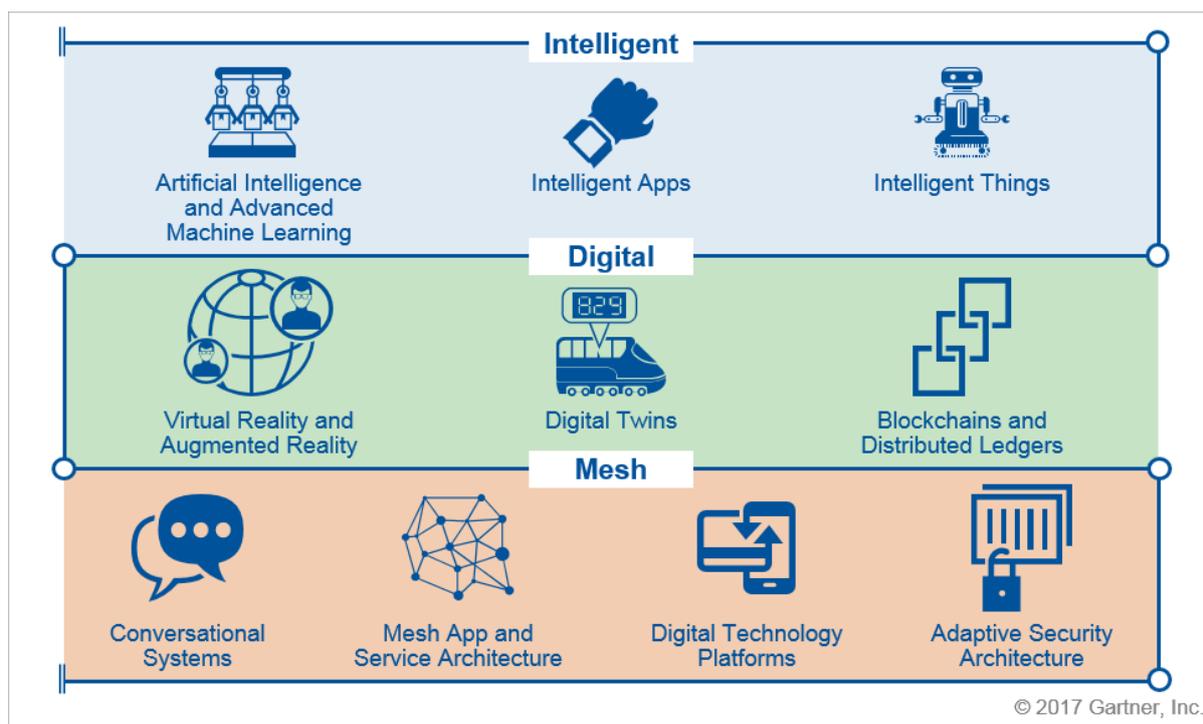


Figure 1. The Top 10 Strategic Technology Trends for 2017 – source: Gartner 2017

A detailed description of these technology trends is provided in [Annex 15: Top 10 Strategic Technology Trends for 2017](#).

Alignment with the current NGI work programme

The table below list the topics raised in the current H2020 NGI programme and juxtaposes relevant technology trends for each of the topics raise.

| Research Topics. Derived from Horizon 2020, Work programme 2018 – 2020, and comparison with the top 10 technology trends | | | |
|--|--------------|-------------------------|----------------------------|
| Programme name: | Ref nr: | Specific Topics raised: | Related technology trend : |
| Next Generation | ICT-29-2018- | ■ A more human- | ■ Intelligent Apps |

| | | | |
|---|------------------|--|---|
| Internet - An Open Internet Initiative | 2019 | centric Internet | <ul style="list-style-type: none"> ■ Virtual Reality and Augmented Reality ■ Conversational Systems ■ Blockchains and Distributed Ledgers |
| Interactive Technologies * | ICT-30-2018-2020 | <ul style="list-style-type: none"> ■ Interactive community building ■ Future interaction | <ul style="list-style-type: none"> ■ Virtual Reality and Augmented Reality ■ Digital Twins ■ Conversational Systems ■ Mesh App and Service Architecture ■ Digital Technology Platforms |
| Artificial Intelligence * | ICT-31-2018-2020 | <ul style="list-style-type: none"> ■ Artificial Intelligence | <ul style="list-style-type: none"> ■ Artificial Intelligence and Advanced Machine Learning ■ Intelligent Apps ■ Digital Technology Platforms |
| Internet of Things * | ICT-32-2018-2020 | <ul style="list-style-type: none"> ■ Internet Of Things | <ul style="list-style-type: none"> ■ Intelligent Things ■ Mesh App and Service Architecture ■ Digital Technology Platforms |
| Future Hyper-connected Sociality | ICT-33-2018 | <ul style="list-style-type: none"> ■ Next generation Social Media platforms | <ul style="list-style-type: none"> ■ Mesh App and Service Architecture ■ Digital Technology Platforms ■ Blockchains and Distributed Ledgers |
| A multilingual Next Generation Internet | ICT-35-2018 | <ul style="list-style-type: none"> ■ Interoperable language tools | <ul style="list-style-type: none"> ■ Conversational Systems |
| An empowering, inclusive Next Generation Internet * | ICT-36-2019-2020 | <ul style="list-style-type: none"> ■ Digital Learning | <ul style="list-style-type: none"> ■ Intelligent Apps ■ Conversational Systems ■ Digital Technology Platforms |

| | | | |
|----------------------------|--|--|---------------------------------------|
| | | | ■ Blockchains and Distributed Ledgers |
| EU-US collaboration on NGI | ICT-43-2018-2019 | ■ EU-US collaboration on NGI | |
| -/ Not on the NGI-list / | / Not on the NGI-list, but in the Cybersecurity-list | ■ Mechanisms for adding trust and enhancing security | ■ Adaptive Security Architecture |

The mapping leads us to conclude that mechanisms for adding trustworthiness and enhancing security are currently not emphasized as such in the NGI work programme.

4.4 Step 3: Sources for additional research topics and development ideas

The following sources provide new technology research topics; these will be added to the NGI baseline using the prioritization framework, as described in the next section.

■ **Input from the stakeholder community**

This input is collected using various tools: the online tool, interviews and feedback received through email.

We obtained **quasi-structured input** from the technical internet community and other key actors and stakeholders, with a strong focus on actionable issues at the technology infrastructure level. We asked them for input that could be exciting **new opportunities**, **new ideas** or **new solutions**, or pointers to **nearly forgotten issues** that are fundamentally **wrong** or **broken** in the internet at present – or are simple a **prerequisite** for other key technologies to be adopted.

We separated the individual issues and asked the users to self-classify each idea in one or more of the following categories:

- **Bugs** - Errors, flaws, failures or faults in the fabric of the internet which cause it behave in undesired ways.
- **Features** and **services** – Something that adds new generic functionality to the internet without requiring changes to the core
- **Security** and **hardening** – ideas that reduce the attack surface of users
- **Architecture alternatives** – ideas that try to replace problematic parts of the internet architecture with an alternative, in order to increase choice, or allow support of emerging features and services

- **Dependency management/refactoring** – ideas that are necessary to propagate the innovations identified, and help develop/redevelop/sanitize critical software tools at the infrastructural level
- **Dissemination and propagation** – ideas to propagate the research innovation outcomes
- **Internet Governance** – ideas that primarily impact the governance of the internet
- **Anti-competitive and regulatory issues** – ideas for tackling market obstacles and strengthening opportunities
- **Measurement requirements** – ideas to gain understanding about the value delivered and the assumed severity of certain technical issues
- **Social justice/inclusiveness** – ideas that address universal accessibility and equal rights
- **Transition technologies** – ideas that provide short to mid term practical relief to tackle issues

This classification was voluntary, as it was foreseen that it could be a threshold for some to contribute. We already ask a complex cognitive task from people, asking them to describe complex problems and then make suggestions for the solution space. We did not want to create stress.

■ Outcome from the workshops and events

So far the following stakeholder events have been visited:

- 1) Annual GEANT conference TNC, Linz, May 29th - June 2nd 2017
- 2) Euro-ISPA, Brussels, June 21st 2017
- 3) EDRi Workshop in Vienna, June 24th - 25th 2017
- 4) IETF in Prague, July 16th - 21st 2017
- 5) SHA2017 in Zeewolde, Aug 4th – Aug 8th 2017

Annex 12: Conference and Workshop Reports provides short reports on the conferences.

■ Outcome from desk research

The outcome of desk search is presented in Annex 13: Desk Research.

4.5 Step 4: Defining a framework for identifying the drivers for change for the NGI

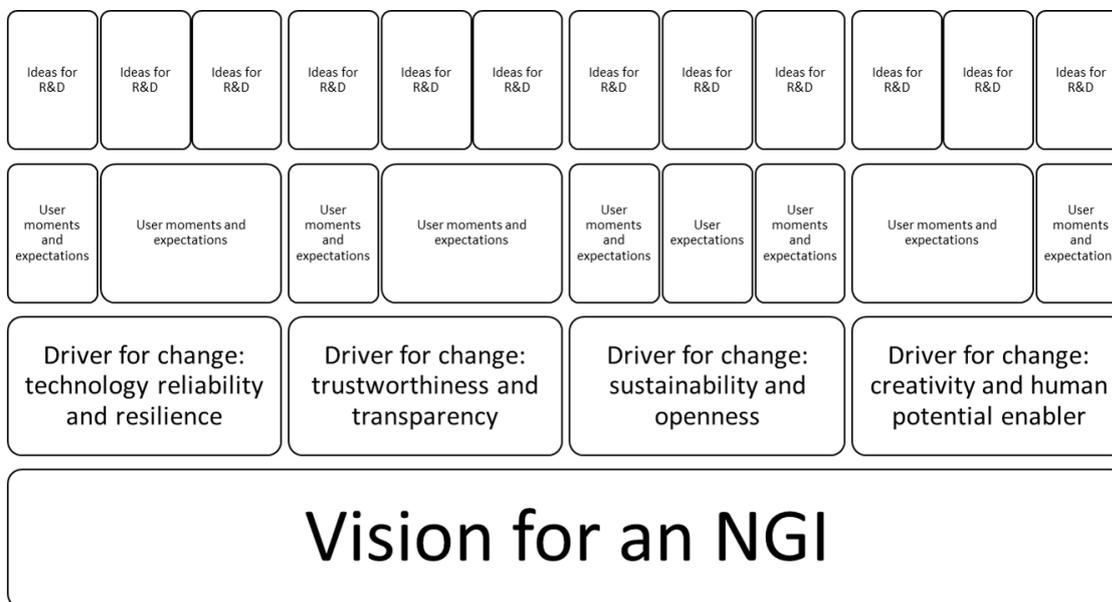
This section proposes a draft framework¹ to define drivers for change for a Next Generation Internet from a user's perspective. The drivers for change are the key messages of the Vision for a Next Generation Internet.

¹ A first draft of the framework was presented to the EC on July 12th and the slides are presented in annex. This first approach aimed at selecting the technology topics based on the number of drivers for change they impacted; after additional testing, this was abandoned, as it was difficult to link a technology topic to a user's perspective. However, the number of drivers impacted by a project is now used as a selection criteria for responses to the calls.

Defining drivers for change from a user's perspective

During the Inception phase of the study, the project team after receiving feedback from the Commission, decided to complement a technological view on the NGI with a user's perspective, in order to **bring the Internet closer to the people**.

The figure below presents this framework:



The framework captures a user's perspective of user **moments in life** - typical activities which will take place- and which are related to the use of the Internet. The framework also presents a set of **user's expectations** regarding how the Internet should work in relation to these moments. These user expectations are derived from stakeholder feedback and desk research on the issues regarding the use of the internet such as security or privacy issues. They are summarized in the light of the user's perspective through these user expectations.

User expectations form four homogeneous groups which then define the **drivers for change** from a user's perspective.

The drivers for change also form the key messages of the **Vision** for a Next Generation Internet.

User moments

The team defined a series of moments¹ which capture a user’s perspective of moments in life or of typical activities which will take place and which are assumed related to the use of the Internet. The table below presents the 12 moments identified as of this interim study.

| Users | Moment | Description |
|--------------------------------------|--------------------|--|
| Citizens Government | Participate | Citizens actively participate in a the legislation processes and are granted high political self-determination. Examples are easy voting and other participatory and awareness moments leading to inclusive and regular citizen participation in political decisions. Such participation includes creating legislation, reviewing decisions, etc. |
| Businesses Citizens Government | Solve | Citizens and businesses actively join local communities, which focus on issue solving and community management, and ensure that the main stakeholders can have a say, provide ideas and concrete solutions. Examples are smart cities or regions communities, local citizen communities, schools communities etc. |
| Businesses Citizens Government | Partner | Government has become a partner of citizens and businesses for all their digital moments. Various levels of authority ensure that regulations and policies exist to enable and foster online exchanges and positive outcomes. Government also builds awareness about them and monitors their effectiveness and efficiency. |
| Businesses Citizens | Create | Citizens, researchers, students can turn an innovative idea into an economic opportunity/ reality. Citizens can launch a new business online in a fair way, without discrimination of any kind, for example, by being able to create new business models supporting innovation. Businesses can generate online revenue, become economically viable, especially at the start. |
| Businesses Citizens | Promote | Citizen launching a business and/or an innovation are easily able to promote their new business/ service or idea. They can manage the discoverability of their business/idea efficiently. |
| Businesses Citizens | Access | Businesses are granted access to data in a fair way – such as monitoring remote sensor information – to reuse it for delivering services. All clients of a business can easily have access to all updates in terms of service in a clear and transparent way. Citizens can chose to filter data according to ethical and/or personal preferences. |
| Businesses Citizens | Attract | Business (small, large, old, new) can easily attract clients and other businesses to their online information and to their collaborative / community interactions. Citizens and businesses stay online and actively use and benefit from the |

¹ Business moments are *moments of opportunity and competition* that lead organizations to the gain or loss of a sale or the transformation of an industry and can happen in an instant. Citizen or Employee moments are moments of opportunities to drastically change owns and ecosystem situation. They are a story which usually begins with a catalysts and depict a different situation that the today’s one. It allows to assess what are the implication for the business, citizen or employee at the centr of the moment and for its ecosystem. They are not meant to be predictions of where an enterprise, a government or a team should focus, but rather, are meant to stimulate thinking around the possibilities.

| | | |
|--------------------------------------|---------------------|--|
| | | information – this engagement is a consequence of their shared interest in information and its exchange. |
| Businesses Citizens Government | Trust | Citizens and business can look for and find reliable information, and have a level of confidentiality related to the subject. They know what is reliable and what can be treated with a level of doubt as well as what is not. The reliability of the information threads (information and discussions build on other information) is easy to analyse. For specific information, the author can be recognized as authoritative sources (pollution level measures, other environmental data) either by government or by authorised bodies. |
| Businesses Citizens | Share | Citizens and businesses can decide what they want to share (health information from personal data or patient records, education data for instance) and with whom (specific communities). Opting out is possible any time for any online service. Safeguards exist and are clearly understood to diminish privacy risks. For specific citizen segments (children, people in need of special care, elderly and non tech savvy people), this can be done by third parties. |
| Businesses Government | Interoperate | Businesses and governmental bodies easily collaborate and partner with each other. The Internet as a platform allows to create specific business and intra governmental platforms which interoperate with low cost/friction and the freedom to switch vendors. |
| Businesses Citizens | Innovate | Citizens, students, researchers, businesses can have innovative ideas and simply and securely promote them. Anybody can understand from whom and where the idea came from and follow how it is evolving and spreading. Anybody can comment and enrich Idea generation: people can decide in which communities to expose their ideas to and discuss them with. |
| Businesses Citizens Government | Initiate | Citizens or businesses can take initiatives in extending/ improving the Internet infrastructure and experiment on it. Citizens or businesses can easily and without cost barriers extend existing Internet service or introduce new ones. Anybody from anywhere knows who has done what and can leverage it. There are no regulatory barriers limiting the changes as far as they are in line with ethics and privacy laws and that the Internet stays open to all with these changes |

List of user expectations from prioritization framework

When designing the framework and defining the moments, the team also listed the user's expectations regarding how the Internet should work in relation to these moments. These expectations are derived from stakeholder feedback and desk research on the issues regarding the use of the internet such as security or privacy issues, aspects related to supporting innovation/new business models etc. They are summarized in the light of the user's perspective through these user expectations.

The figure below presents the moments, listed in rows, and the user expectations – listed as columns. Each moment is put in relation with one or several expectations, as illustrated with a dot in the matrix.

User expectations

| Citizen, business and government moments | User expectations | | | | | | | | | | | | | | |
|--|------------------------|---------------------------|---------------------|---------------------------|--------------------------|-----------------------|---------------------------------|-------------------|--|------------------------|---------------------------------------|---|--|------------------------------|--------------------------------|
| | Technology reliability | Infrastructure resilience | Know who someone is | Know who authored content | Know if content is legit | Chose to be anonymous | Chose w/ who you are visible to | Know where we are | Anybody can access and use from many where at any time | Technology open to all | Low cost of use, no cost or fair cost | Know that transactions and exchanges are secure | Low business entry threshold (internet coin) | Proactive digital assistance | Intuitive – no training needed |
| Participate | ● | ● | ● | ● | ● | | ● | ● | ● | ● | ● | ● | | ● | ● |
| Solve | ● | ● | ● | ● | ● | | ● | ● | ● | ● | ● | ● | | ● | ● |
| Partner | ● | ● | ● | | | | | | ● | ● | ● | ● | ● | | |
| Create | ● | ● | ● | ● | ● | | | ● | ● | ● | ● | ● | | | ● |
| Promote | ● | ● | ● | | | | | ● | ● | ● | ● | ● | | | ● |
| Access | ● | ● | ● | ● | ● | | | ● | ● | ● | ● | ● | | ● | ● |
| Attract | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | | | ● |
| Trust | ● | ● | ● | ● | ● | | ● | ● | ● | ● | | ● | | ● | |
| Share | ● | ● | | ● | ● | ● | ● | ● | ● | ● | | ● | | ● | ● |
| Interoperate | ● | ● | ● | ● | ● | | | ● | ● | ● | ● | ● | ● | | |
| Innovate | ● | ● | ● | ● | ● | | ● | ● | ● | ● | ● | ● | | | |
| Initiate | ● | ● | ● | | | | ● | ● | ● | ● | ● | ● | | | ● |

These user expectations (i.e.: technology reliability) were grouped into four main categories which form the “drivers for change” of the NGI initiative.

Drivers for change

The four drivers for change reflect the overall view of the user’s expectations and are defined by grouping the user expectations into four categories. These drivers for change are:

- technology reliability/resilience
- transparency/trustworthiness
- sustainability/openness: supporting inclusiveness and diversity through interoperability
- enabling creativity and human potential: a user centric approach supporting a potential for innovation

The figure below illustrates the user expectations which relate to the drivers for change.

User expectations

| Drivers for change | User expectations | | | | | | | | | | | | | | |
|--------------------|--------------------------|-------------------------------|--------------------------|--|--------------------------|-----------------------|---------------------------------|-------------------|--|------------------------|---------------------------------------|---|--|------------------------------|--------------------------------|
| | Resilience / Reliability | Transparency/ Trustworthiness | Sustainability/ Openness | Creativity and human potential enabler (user centricity,...) | | | | | | | | | | | |
| | Technology reliability | Infrastructure resilience | Know who someone is | Know who authored content | Know if content is legit | Chose to be anonymous | Chose w/ who you are visible to | Know where we are | Anybody can access and use from many where at any time | Technology open to all | Low cost of use, no cost or fair cost | Know that transactions and exchanges are secure | Low business entry threshold (internet coin) | Proactive digital assistance | Intuitive – no training needed |

These drivers for change are used as key messages in the Vision – see section 3.

4.6 Step 5: Defining a framework for analysing and assessing the topics and the responses

The framework defines drivers for change for a Next Generation Internet from a user's perspective. The drivers for change are the key messages of the Vision for a Next Generation Internet.

This section proposes a draft framework for:

- the prioritization process of the technology topics to be included in the NGI work programme - it assesses novelty and dependencies of technology topics.
- the selection criteria for the choice of projects to be funded from a user's perspective - it evaluates the impact of the technology topic on driving change as one of the of the prioritization indicators choice of the projects to be funded

The framework is pictured below.

The **ideas for research and development** are collected through the various sources described in section 4.4. The ideas/topics are checked for novelty against existing initiatives in a first step to defining the map of relevant topics. This **novelty criteria** is also addressed very efficiently by requesting input on relevant topics to the stakeholders who are aware of the activities in this field and who can then define highly relevant topics immediately.

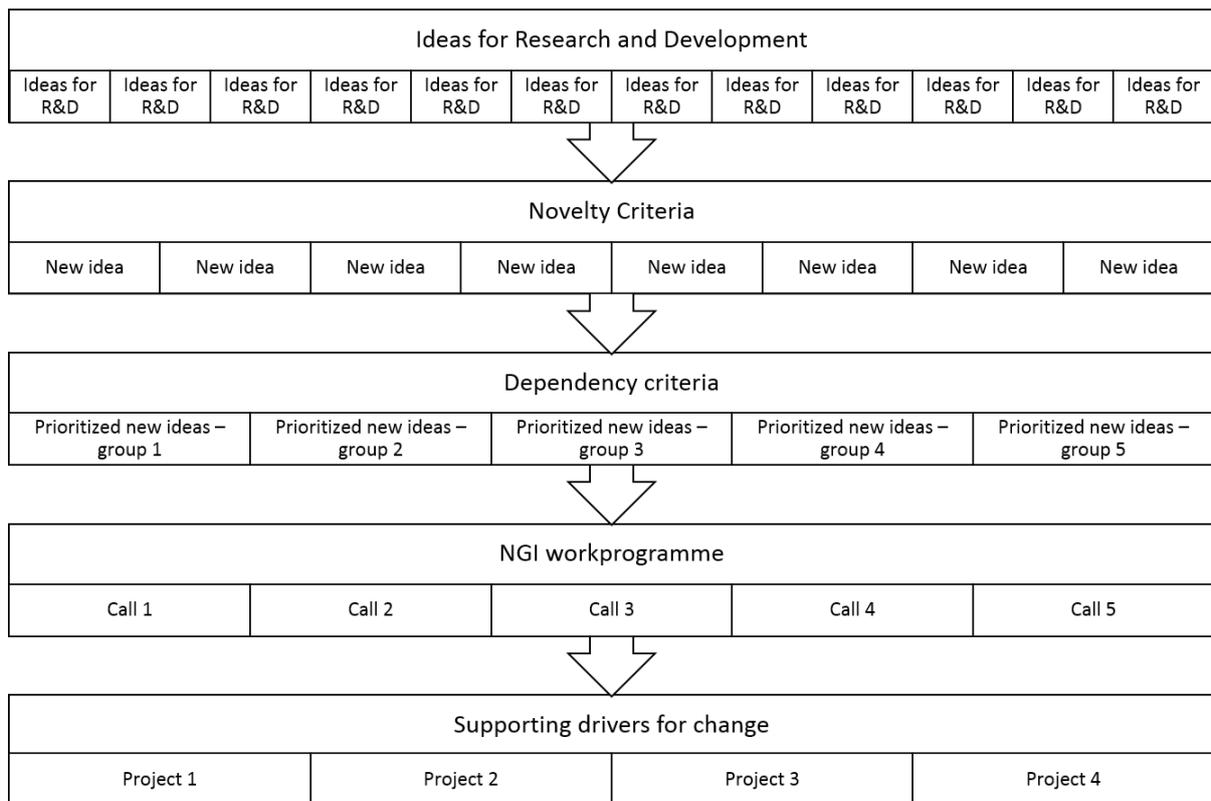
In a second step, the **dependency criteria** is applied: some technology topics are more important to prioritize first when other topics logically and functionally depend on them.

These prioritized new ideas are then grouped into potential calls which are to be added to the future **NGI work programme**, building on and complementing the baseline programme that was established prior to our study. Note that because of the cascading mechanism of sub-granting, which transfers the responsibility and execution to an independent entity outside of the European Commission, the engineering requirements and the involvement of the right stakeholders (if not in terms of direct engagement, then in terms of oversight) will often need to be explicitly written into the call texts. The same holds for the continuous interaction with the 'NGI mission control', to make sure that proper continuous alignment with the larger overall approach and consistent quality assurance take place.

The responses to the calls of the work programme ideally have strong links to the realms that are most affected by the topic, and rise above the interests of individual contributors to serve the larger societal interest of the NGI. With realms we mean high level technology aggregates: the data center (of hosting companies), the internet exchanges, the mobile environment, the web platform, the desktop. These all have specific actor ecosystems, and collective buy-in, access to operational insights and an intersubjective approach will in many cases be essential for real-world results. Note that some currently dominant actors may not always be very inclined to collaborate, if such would improve the agency of users and thus would weaken their business position. In that case, the recommended approach is to move ahead with other actors willing and able to prove the viability of the approach, establish proper standards and then use other instruments such as regulation to move ahead. For

instance, in case the focus of a call is on establishing new standards in the routing layer of the internet, the involvement of an association of Internet Exchanges

Subsequent submissions by subgrantees (so *within* each successfully granted call) are going to be heavily determined by the topic at hand and may be analysed along several criteria, including for example technical excellence, expected coverage of specific important standards, or the chances of real-world adoption by significant actors. One of the generic criteria that may be used to assess their relevance is their **impact on the users**. This is done by assessing how each project supports the drivers for change: we count the number of drivers for change which are addressed by the project. As a reminder, the drivers for change were defined following a user’s perspective – see section 4.5.



Step 5 is applied in the following sections.

5. Preliminary list of research topics and first focus on technological topics

This section applies **step 5** of the framework, presenting:

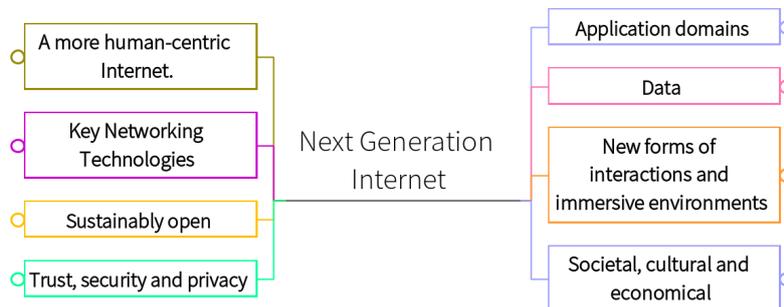
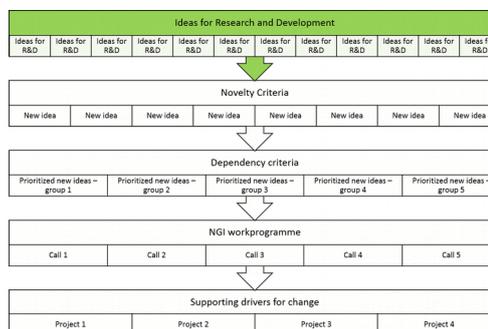
- a list of preliminary research and development ideas from desk research
- a mapping of existing research and standardisation activities which are used for applying the novelty criteria to the initial list of ideas
- a list of relevant research topics derived from the feedback of the stakeholder community

5.1 List of Preliminary Research and Development Ideas from Desk Research

This section presents the preliminary list of research and development ideas identified during the data gathering phase of this study. The list is a synthesis of the input derived from the sources mentioned in section 4.4.

It is a first landscape of existing ideas which is derived from all the data sources - it presents the state of play of ideas which will be used as input as shown in green the figure depicting the framework. The mind map presents 9 main topic clusters:

- Trust, security and privacy
- A more human centric internet
- Key networking technologies
- Data
- Application domain
- New forms of interaction and immersive environments
- Sustainably open
- Social, cultural and economical



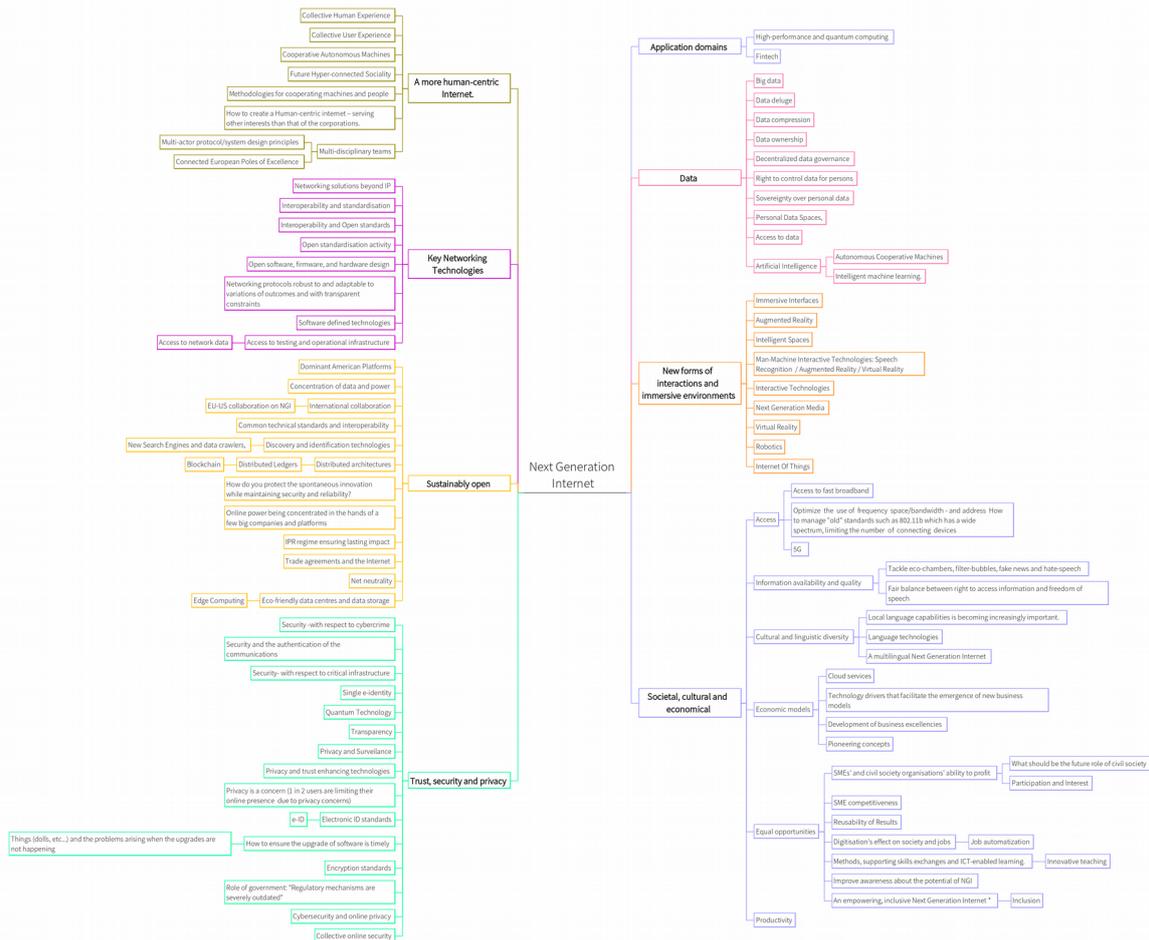


Illustration 1: Diagram of all the categories identified in desk research

It should be noted that due to the wide variety of input, conflicting interests and different layers of engagement (user, legislator, engineer, commercial stakeholder, etc) not all of the topics are equally actionable for the NGI initiative. Because many things are being connected to the internet, famously exemplified by the “Trojan Room Coffee machine” put online at Cambridge in 1991¹, the internet can easily be mistaken as the universal entry point for all associated problems, demands and challenges. Users or legislators may express desires that are not even feasible, or which are developed independently from the internet in a separate domain. The key aspect of handling such input then is to extract or translate what direct action is required from the internet to satisfy the underlying intention of such input.

An example of what is not directly relevant here, but which does contribute to urgency of specific actions for the NGI is Artificial Intelligence, which is a major trend recognised by many sources. AI may indeed use the internet to obtain data and access computing facilities, and may exert remotely control of resources through the internet (and even resources in the infrastructure of the internet). From a technology point of view AI itself however is network technology agnostic and can be developed competitively (like human intelligence) even with the current generation of the internet – there is conceptually no significant role for the internet layer. Large scale use of AI in critical places of

¹ <https://www.cl.cam.ac.uk/coffee/coffee.html>

society seems a reasonably safe prediction of the future, and this would certainly require a number of security traits identified for the Next Generation Internet – in order to prevent for instance adversary training¹ based on spoofed data sources as an attack vector.

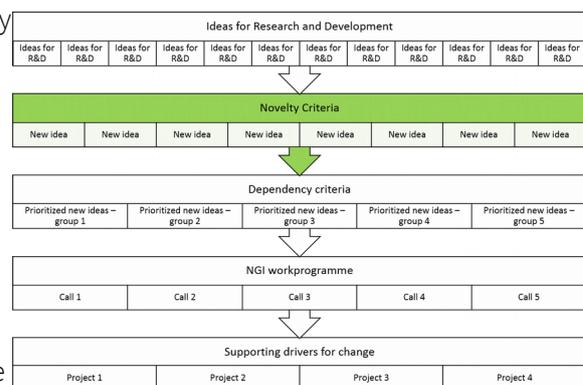
Also, engineers and academics may suggest features that are catering for legacy problems that would be solved another way soon, or may suggest spending significant effort to cater for specific edge cases which may be relevant in the longer term but are not a priority in the short term. Risk assessment is therefore a task that should still be undertaken, possibly in short academic study commissioned by the NGI programme.

Commercial stakeholders may try to prevent the development of technology commons that would increase citizen choice and lower the cost of technology to make it available for the majority of the population. Exclusivity and lock-in are major business drivers, but while extremely favourable for the profit margins of individual companies they are bad for innovation, robustness and inclusiveness.

Our framework for assessing research and development ideas for funding has been designed to help identify the ideas without some of these unfortunate biases, by focusing on implementing the Vision which articulates around the drivers defined from a user’s perspective.

5.2 List of relevant research topics derived from the feedback of the stakeholder community

This section presents the research topics requested by the stakeholder community. It is part of the data gathering phase of the study, it is an analysis of the landscape of existing ideas provided by the stakeholder community and is used as input as a first list of technology topics which have passed the novelty criteria as shown in green the figure depicting the framework. It is reasonable to assume that these stakeholders are aware of missing initiatives and have applied implicitly the novelty criteria to their suggestions for technology topics.



Input from the stakeholder community

The input from the stakeholder community was received in many different formats and across different levels of abstractions. The primary input consisted of interviews, and input during discussions, as well as and workshop contributions during events from the communities described in Annex 8. Overall, the team estimates that around 300 individuals contributed their ideas. In addition, 24 written contributions were made through the online platform.

¹ Ian J. Goodfellow, Christian Szegedy et al; Explaining and Harnessing Adversarial Examples. See: [arXiv:1412.6572](https://arxiv.org/abs/1412.6572) [stat.ML]

Some input offered a holistic overview of technology domains, mapping these to current projects working on solutions from the community that often could use support (see the figure from the contribution by “You Broke the Internet”), while others brought forward individual topics, voiced more abstract concerns and highlighted design principles.

The challenge that seems implicit in the minds of many contributors, is that a two track strategy seems necessary. The first track is about mitigating the current situations as possible, and preparing for a more evolutionary path where step by step elements are replaced until the desirable situation is reached. And the second track would be aiming for a technology leap, where the next generation internet is created as a new technology platform unencumbered with legacy problems. As one contributor put it: “Trying to band-aid the commercial Internet will likely leave us in a broken state for 20-30 years.” These represent two major mindsets that cannot be easily reconciled, but that can actually work in parallel.

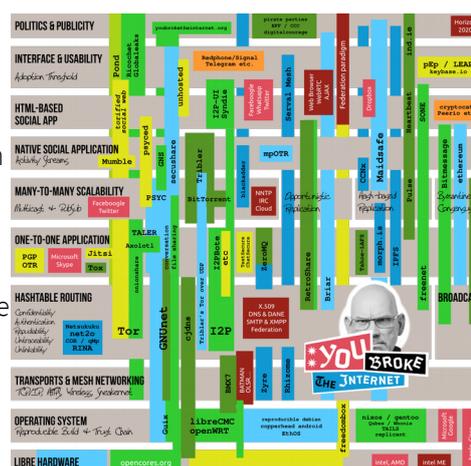


Illustration 2: An example of very comprehensive input: the overview map provided by “You Broke The Internet”

Most of the input concerns rebuilding trust in the fundamental building blocks of the internet, and decoupling key services delivered on top from dominant actors where possible. Both civil society and the technical community emphasize that – often referring to the Snowden revelations – the original core architecture is fundamentally no longer trustworthy. There is ample proof of fundamental weaknesses that have been – and continue to be – actively exploited. The most fitting analogy that was made was that of a trojan horse – software that serves its intended purpose, but also has a hidden layer of functionality serving another master. Once that hidden nature is revealed, merely continuing on that path is no longer an option.

This does not mean that soon the users will no longer have internet access, but that we cannot guarantee their safety in any way. Thus, we urgently need to introduce stronger and more predictable technologies known to be safe to complement what is in use – and ultimately take over most critical uses. This in itself is not so much a single research topic, but a ‘moonshot plus’ research goal with many topical dimensions – the main ones being:

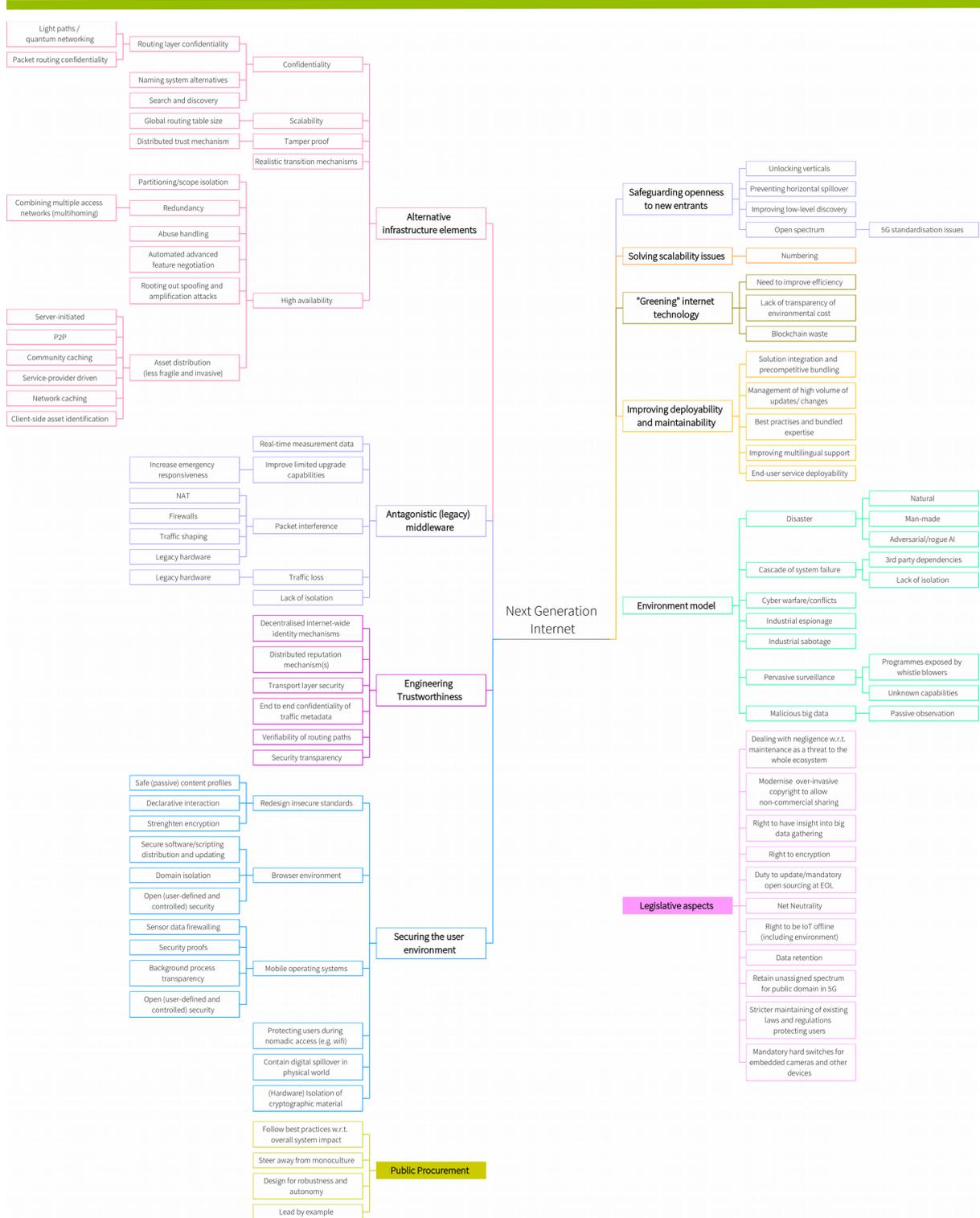
- Research and develop feasible transition mechanisms
- Benchmark candidate alternative architectures
- Measure the receptiveness of the deployed infrastructure for changes
- Isolate and contain legacy technologies

An overall concern emerging from the input we received is that securing the contents and metadata of communications is one of the key structural pain points of the current technology stack. The large scale gathering of observational big data on users combined with foreign pervasive surveillance are

perceived as major threats to the European autonomy, civil rights, security and our economies. In the case of human enemies, the risk of abuse of already unacceptable but in case of the use of weaponised or autonomous AI the risk should be put at 100% making it unforgivable. The NGI should therefore as a design principle prevent any systematic collection of communication profiles (metadata), because (as one submission mentions) "the analysis of the social graph of a population poses a particular threat to democracy" [itself].

The overall implication is that there is an immediate need to prepare for the wide introduction of modern and trustworthy alternatives and mechanisms that satisfy the requirements of the European society. The internet has many use cases and a great diversity of users with different interests, and the design principles for future alternatives should do well to cater for the 'tussle' among divergent interests – such is a core tenet of good architecture¹ and should be designed for. The future of internet innovation depends on the ability to actively avoid the formation of single points of failure, control or surveillance. It should be recognised that such a transition across different technologies and domains of the largest technological construct ever, is perhaps the largest undertaking ever. The implicit message is that the single most important task to achieve the NGI could be coordination.

¹ <http://conferences.sigcomm.org/sigcomm/2002/papers/tussle.pdf>



Detailed description of input

Threat catalogue

It is clear that the internet as a whole needs to be extremely resilient and should be able to cope with many parts of the modern threat landscape. In recent years it has become customary in the IETF that “Whenever a new protocol is developed or existing protocols are modified, threats to their security should be evaluated”.¹ For that purpose, a threat catalogue tends to be included which tries to be exhaustive.

A number of different threat categories were identified as a contribution to a threat catalogue that could be used for the NGI initiative. The main threat categories that emerged from the input could be commonly grouped as ‘Force majeure’ (Natural disaster, Man-made disasters, Adversary AI), ‘Technological’ (Cascade of system failure, Spillover from inadequate isolation/segmentation), and ‘Human intent’ (Cyber warfare and cyber conflicts, Industrial espionage, Industrial sabotage, Pervasive surveillance and Malicious big data).

- **Natural disaster**
(Events that damage critical parts of the infrastructure, such as earthquakes, solar flares, floods)
- **Man-made disasters**
(Nuclear explosions, acts of terrorism, vandalism and other forms of intentional and unintentional sabotage or failure which are the result of human action)
- **Adversary AI**
(While human adversaries have an understanding of concepts such as mutually assured destruction, AI does not. It also tends to be quite thorough and less considerate in taking up tasks, with a limited ability to understand external effects outside of that scope. As AI is handed larger responsibilities, such as handling some of the largest data centres on the planet², the risk of non-benevolent or adversary AI to impact the larger system becomes more realistic.)
- **Cascade of system failure**
(Many resources on the web and the wider internet are no longer self-contained, but have hard-coded dependencies on resources delivered by third parties, such as content delivery networks and cloud providers. These are used for critical features such as navigation. An outage somewhere in this chain can ripple an avalanche of unintended outages throughout many different systems. An example is the WHOIS of a registry that needs to be able to be used in case of emergencies to notify the administrators of a certain domain, but turns out to depend on 3rd party javascript sources)

¹ <https://www.rfc-editor.org/rfc/rfc4081.txt>

² <https://deepmind.com/blog/deepmind-ai-reduces-google-data-centre-cooling-bill-40/>

- **Spillover from inadequate isolation/segmentation**

(The combination and/or proximity of different types of applications and user domains in a single infrastructure means that the risks of that combined system may end up as the sum of all risks. One submission pointed out a quote by a security manager: “In a relatively short time we've taken a system built to resist destruction by nuclear weapons and made it vulnerable to toasters.”¹)

- **Cyber warfare and cyber conflicts**

(Disruption of the internet infrastructure of a region for military and political purposes is by now known as the fifth domain, next to land, sea, air and space)

- **Industrial espionage**

(Theft of advanced technology from industry, academia and military through exploiting internet infrastructure weaknesses)

- **Industrial sabotage**

(Disruption and exploitation of internet weaknesses aimed at competing global regions and economic actors, aimed at giving the attacker a competitive edge)

- **Pervasive surveillance**

(Mass scale monitoring of every aspect of public and private life of internet users wherever such is feasible. Already in 1967 – before the launch of the ARPAnet – DARPA identified the capabilities of "passive subversion" (including collection through passive monitoring of network traffic or electromagnetic emanations from computer or network equipment) in an official confidential report² which urged the development of internal and external encryption technologies – none of which were made available to the ARPAnet. Several long term programmes for pervasive surveillance dating back to the earliest days of the internet have meanwhile been exposed, most notably Edward Snowden. However, the threat model should take into account that not all capabilities are likely to have been revealed, and that other actors have also set up similar schemes.)

- **Malicious big data**

Passive observation of users by companies without their explicit knowledge and consent, which includes storing the complete browsing history of users, location data, media consumption, shopping behaviour, cross-device identification of users, stealth identification of other users in the vicinity, undisclosed audio streaming for off-site analysis, persistent identifiers, etc.)

These different categories of threats likely result from weaknesses that span across various categories, which should be resolved in the Next Generation Internet. Note that given technologies like AI, no

¹ Jeff Jarmoc, head of security Salesforce, quoted in a summary article at:
<http://www.bbc.com/news/technology-37738823>

² “Security Controls for Computer Systems: Report of the Defense Science Board Task Force on Computer Security”, DARPA, 1967. See: <https://assets.documentcloud.org/documents/2800105/Document-01-Defense-Science-Board-Task-Force-on.pdf>

fundamental flaw (whether a design oversight or backdoor that was introduced in stealth) can be expected to remain unpunished for long. Setting the risk of occurrence to 100%, means that the uncertainty now merely lies with how much time is left.

Safeguarding openness to new entrants

The following aspects of safeguarding openness to future entrants were identified:

- **The need to unlock verticals**
(Active countermeasures against market dominance and lack of choice and control in application domains critical to the users. By introducing suitable microscale alternatives (based on open source, open standards), the dependency on hyperscale giants can be dissolved)
- **Preventing horizontal spillover**
(Avoid the take-over of strategic markets by dominant players from related fields)
- **Improving low-level discovery**
(Unbiased and unmediated search and direct discoverability of services and content offered where possible)
- **End-user capabilities with open spectrum (specific to 5G)**
(The availability of enough end-user controlled radio spectrum allows for grass roots innovation and is vital for innovation and choice)

Alternative infrastructure elements

High availability is a key aspect of the need for alternative infrastructure elements. Key aspects of high availability are:

- **Partitioning/scope isolation**
(The ability to segment parts of the network in such a way that issues in one segment have no side effects in other segments/parts of the network, which would allow for uninterrupted use outside of any affected areas)
- **Redundancy**
(Avoiding single points of failure and quality degradation by providing multiple independent alternatives, such as the ubiquitous ability to combine multiple access networks in parallel – often referred to as multihoming/multipath capabilities)
- **Abuse handling**
(An important part of maintaining high availability is streamlining and automating how incidents are handled across the network, especially in parts or functions of the network that are strongly connected. This makes the overall system more secure, because it allows increased responsiveness to changing operational conditions, particularly in time of emergency)

■ **Rooting out spoofing and amplification attacks**

With a minimum of effort the current internet can be weaponised to attack itself: there are old internet protocols that are still in common usage which will happily answer every request they get sent with an answer that can be over 4000 times larger.¹ As long as spoofing can still happen, this means that attackers have a huge advantage over those that have to keep their systems up and running)

■ **Smarter asset distribution (less fragile and invasive)**

(Providing distributed alternatives to obtaining digital assets from a single source is an important aspect of robustness in the context of various threats. A cascading failure due to missing 3rd party web software assets on critical web resources (an anti-pattern that is still common) can easily occur, while that exact same open source software would still be available from many other sources – and perhaps even already available on the user machine itself. In such a situation, service failure is completely unnecessary. Given the common and transverse nature and the operationally critical aspect of this issue, and the fact that it may impact different actors in different ways, developing complementary solutions in parallel is most robust. Note that this can also contribute to make the internet (and in particular the web) “less forgetful” - allowing content that would otherwise have disappeared to remain available. This involves:

- **Server-initiated**
(the service that offers the assets, can suggest or provide a suitable means of taking care of distributed delivery in case of failure)
- **P2P**
(end-to-end sharing of assets with known friendly peers, a solution that could work even in the most extreme scenario's. Note that from a scaling perspective, community caching is more suitable)
- **Community caching**
(collaborative caching and sharing of assets, should also work even in the most extreme scenario's. One important requirement is that the sharing facilities shield of the privacy of the participants in the network through a level of indirectness, i.e. caching should not mean that the participants you connect with have interacted with that resources themselves)
- **Network caching**
(The operator of the network may prefetch assets likely to be consumed within the network when there is surplus capacity, in order to prevent peak usage.
- **Service-provider driven**
(Independent service providers (such as VPN providers) may provide a fall-back service)

¹ <https://www.enog.org/presentations/enog-7/264-AnalyzeAmplAttack.pdf>

- **Client-side asset identification**
(Efficient de-duplication of assets across different domains, so that a generic asset already cached or downloaded can be reused over and over again)

Confidentiality

Given the **threat catalogue**, it is clear that securing the contents and metadata of communications is one of the key pain points. The internet was not merely designed with an incomplete threat model, many threats were actually already known at a decision maker level¹ but the design of the ARPAnet was actively kept incapable of handling them through involvement of the US National Security Agency. This laid the ground work for pervasive surveillance, industrial espionage and sabotage. Not just the content of what moves across the network (the so called ‘payload’) has to be protected. The NGI by virtue of its requirements should go further: it should prevent any systematic collection of communication profiles (metadata) of users, because (as one submission mentions) *“the analysis of the social graph of a population poses a [...] threat to democracy”*.

The following confidentiality aspects should be considered:

- **Routing layer confidentiality**
(The current routing mechanisms are known to be very weak against man in the middle attacks and passive observation. They typically expose communication patterns to anyone in the path, even when end-to-end encryption is used. There are known solutions for this problem that need to be further developed and then upscaled. In the (limited) domain of optical networking/‘light paths’, the use of quantum networking should also be further investigated as a solution for even more confidentiality for e.g. backhaul)
- **Naming system hardening and alternatives**
(The DNS system is known to leak a lot of detail about the behaviour of users to third parties, such as public DNS operators and wifi hotspot operators (and since these are known to be very unsafe, to anyone). DNS is regularly used as a tool of censorship and in some cases surveillance. A dual strategy of hardening at the one end and shifting to fundamentally more secure solutions at the other is recommended.)
- **Search and discovery**
(Use of commercially available search tools can leak a great deal of private information about users, especially in case the search tools are cross-correlated with covert observational data (‘analytics’), in-service 3rd party data exposure (such as through advertisements from a remote server). *This topic colludes with one of the three upcoming topics previously identified.*

There are important other dimensions than confidentiality, such as **scalability**. This is a critical factor that is easy to get wrong. The internet has many detrimental effects from current scalability limits

¹ Ware, Willis et al (1967): **Security Controls for Computer Systems: Report of the Defense Science Board Task Force on Computer Security**. See: <https://assets.documentcloud.org/documents/2800105/Document-01-Defense-Science-Board-Task-Force-on.pdf>

resulting from flawed design parameters. In the realm of applications this can also be seen. The bitcoin protocol is not an open standard that was designed with scalability in mind, with case in point being the original Bitcoin distributed blockchain data which has now reached a physical size of over 130 Gigabyte – and counting. This will make it hard to deliver on most of the positive hype associated with it, and is already causing a lot of trouble for users. Likely it will not be the universal solution to all problems on the Internet today, as some had originally anticipated.

A poignant and unwelcome example given by one respondent was that companies are seen turning off (the often seen as future proof) IPv6 after sometimes years of successful usage. When questioned about this, the answer given is that some older router equipment started reaching operational limits (due to the combined size of the global routing table for both IPv4 and IPv6). Given that the vast majority of services are still reachable under both protocols, but overall coverage is significantly better under IPv4, the business case for squeezing the last bits out of legacy router capacity by downgrading to IPv4 only is reportedly regularly made. The Next Generation Internet should be designed with such practical economic considerations at a system level in mind; the mere fact that a newer and improved version of some technology – no matter how ‘core’ – exists is not by itself any justification for users to invest. Only when there is enough (cumulative) added value, a full transition is feasible.

In addition to being economical new technologies need to be **tamper proof**: integrity of traffic is an essential characteristic. Given the inherent vulnerability of any single root of trust, there is a preference for **distributing trust mechanisms** to remove single points of failure, and finding ways to **delegate trust** in an auditable and controlled way.

Realistic **transition mechanisms** are a key aspect of any proposed technology upgrade – a perfect technology that cannot be deployed in practical terms will not be of much use. While satisfying all other design criteria, the following aspects need to be taken into account for any candidate alternative technology as early as possible:

- Research and develop feasibility of transition mechanisms
- Benchmark candidate alternative architectures with regards to scalability and efficiency, and
- the ability to isolate and contain the impact of legacy technologies on the new technology

The topic of **antagonistic (legacy) devices** such as middleware and CPR devices is closely linked to the feasibility of the introduction of the Next Generation Internet technologies. In order to understand the health of the system, real-time and longitudinal measurement data is essential. These insights may help to **improve limited upgrade capabilities** by measuring and understanding the **receptiveness** of the deployed (legacy) infrastructure to systemic behaviour change, and take any out-of-band countermeasures such as replacing specific broken components or undesirable behaviour. This is also important for increase **emergency responsiveness**.

Some characteristics of legacy devices that need to be dealt with:

- Packet interference and rewriting due to missing or faulty support for modern protocols
- NAT

- Lack of IPv6 support
- Firewall configuration errors
- Translation issues across protocols

In addition, adoption can be hindered by other issues with connections:

- Traffic shaping
(Violations of net neutrality)
- Traffic loss issues due to for instance physical damage

A key research topic is how to isolate and circumvent these issues, in order to increase the receptiveness of the overall system to new technologies being introduced.

"Greening" internet technology concerns the need to improve energy efficiency, both locally and at an internet level. Currently there is a significant **lack of transparency of environmental cost**, which should be urgently resolved given the vast scale of resource usage.

Both civil society and the technical community emphasize that – often referring to the Snowden revelations – the original core architecture is fundamentally no longer trustworthy. There is ample proof of fundamental weaknesses that have been – and continue to be – actively exploited. The most fitting analogy that was made was that of a trojan horse – software that serves its intended purpose, but also has a hidden layer of functionality serving another master. Once that hidden nature is revealed, merely continuing on that path is no longer an option. Providing alternative technologies that engineer **trustworthiness** (security by design) is therefore the pivotal aspect of the NGI initiative:

- **Decentralised internet-wide identity mechanisms**
(A better protection of users starts with the ability to distinguish users from each other)
- **Distributed reputation**
(As in real life, reputation provide additional trust – however, reputation should have reasonable dampening mechanisms to avoid reputation attacks)
- **Transport layer security**
(Traffic should move securely between end-points.)
- **End to end confidentiality of traffic metadata**
(the fact that machines are forwarding packets does not mean they should learn who is communicating with whom. IP datagrams leaks this information, additional or alternative mechanisms are necessary to prevent loss of confidentiality).
- **Verifiability and control of routing paths**
End hosts might want to avoid packets being routed through adversarial or untrusted networks, or they might want to choose the most suitable path with regard to a specific metric (e.g., latency or bandwidth)

■ Security transparency

(Users should be able to grasp the overall security situation of a specific connection)

An important difference that the NGI Initiative can make is that the R&D efforts are not just focused on theoretical aspects, but actually seek to achieve and/or improve **deployability** and **maintainability** in the context of the actual internet environment. Even with the availability of iterative **best practises and bundling of expertise**, the cost of manual setup and maintenance quickly becomes prohibitive to a large part of the internet population. This has led to slow uptake and large scale technical debt. A key aspect of a successful approach for the NGI is reproducible solution integration and pre-competitive bundling, where the cost for the effects of the asymmetric security benefits is dealt with as an integral part of the process. The management of high volume of updates/changes is efficiently handled in a collective manner, rather than relayed to each individual participant. A major result would be end-user service deployability: the end-to-end principle of the internet does not distinguish who sends and who broadcasts – but the user needs to be empowered by the availability of good technology to deploy and build on.

This maintainability not only concerns technical aspects, but also cultural – such as offering scalable shared mechanisms to support **multilingual use**, i.e. availability of ICT in every language – driven by the needs of the language communities rather than business decisions.

Different aspects of securing the user environment came up:

■ Redesign insecure and overpowered standards

(Tainted and suspect standards need to be replaced by hardened alternatives, not just in theory but in actual usage. Overpowered standards that are detrimental to user privacy and security – such as cookies, where the original engineers that created it already warned against allowing 3rd parties to use them¹ – can only disappear when the original need is fulfilled by a minimal functional replacement that prevents further abuse).

■ Safe (passive) content profiles

(The original design of the web as a set of documents where one can safely surf from link to link, has been lost over time due to the rise of demanding applications that appropriated the technology to get system agnostic interfaces. As a result, documents are now no longer safe. When a user browses an unknown website, he or she typically grants the operator the same technical privileges as a bank or trusted software supplier would need – browsers have not been given the native abilities to distinguish among known and unknown). Browsing the internet, the risk of abuse is very significant. Availability of a safe content profile (e.g., return of the web document) would provide a subset of features that is known to be secure and passive, which would guarantee the end users are not attacked while they just want to read a document.

¹ RFC 2109: “Embedded or inlined objects may cause particularly severe privacy problems if they can be used to share cookies between disparate hosts.”. See <https://www.ietf.org/rfc/rfc2109.txt>

- **Declarative interaction**
(Allowing to running unverified software on web pages poses a risk to the user². By standardising popular interaction patters, users only have to passively declare the desired interaction, and do not have to bother the user with permission to run unverifiable scripts on a web page.)
- **Secure software/scripting distribution and updating**
(A complementary approach, creating the possibility for generic software and scripts to be provisioned through another secure channel which is not linked to any particular website)
- **Domain isolation**
(Another part of securing the browser environment is by domain isolation: similar to how experimental operating systems like Qubes OS² provide a very strict isolation between types of activities, the amount of observational data about a user between their use of different websites should be minimised unless the user explicitly makes the connection.)
- **Open (user-defined and controlled) security**
(Allow users to easily override weak security settings of software vendors and and protect their communication with the level of protection the user himself deems necessary)
- **Sensor data deniability and firewalling**
(In browsers, mobile operating systems and even more in wearable tech there is a real need for users to be in control of what the sensors and application software inside their device are revealing about them to the outside, such as their location or life habits. A user should be able to silence or randomise sensors, or to have his GPS module give inaccurate data about his whereabouts to app that do not need such intimate information.)
- **Security proofs**
(We are past the stage where a pretty design is satisfactory. The security of browsers and operating systems as the client side run environment of the Next Generation Internet should be subject to academic scrutiny)
- **Background process transparency**
(Users should be able to easily inspect every background process in the technology they use)
- **Protecting users during nomadic access (e.g. wifi)**
(Use of untrusted networks such as the wifi in a train station or coffee bar is a pervasive risk in the current generation of the internet. Updates to the technology are required, and once these are in place legacy technologies outside of the private home should be phased out by means of regulation).

² Gruss, D. "Software-based Microarchitectural Attacks", June 2017. PhD thesis for Graz University of Technology. See: https://gruss.cc/files/phd_thesis.pdf

² Qubes OS: A reasonably secure OS. See: <https://www.qubes-os.org/>

- **Contain digital spillover in physical world**

(Mobile devices and wearable tech potentially leak undesired information about people other than their owner. How do we prevent such spillover in a machine processable way, so that people do not have to justify or explain themselves and can feel safe in the company of other people)

Legislative aspects

The Next Generation Internet wants to protect users, and is thus dependent on the right legal and regulatory environment. Issues that were suggested:

- **Dealing with negligence w.r.t. maintenance as a threat to the whole ecosystem**

(Disallow known insecure systems that cause significant harm to others)

- **Right to have insight into big data gathering**

(The user should be able to know exactly what observational data is being gathered, and who it will be sent to before it actually happens)

- **Right to encryption should be universally established**

(Encryption is the single most important technological building block of internet security)

- **Duty to update/mandatory open sourcing at EOL**

(User should not need to throw out working devices, because the original vendor is no longer supporting security updates)

- **Enforce Net Neutrality**

(Strict enforcement of the legal requirement that no type of internet usage shall be discriminated against by access providers)

- **Right to be IoT offline(including environment)**

(People should not be forced to use invasive technologies by their employer or other persons that have authority over them)

- **Strike data retention**

(Retaining data of internet usage is unprecedented in the physical space and has a chilling effect on society)

- **Retain unassigned spectrum for public domain in 5G**

(There are several issues that need to be resolved in the context of 5G standardisation, where a dependency on regulated radio spectrum disadvantages other uses).

- **Stricter maintaining of existing laws and regulations protecting users**

(Business practices like Real-Time Bidding are in clear violation of the letter and intent of existing privacy regulations, and yet these practices continue to take place)

- **Mandatory hard switches for embedded cameras and other devices**

(Cameras and microphones are particularly invasive, and a high profile target for abuse. Users

should be able to physically switch off cameras and microphones they are not using, so that they can be 100% safe from the emergence of sudden software flaws or security glitches.

- **Modernise over-invasive copyright to allow non-commercial sharing**

(Dominance of tech actors in media distribution leads to further strengthening of monopolies in other areas. The argument made during the consultation is that lifelong copyright protections are not in the interest of society any more)

The last aspect dealt with, is **public procurement**. While this is outside of the scope of R&D and legislation, the European Commission is urged to:

- Follow best practices with regards to *overall system impact*
- Actively *steer* the market away from monoculture
- Design its own internal systems for *robustness* and *autonomy*
- Lead by *example*¹

5.3 Existing research and standardisation activities

The suggested list of topics presented in section 5.2 has been assessed against existing research and standardisation activities to validate relevance and novelty by checking any collisions. This section provides a summary of the mapping of existing research and standardisation activities.

Existing research in H2020

The ongoing research projects related to the Internet and the Next Generation Internet in Europe are largely financed by the H2020. Reporting from national official NGI contacts indicate that limited directly financed research activities are ongoing, other than the H2020 projects.

In order to understand the focus of the existing research programs at H2020, the team has conducted a quantitative text analysis of all research projects funded by H2020. The findings are depicted below in a number of tag clouds.

Nine projects in H2020 are directly concerned with aspects of the future internet. These seem to focus most on specific futuristic use cases of the existing internet, such as connected vehicles/mobility and hosted services/cloud – and not so much on evolution of the internet stack. Note that key terms for the NGI, like resilience and trustworthiness seem absent, while more short term approaches (such as “opportunistic” and “efficient”) are in fact present. The links to the internet standardisation community seems limited as well: none of the most-named acronyms that arise from these projects (such as SHARCS, SocialCar, CHOReVOLUTION, ARCFIRE, FUDACT) show up anywhere in the IETF document streams (both internet drafts as well as published RFC’s).

¹ A practical example of this not being the case, is the fact that the European Commission still does not consistently support key internet standards in its own internet presence – such as DNSSEC and IPv6.



Illustration 4: Word cloud for 106 IoT related projects in H2020

To investigate the focus of H2020 projects related to future internet, similar word clouds have been generated for IoT (Internet-of-Things) as well as for Cyber Security.

Again, the interest of the IoT research in H2020 seems mainly centred on developing applications around ‘smart objects’ that can easily be seen to benefit *from* the internet. Or, put differently, the focus lies with putting “things on the internet”. The major reverse aspect of the IoT phenomenon – how the rest of the internet should deal with the inherent scalability and security issues that seem almost synonymous with the large scale deployment of low-security devices – seems mostly absent. Also here, the actual engagement with the internet standardisation community seems underappreciated. The more specific terms in the wordcloud – like Sedicii, RAWFIE, Smartrain, EMBERS, COGISEN, LV-PRI20, VICINITY and eWine – do not appear in any current internet drafts and/or IETF RFC’s.



Illustration 5: Word cloud for 84 H2020 projects related to Cyber Security

IoT and solving issues around the realisation of IoT in different sectors appears to be a major research topic in H2020, and making sure the future internet is ready for this challenge would be highly relevant for the NGI.

Cyber Security is another a major theme for research funding within H2020. The observation we make here is that overall the internet layer seems to be almost transparent to the research conducted inside the H2020 Cyber Security stream. Or put differently: from the overview it appears that Cyber Security research works with the current generation of internet trying to mitigate its many fundamental weaknesses and/or to create workarounds and identify usage constraints for critical infrastructure verticals such as water management, energy producers and banking. The research currently in the pipeline does not seem to be primarily concerned with the design of another generation of the

internet that does not have these weaknesses. This is a task that seems clearly delegated to the Next Generation Internet initiative.

Existing research in the Member States

The team has analysed existing research activities in the Member States on the subject of the future or next generation internet. This has been undertaken through the national contact points. All MS contact points have received a request to submit an overview of ongoing research activities in the area. Five countries responded to the request.

Due to the limited response a search for research projects has been undertaken using search engines. The result of the mapping, is:

- The vast majority of research projects in the area of future internet or next generation internet are financed or co-financed by H2020.
- MS research in the area is not funded by national research councils.

The table below describes the related research projects that are not H2020 funded.

| Name | Description | Organisation | Funding |
|---|---|--|---|
| Child safety on the Internet: looking beyond ICT actors | This project will map the range of non-ICT companies engaging digitally with children and identify areas where their actions might affect a child's exposure to online risks such as data theft, adverse online experiences or sexual exploitation. | Oxford Internet Institute | |
| Economic Geographies of the Darknet | This project will investigate illegal economic activities in anonymous internet marketplaces. Very little is currently known about the flows of drugs, weapons, and other illicit items, in marketplaces that operated on the so-called 'darknet.' | Oxford Internet Institute | |
| PETRAS | The PETRAS Internet of Things Research Hub is a consortium of nine leading UK universities which will work together over the next three years to explore critical issues in privacy, ethics, trust, reliability, acceptability, and security. This project also runs in collaboration with IoTUK. | UCL, Imperial College London, Lancaster University, University of Oxford, University of Warwick, Cardiff University, University of Edinburgh, University of Southampton, and University of Surrey. | £9.8 million grant from the Engineering and Physical Sciences Research Council (EPSRC) £23 million in total budget. |
| iLabour: The Construction of Labour Markets, | The iLabour project is premised on the idea that a fundamental change is taking place in labour markets. It seeks to understand | | This work is supported by a European Research |

| | | | |
|--|--|--------------------------|------------------------------|
| Institutions and Movements on the Internet | the social and policy implications of this momentous shift. | | Council (ERC) Starting Grant |
| THE PEOPLES' INTERNET | Who has access to what kinds of information? Who communicates with whom? As importantly, who knows what <i>about whom</i> : Which individuals and institutions are in position to monitor the actions of other individuals and institutions? | University of Copenhagen | Carlsberg Foundation |

Except for the projects listed above, the analysis of the H2020 projects undertaken above, provides the best overview of research in Europe in the area.

Existing standardisation activities in IETF

In addition to analysing the body of research projects dealing with subjects related to the future internet, standard setting organisations are a useful source of information. In relation to the Internet, the IETF is the most important body, establishing the core standards on which the Internet is based and is likely to be based on in the future. To give an indication of the focus of the IETF a quantitative analysis of the published RFC's has been performed, providing the following view:

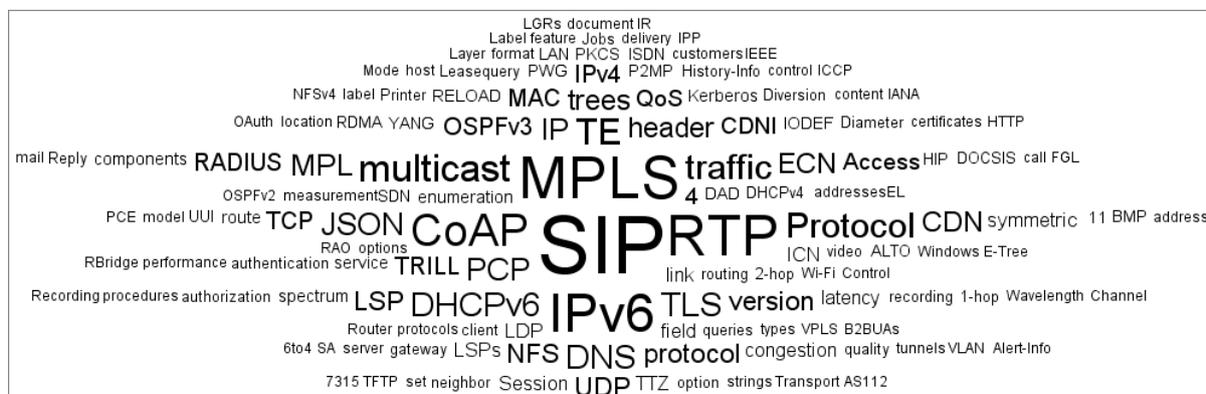


Illustration 6: Word cloud for all RFC's published 2015 - 2017

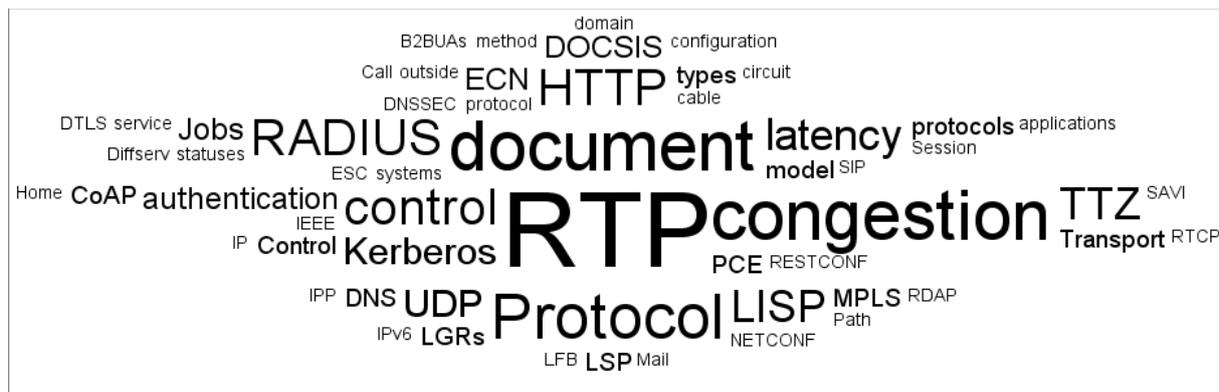


Illustration 7: Word cloud for RFC's published in 2017

It is important to note that this is work that has been recently *finalised* from the point of the IETF, i.e. these overviews are looking back upon the work that has already been performed and published as technical recommendations and experimental setups. The research has been done and the documents have already gone through the various vetting layers of the standards process, though not all will have working and interoperable implementations.¹ IETF does not concern itself directly with deployment, meaning that this stage is for many of the technologies the final stage. It is interesting to note that in the overview of 2017 published RFC's RTP (and not its secure version SRTP as introduced in 2004) is the most important work item, "congestion" and "latency" still appear as a major topic and RADIUS is still prominently featured as one of the key terms while DIAMETER (which as the name implies is the much improved successor to RADIUS² introduced near the turn of the century in RFC 3518) is completely absent. Meanwhile a number of features have of course been 'backported' to RADIUS, but this certainly has limits.

In order to understand the current focus and expected future outcome of the IETF Working Groups, an analysis has been performed on the charters for each of the 123 active working groups within IETF:

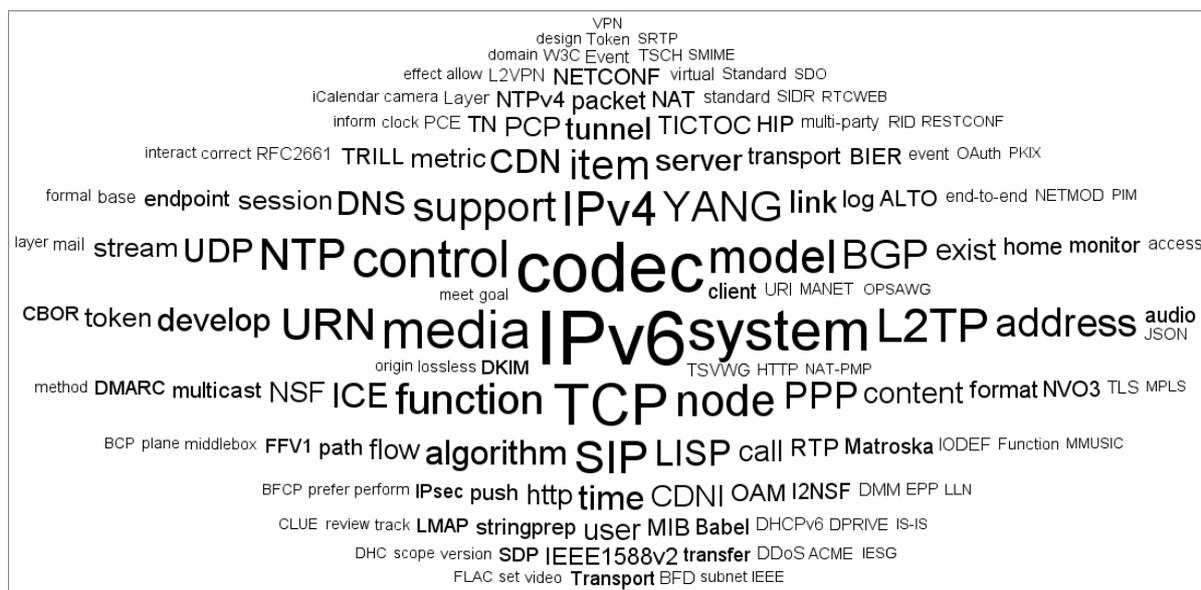


Illustration 8: Word cloud derived from charters for the 123 IETF working groups

¹ <https://www.rfc-editor.org/info/bcp9>
² RADIUS has known issues with reliability, scalability (it for instance has an 8 bit address space for extensions which is now exhausted) and security.

The composition of working groups inside the Internet Engineering Task Force is in constant flux, as the IETF resolves its working groups when their work is done. The above visualisation of the charters of the *active* working groups made on August 31st 2017 is therefore but a snapshot. Yet, it seems clear that the vast majority of the most recurring terms in the charters of the active working groups indicate a very significant burden related to the maintenance of relatively old technologies – e.g. internet technologies that were created in the first half of the existence of the internet such as IP (v4 and v6), BGP, SIP, NTP, DNS and SIP. Especially if you compare it to technologies from that same era in other realms: floppy disks, VHS, GSM and ISDN have meanwhile been all but abandoned and have not seen active development for decades. Many groups within the IETF appear to have to worry a significant part of their time about handling issues with legacy technologies, which is not a sign of healthy technological development. This could lead to the conclusion that the internet is not as good at scaling as it would appear at first glance, and adds to the argument that the internet is far less capable than of evolving architecturally than it should.

6. First suggestions on which Technological Topics the focus should be

This section presents a first aggregation of the technology research topics based on a dependency analysis. The three topics we suggest to prioritize are:

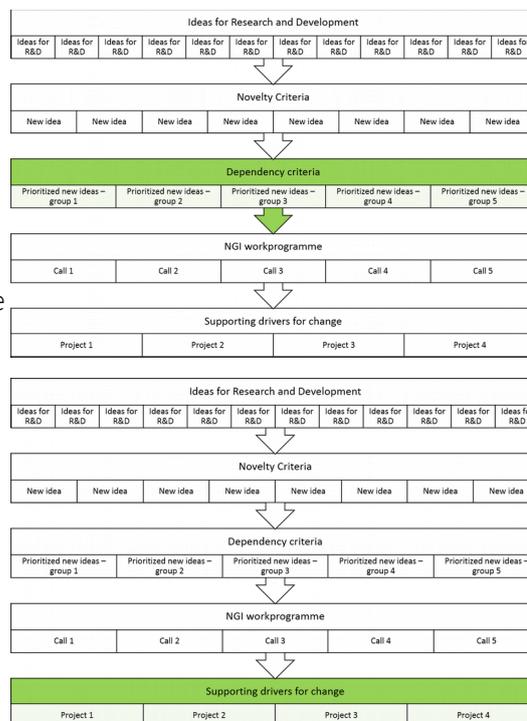
- **improving maintainability**
- **trustworthiness**
- **alternative infrastructure**

These are derived from a filtering of the complete list above based on a dependency analysis – as shown in green in the figure depicting the framework.

It makes very limited sense to introduce alternative infrastructure, if lower level technology it builds on is not trustworthy. And creating trustworthiness means that the situation needs to be manageable in the first place.

As a secondary and more fine-grained decision mechanism within the actual granting process (which is expected to take place through a sub-granting mechanism), we suggest that among alternatives competing projects may be selected based on their support for the largest number of drivers for change – to maximise and speed up the outcome for the end user. This step is presented in the framework figure below in green.

We will explain each of these topics, as they are essential for the intervention logic of the NGI.



Improving maintainability

It is essential to increase the flexibility and responsiveness of the internet as a system; no secure system is able without “convenient mechanisms and procedures for maintaining it”.¹ And yet, we completely lack such a shared mechanism, similar to our lack of configuration integrity testing and lack of auditability. We require the technology stack of the internet to be responsive to changing operational conditions, particularly in time of emergency. Its operators should have the capability to make appropriate modifications in the operational status of the system in the event of catastrophic system failure, degradation of performance, change in workload, or conditions of crisis, etc. And the system should have continuous automatic assurance checks of overall integrity: “It must self-test, violate its own safeguards deliberately, attempt illegal operations, monitor communication continuity, monitor user action, etc., on a short time basis”.²

Before undertaking anything else, the NGI Initiative should make sure that the R&D efforts can be **deployed** and **maintained** in the context of the actual internet environment. Even with the availability of iterative best practises and bundling of expertise, the cost of manual setup and maintenance is prohibitive to a large part of the internet population. This has led to slow uptake and large scale technical debt. A key aspect of a successful approach for the NGI is creating a universal and reliable path to automatable deployment – through reproducible solution integration, precompetitive bundling and automated testing that the deployed situation is as was intended. That way the cost for the effects of the asymmetric security benefits is dealt with as an integral part of the process. The management of high volume of updates/changes can only efficiently handled in a collective manner, and will fail when relayed to each individual participant. The highest possible result of the NGI would be to achieve the same for end-user service deployability: the end-to-end principle of the internet does not distinguish who sends and who broadcasts – but the user needs to be empowered by the availability of good technology to deploy and build on.

Trustworthiness

Both civil society and the technical community emphasize that the original core architecture has been exposed as fundamentally untrustworthy. The shocking dishonesty with which the internet was brought into the world and promoted as a major contribution to humanity while pursuing a completely different hidden agenda, and the subsequent inability to deal with large scale intrusive behavior by private and extralegal actors combined are for many the key rationale for creating a Next Generation Internet. As one interviewed expert succinctly put: “we need trust built from the ground up”. Every technical primitives from the current internet needs to be re-evaluated in terms of the complete **threat catalog**, as we cannot afford our multitrillion euro economies and societies to not be able to trust the internet as we move forward. We need an Next Generation Internet that – without a

¹ Ware, Willis; “**Security Controls for Computer Systems: Report of the Defense Science Board Task Force on Computer Security**” DARPA, 1967. As noted before, this confidential and comprehensive report was kept distinct from the development of the ARPAnet and served as the basis for the development of an alternative to the internet that was not shared with the world

² Idem.

shadow of a doubt – is primarily engineered to achieve solid trustworthiness in all aspects of its operation.

Security by (re)design is therefore a pivotal aspect of the NGI initiative. This starts and ends with achieving **security transparency**, so that users are able to fully grasp their overall security situation. Trust from the ground up means ubiquitous and flawless **transport layer security** combined with **verifiability and control of routing paths** and **end to end confidentiality of traffic metadata** - if we want to achieve security and confidentiality, we need to make sure that the internet does not leak information it merely is supposed to transport. Other key mechanisms include **decentralised internet-wide identity mechanisms** and **distributed reputation**, which allows users to establish trust among themselves based on intrinsic decentralised qualities of the internet without elevating specific actors to a position of control. In addition, we need capabilities for creating **automated** or **transitive trust**.

Alternative infrastructures

The third topic is **alternative core infrastructures** to structurally increase the resilience and robustness at a systemic level. Note that high availability of individual resources is a separate issue, the topic here is the ability to re-engineer and/or replace core protocols known to be unreliable or untrustworthy. This would provide a lasting answer to the threats from the **threat catalogue**, for instance changing the whole dynamics of currently ‘undefeatable’ threats such as distributed denial of service by botnets and mass surveillance. Basically this means fixing the known fundamental architectural weaknesses and applying lessons learned in the lowest possible layer before it is too late – as well as introducing exciting new capabilities to further evolve the internet.

The challenge is that these should not just exist in a test bed or a technical specification, but should be deployable and deployed everywhere in a realistic manner. The first topic (maintainability) is therefore vital to achieve that means – without a strong global deployment strategy inside operating systems, routers and management software, alternative infrastructures do not stand a chance. In addition to such deployments, providing adequate fallback mechanisms is a priority.

Desired traits of alternative infrastructures are

- **Partitioning/scope isolation**
(The ability to segment parts of the network in such a way that issues in one segment have no side effects in other segments/parts of the network, which would allow for uninterrupted use outside of any affected areas)
- **Redundancy**
(Avoiding single points of failure and quality degradation by providing multiple independent alternatives, such as the ubiquitous ability to combine multiple access networks in parallel – often referred to as multi-homing/multi-path capabilities)
- **Abuse handling**
(An important part of maintaining high availability is streamlining and automating how

incidents are handled across the network, especially in parts or functions of the network that are strongly connected. This makes the overall system more secure, because it allows increased responsiveness to changing operational conditions, particularly in time of emergency)

■ **Smarter asset distribution**

(Providing distributed alternatives to obtaining digital assets from a single source is an important aspect of robustness in the context of various threats. A cascading failure due to missing 3rd party web software assets on critical web resources (an anti-pattern that is still common) can easily occur, while that exact same open source software would still be available from many other sources – and perhaps even already available on the user machine itself. In such a situation, service failure is completely unnecessary. Given the common and transverse nature and the operationally critical aspect of this issue, and the fact that it may impact different actors in different ways, developing complementary solutions in parallel is most robust. This involves:

- **Server-initiated**
(the service that offers the assets, can suggest or provide a suitable means of taking care of distributed delivery in case of failure)
- **P2P**
(end-to-end sharing of assets with known friendly peers, a solution that could work even in the most extreme scenarios. Note that from a scaling perspective, community caching is more suitable)
- **Community caching**
(collaborative caching and sharing of assets, should also work even in the most extreme scenarios. One important requirement is that the sharing facilities shield of the privacy of the participants in the network through a level of indirectness, i.e. caching should not mean that the participants you connect with have interacted with that resources themselves)
- **Network caching**
(The operator of the network may prefetch assets likely to be consumed within the network when there is surplus capacity, in order to prevent peak usage.
- **Service-provider driven**
(Independent service providers (such as VPN providers) may provide a fall-back service)
- **Client-side asset identification**
(Efficient de-duplication of assets across different domains, so that a generic asset already cached or downloaded can be reused over and over again)

7. Mapping of ongoing relevant initiatives and gap analysis toward Vision and targeted capabilities

A key observation to make at the start of this chapter is that the context of the projects is extremely important. In order to advance the actual state of play in the internet, in order to achieve the goals of the NGI and realise the high level vision of an internet we can trust with the fate of humanity, one cannot afford to just invite stand-alone contributions to the topics identified. This is known to produce a mismatch with the interactive, meritocratic and self-structured bottom up process of the Internet world, as well as with its operational practices.

A project done without any stake in or responsibility for what happens after the project ends is unlikely to be sustainable. In the sector this type of project is sometimes unaffectionately referred to as "code dump" practices. Funding nobody is better than funding the wrong people. Opportunistic projects that have no intention of really solving the problems at hand actually are very harmful to the NGI ecosystem, as their mere presence already creates confusion and cultivates the expectation that the problem is being properly addressed while in reality that is not going to be the case. DG Connect is therefore advised to make sure that there is not a "Hollywood facade" of fake projects working on fake solutions, as this could threaten the success of the whole NGI initiative.

Running the internet is a major operation involving many actors and high operational demands, and as all historical efforts have shown one cannot just throw some technologies at them and expect (let alone demand) any of it to be adopted in the actual infrastructure. Without adequate input and early involvement from the right actors in the technical and operational community the chances of getting the technological requirements for a smooth integration and deployment across the NGI initiative (let alone at internet scale) right are very low. This is not to say that everyone needs to agree, as with the introduction of any new technology there are likely conflicting interests. Some currently relevant actors may become less relevant as a result of the NGI. In that case, however, there will still need to be strong relationships with the rest of the technical and operational community.

The three topics suggested for prioritisation are:

- **improving maintainability**
- **trustworthiness**
- **alternative infrastructure**

Improving maintainability

To create a maintainable technology stack for the NGI, there are some existing efforts that can likely be built upon. Maintainability starts with predictability: it needs to be clear to anyone working on an NGI project how to deliver their results in a way that anyone can effortlessly evaluate and use them. And it needs to be clear to others (outside of the EC funded realm) how to do the same – the NGI may be led from Europe, but ultimately it will be a global and ongoing effort, so competitive ideas and approaches should be encouraged.

Deployability means that it should be possible to easily distribute new technologies in order to deploy them. A key starting point in this respect is the *reproducible builds* community.¹ The eponymous aim of this community is to provide a verifiable path from software source code to its compiled binary form. On top of that, the Nix and Guix package management systems – unique software delivery technologies invented by top European computer scientists – provide a clean and reliable method to isolate and lock down all the dependencies of software in order to create reproducible environments. These allow to package and run software while minimising the attack surface by not including unnecessary parts. This would allow to create a single complete repository of software produced for and required by the NGI – the results of every subproject within NGI should after all be available as a building block to others.

The ability to instantly switch back and forth between different (colliding) versions of both software and any dependencies would allow anyone early access for compatibility testing and thus will help to anchor quality assurance within a broader user group. It would also create a shared workflow across all of the NGI initiative where one may consistently apply best practices such as continuous integration, code fuzzing and the creation of integrated test suites. The results and failures, as well as collisions across projects – for instance when two projects try to both patch an operating system kernel in exactly the same place – would become immediately visible to anyone.

Declarative software management is not just convenient and robust, but also more transparent and responsive – provenance can be easily reviewed with a minimum of overhead, and even users should be able to efficiently patch vulnerable or deficient software in case of emergency. A possible desired outcome would be that all NGI projects deliver their software as working modules inside a shared environment (such as NixOS² and GUIXSD³) - while expanding these systems and allow them to run reliably on a number of other open source OS-es (such as Minix, OpenBSD and Illuminos). We recommend to work with all relevant processor architectures (including open hardware initiatives such as RISC-V⁴) to increase redundancy and to not unnecessarily introduce a dependency on the Linux kernel or any other component.

A complementary approach can be found in the unikernel world⁵, where projects like Mirage OS and Rumprun strip the runtimes even further to compile self-contained software which helps to minimise the attack surface and increase the trustworthiness. The combination of these two approaches could be useful across a variety of environments but in particular for resource constrained environments like mobile platforms and routers. These are but a few starting points, the overall goal is to converge systems and to create the distributed capability to make appropriate near-runtime modifications in

¹ <https://reproducible-builds.org>

² <https://nixos.org>

³ <https://www.gnu.org/software/guix/>

⁴ <https://riscv.org/>

⁵ <http://unikernel.org/projects/>

the event of catastrophic system failure, degradation of performance, change in workload, and conditions of crisis.

Increasing trustworthiness

Increasing trustworthiness is a topic that will by definition revolve around many smaller projects, each tackling different parts. The overarching goal is to replace any suspect technology (or suspect parts of larger technologies) with an alternative that does not suffer from the same lack of trustworthiness. It requires very specific domain expertise as well as a very systemic analysis of standards and infrastructure software which is currently ubiquitously operational in the internet. Trust needs to be built from the ground up, and so rigid software security practices and independent security proofs are likely to provide the strongest guarantees. Of course this has strong ties in with the previous topic of manageability – the more modular the larger system is, the easier.

Alternative infrastructures

For alternative infrastructures, there are projects like a number of relevant smaller and larger initiatives that may contribute to the goals, such as the SCION architecture¹, ARPA2², DPDK³, Open Optical Packet Transport⁴.

Operational recommendations

In the context of the NGI, the cascading funding model (which is able to avoid a lot of the bureaucracy) is vastly superior to the traditional consortium based calls. However, if the funding model is too financially attractive to intermediaries, this will likely attract the wrong type of organisations. We recommend to lower the rate for overhead that generic intermediaries may keep from 20% to 8%. A strong intrinsic commitment to the goals of the NGI is probably more important than any other operational aspect.

Intermediaries should have an adequate and knowledgeable reach in the various platform communities that can drive the particular transition aimed for. There are separate communities that ideally would have a limited set of competing intermediaries that directly address them, rather than switching intermediaries on a topic by topic basis: there is only a limited set of actors in for instance the mobile community, in the browser community, in the data centre/cloud hosting community. Depending on where action is needed, targetted outreach is necessary – an organisation starting from scratch would not add value and would fail to reach the right organisations and individuals.

The call process for the subgrants should be open and competitive. The process should also be convenient, and short. We cannot afford to waste the time of the people that are doing such important work. Why should developers and scientists be burdened by the need to grasp complex

¹ <http://scion-architecture.net>

² <http://arpa2.net>

³ <http://dpdk.org/>

⁴ <https://telecominfraproject.com/project/backhaul-projects/open-optical-packet-transport/>

procedures, or finding out where their (potentially multidisciplinary) project would fit? A forest of intermediaries with inconsistent methods and different schedules would be impossible to work with for applicants.

We suggest to also create an ongoing, completely open competitive call category with small grants, with just the NGI vision as guidance. This will allow the researchers and developers to suggest important topics that have been overlooked, and serve as a generic idea generator. Among the potential selection criteria for the projects, the model of the drivers for change can help select projects especially relevant to citizens.

8. Community activities

8.1 Setting up the community: stakeholders, tools and communication packages

The stakeholder communities are defined in the Inception report. These communities are complemented with a wider range of stakeholders who are targeted personally by email, or who are identified at events and workshops. A complete list of the stakeholders is presented in Annex 8: Stakeholders. A specific news was published on Futurium¹ announcing the launch of the stakeholder consultation and linking to the online platform.

A **social media campaign** was also carried out, targeting various media – in the full knowledge that several of the communities and types of people that were critically important to reach are typically averse to social media, but other target groups regularly use social media. A dedicated project² was opened on Researchgate, a social networking site for scientists and researchers to share papers, ask and answer questions, and find collaborators. A reference to the project was made on the Facebook group “I Feaking Love Science”³. The professional networks of the consultants was also leveraged.

Note that several US based mailing lists declined to pass the message on, citing various reasons or no reason at all – even though similar messages originating from the USA were.

To obtain feedback from the stakeholder communities, the team did an extensive effort to contact these communities through their leadership, including visiting a number of **conferences** and through internal mailing lists such as the mailing lists from Internet Society global chapters, FSFE and EDRI. These mailing list are the main means through which the bottom up processes inside these organisations are carried out.

Where suitable we provided interested stakeholders with additional information that explained what input we were looking for through e.g. the **information-package**, see Annex 10: Stakeholder Information Package. We asked participants to provide their input using our online tool, which was specifically designed and developed for this purpose by dr. Steven Pemberton – an academic expert in web technology and usability, and erstwhile chair of the W3C XForms and XHTML working groups. The screenshots of the **online tool** are provided in Annex 7: Online Platform. It presents a way of contributing information in a user-friendly way, encouraging structured input while allowing unstructured input if this fits better the contributors needs.

Complementary to the above described written feedback, the team visited a number of conferences to fetch direct feedback and to collect data. We used existing events from the various key

¹ <https://ec.europa.eu/futurium/en/blog/ngi-data-gathering-toolInnet-online-tell-us-how-change-internet-better>

² <https://www.researchgate.net/project/Next-Generation-Internet>

³ https://www.facebook.com/IFeakingLoveScience/?ref=br_rs

communities themselves, to increase the rate of potential feedback. A short description of the **workshops and events** is available in Annex 12: Conference and Workshop Reports.

We also collected feedback on the platform by targeting explicitly identified stakeholders by email, from our network as well as people that were suggested by other participants. In Annex 8: Stakeholders is the complete **list of contacts** with details regarding their background/expertise.

8.2 Workshop organisation

Choice of the Experts for the workshops

The aim of the first workshop is to **validate the vision**, to do **double loop learning** why many previous efforts failed and to determining technological topics which are in the scope of the NGI research funding and which relate to the vision, ensuring it can be made operational.

Our approach is to be inclusive in the stakeholders we invite, while at the same time focusing on the internet as a shared infrastructure – meaning for instance that industry verticals are out of scope.

We will invite experts from these different backgrounds:

- Standardisation
- Infrastructure of the Internet
- Governance of the Internet
- Security and cryptography
- Privacy and civil rights
- Civil society
- Open source communities
- Academic research and education
- Technology vendors (e.g. browser, mobile)
- Start-up – Investors
- Industry
- International – UN, World Bank...

Motivating the experts

As the experts' participation is key in the success of this study, special attention was given to motivating the experts to come, including personal invitations, a details expert communication package – see Annex 11: Workshop Experts Information package - a list of the other experts invited and an agenda which ensures that their participation and contribution will be impactful.

Experts invited and confirmed

The experts that were confirmed to participate in the workshop are available in [annex 16](#).

Choice of the venue

The choice of the venue was from a technical point based on the following criteria:

- the size of the room – which could host 25 people
- a neutral space linked to the operational internet community
- an environment that is in line with the result-oriented nature of the NGI initiative

However, the team felt that it would be suitable to put this important event in a historical context and an historical environment. The venue therefore chosen was the [Centrum Wiskunde & Informatica](#) (CWI), the Netherlands national research institute for mathematics and computer science. Despite its modest size it has been the home of many famous mathematicians and computer scientists such as Edsger Dijkstra, Adriaan van Wijngaarden, Guido van Rossum (the creator of the Python programming language) and David Chaum (the inventor of anonymous digital payments). In 1980 Jaap Akkerhuis and his colleague Ted Lindgreen from the particle physics institute NIKHEF devised and set up a high performance fiber optic network at the science campus for the linear particle accelerator at the latter institute which ran TCP/IP – the first such network in Europe and in fact one of the earliest anywhere in the world. In 1982 CWI became the first main node of the EUnet when it was launched under the leadership of Teus Hagen, and in 1988 the first regular connection outside of the US to the NSFnet was (quietly) launched. cwi.nl was the first national domain name ever issued. It is important to note that this happened completely out of the context of policy making at the European Commission and member state governments – the internet was brought to Europe in a very practical manner as a grass roots technology by scientists and researchers without much buzz or business interest. It successfully competed against the dominant communication technologies of the day, most notably the OSI stack which received strong political backing and huge amounts of funding from the EC and member states. We believe by organising this workshop at the heart of Europe's internet history, the Next Generation Internet may take some lessons from that book to enable it to reboot the internet in Europe.

Agenda

11h.00 Introduction NGI – Georgios Tselentis, *Programme Officer EU-Policies DG-CNECT*

A summary of the Next Generation Internet initiative, its objectives, timelines and setup.

11h.10 Purpose of the workshop, Introduction – Michiel Leenaars, *Director Strategy NLnet*

A short introduction to the overall planning of the workshop, that sets the stage for the discussion. Introduction of the draft vision document as the intended foundation of the NGI initiative.

11h.30 Identification of NGI topics – All

The participating experts are invited to shortly introduce their background, and highlight the most urgent topics they would like to see addressed by the NGI initiative.

12h.45 Lunch

Working lunch: discussion among participants about where potential conflicting topics might appear.

13h.45 Presentation of the outcome of the morning – Study team

A preliminary summary of the input provided by the various participants in the morning session .

14h.00 Questions and challenges ("Devils advocate round") – All

Critical review and discussion. Are there possible collisions, hidden risks, or other unintended aspects regarding ideas presented so far? Is it possible to address these in a satisfactory way, while still preserving the intention of the approach? Are there roadblocks (due to for instance externalities) that need to be avoided? How do we resolve conflicts of interests (e.g. through legislation)?

14h.30 Requirements, dependencies and critical factors – All

Is the approach complete? Is there anything important to add or remove? Which external and internal dependencies need to be resolved (e.g. trust on higher layers depends on new capabilities in the lower layers)? What gaps need to be bridged?

15h.00 Success factors and expectation management – All

What are the requirements for the NGI to be successful? Are there any lessons to be learned from previous efforts to change the internet? What would be the key indicators that the NGI is a success?

15h.30 Funding model, deployment and sustainability – All

What is the intervention logic? How can the NGI not just select the right topics, but actually have a real-world impact on the development of the internet? Is the selection of the right topics enough to warrant successful adoption, or should the process be designed to more closely interact with specific stakeholders along the way.

15h.55 Final Comment round (3 min each) – All

The experts contribute thoughts and guidance for the NGI initiative.

16h.55 Closing remarks – Study team

A preliminary summary of the outcome of the day.

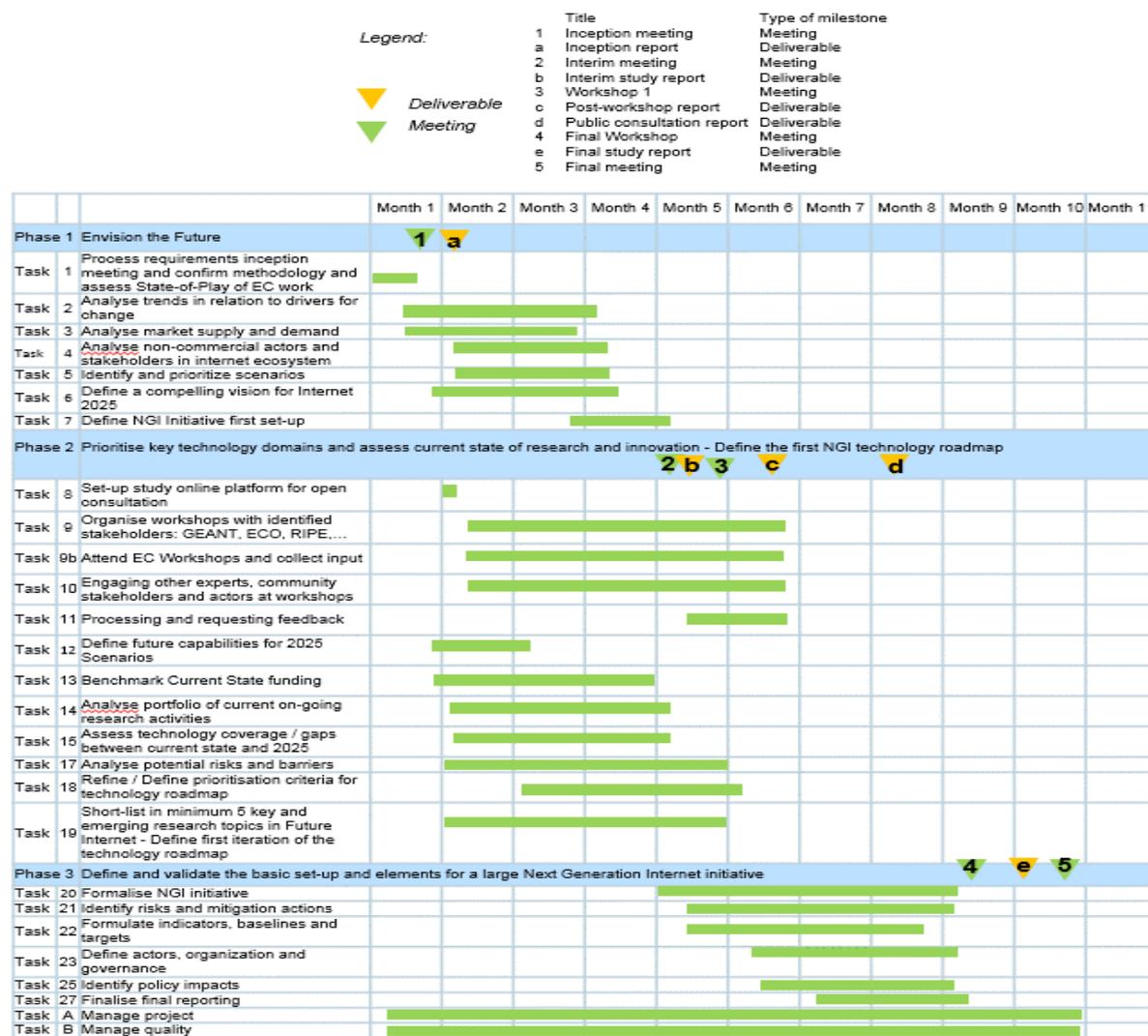
17h.00 End

Annex 1: Scope of the Interim Reporting

This section presents the planning and tasks as agreed upon during the stage of Inception Reporting. The Interim Study Report is the second of five reports which collectively form the formal deliverables of the project :

- An **Inception report**, specifying the methodology, resources and objectives
- An **Interim study report**, including in particular a preliminary list of research topics and a first draft design of a possible Next Generation Internet programme
- The **post-workshop report**
- The **public consultation report**
- The **Final study report**

In the overall Planning , the Interim Study report was scheduled to report 4,5 month after start:



The Interim Study Report was scheduled to cover the following topics, as presented in the table below:

| | Study methodology outcomes | Inception report | Interim study report | Post-workshop report | Public consultation report | Final study report |
|----------------|--|------------------|----------------------|----------------------|----------------------------|--------------------|
| Phase 1 | Envision the Future | | | | | |
| | Study methodology | X | | | | X |
| | 2025 Vision | | X | | | X |
| | NGI Programme concept, first principles and intervention logic | | X | | | |
| | Preliminary list of research topics | | X | | | |
| Phase 2 | Prioritise key technology domains and assess current state of research and innovation - Define the first NGI technology roadmap | | | | | |
| | Future targeted capabilities and scenarios | | | X | | X |
| | Mapping of ongoing relevant initiatives and gap analysis toward Vision and targeted capabilities | | X | | | X |
| | First focus technological topics | | X | | | X |
| | First version of the technology roadmap | | | X | | X |
| | Benefits and impact analysis. Risk analysis | | | X | | X |
| | First communities by specific technological topics | | | X | | X |
| | Workshop 1 and broad public consultation outputs | | | X | X | |
| Phase 3 | Define and validate the basic set-up and elements for a large Next Generation Internet initiative | | | | | |
| | Recommendations for a Next Generation Internet research and innovation initiative programme and its operating model | | | | | X |
| | Final workshop outputs | | | | | X |

Annex 2: Progress Reports

This section presents the progress reports delivered during the period between the start of the project and the delivery of this interim report. A summary of the activities is presented in section “Initial steps taken”.

The reports are made available as separate documents sent together with this report to the European commission.

Annex 3: Background themes which shaped the Vision

The Internet is profoundly changing society and business

The Internet has become part of the fabric of society, enabling citizens, businesses and governments to collaborate, exchange and build knowledge and create value. It is providing the main platform for new businesses, enables new ways of doing business and changing business boundaries and dynamics for both large enterprises, small and medium ones and individual businesses. It is one of the key underlying elements for optimizing value chains and business operations. It is changing the way governments interact with citizens, how we educate and learn, how we manage our health. And last but not least: it has enabled collaboration across dispersed communities, and has forever changed the way culture and societal discourse takes place.

What enabled such a large diversity of services is the "permission-less innovation": the internet and the web today are open platforms, without gatekeepers. Even an anonymously created open source-project like Bitcoin can introduce and deliver a new, ground-breaking service without asking anyone for permission. This is an important aspect of inclusiveness, diversity and equal opportunities.

Gartner predicts by 2020:

30% of web browsing sessions will be done without a screen using voice recognition

Algorithms will positively alter the behavior of over 1 billion global workers

More than five billion additional people will connect to the Internet globally,

Over 50 billion objects will be connected to the Internet, transmitting data coming from people, sensors, the environment and objects themselves

There will be massive potential for data generation with 21 billion Internet of Things endpoints estimated to be in use

30% of meetings will be facilitated by virtual concierges and advanced analytics

20% of activities dependent on human expertise will be done using knowledge automatically extracted and previously codified by observing human activity

15% of organizations will have unified observational, social network and people analytics to discover, design and share better work practices

Sales of Head-Mounted Displays for both Augmented Reality and Virtual Reality applications will reach nearly 40 million

The Internet needs to technically evolve

The NGI vision has clear social and economic objectives that need to be met and articulates into a powerful vision for the internet.

This makes the Next Generation Internet initiative radically different from historical efforts undertaken in this area in Europe and elsewhere, because rather than merely stimulating research and development in a number of interesting technology areas, the NGI initiative aims to affect the whole of the internet - and intends to have an actual impact at the system level.

Policy making in the area of internet research has until now been largely focused on keeping up with the perceived speed of development of "the internet", by which is normally meant the speed of adoption of technology and services on top of the internet. Typically, policy makers and governments are expecting and driving more innovation and increased performance in the digital economy, new

opportunities for smart cities and regions and public services, driving on one hand citizen engagement and direct democracy and on the other hand public sector operational efficiency and effectiveness. Industry is pushing for growth and competitiveness, targeting new markets and new consumers. Corporations and small and medium businesses renovate and expand their service and product portfolios leveraging digital technologies while facing new entrants.

The Internet in 2025 and beyond should enable this growth with open connectivity but also provide more and better services, more intelligence, access to more knowledge and information while allowing the freedom to access, participate and collaborate.

The tragedy of the commons

The actual technical fabric of the internet itself is another story entirely: much of today's problems with the internet stem from the fact that its technology stack is ossified. As the internet got catapulted into the mainstream economy in the nineties, it became a victim of its own success: the legacy technology from that era is still entirely dominant. Not a single technology upgrade designed by the Internet Engineering community has actually been adopted at true internet scale since, actually negatively affecting both cost and risks: the old, insecure, technically limited and often very expensive technologies have to be kept up and running.

In 2013, the Internet Architecture Board (the technical committee that provides the architectural oversight of the activities of the Internet Engineering Task Force, and oversees the Internet Standards Process) organised a high level workshop in Cambridge on Internet Technology Adoption and Transition (ITAT).¹ The workshop involved the top of the internet standards world, as well as hand-picked thought leaders from around the world. The conclusion was that the core internet technologies are failing to evolve, due to the complexity of interdependencies and the enormous pressure of the mass use of its legacy technologies. The asymmetry of allocation of cost (who should invest) versus the distribution of benefit creates a 'tragedy of the Commons': society is unable to reap in full the abundance of potential benefits of technology upgrades to the core technologies of the internet because lack of ownership for any solutions.

¹ <https://www.iab.org/activities/workshops/itad>

Unprecedented security challenges

While the observed inability to evolve the most important driver already would be enough to warrant immediate action, the situation became even more urgent in 2013. That year the internet world was shocked by the revelations of a whistle-blower called Edward Snowden, in what is considered by many the biggest IT scandal in history. He revealed fundamental security gaps in the core infrastructure of the internet that were actively exploited at a scale never before experienced in history for intelligence activities conducted by US and UK national intelligence agencies, particularly the US National Security Agency (NSA) and the UK Government Communications Headquarters (GCHQ). Pervasive surveillance capabilities undermined even the most common security measures and thus constituted an immediate attack on the trustworthiness of the Internet.

In response, the technical community started work to address or mitigate the vulnerabilities exploited in these attacks. But the decentralised setup of the original internet – from a technological point great because it allows to adopting new technology on top quickly – remains counterproductive at an economic level. Nobody can be held responsible and the asymmetry of cost and benefit has been halting progress.

The European Parliament demanded action to safeguard citizens' fundamental rights, urging the EC to take the initiative to repair the issue. In 2015 the Parliament repeated this with a motion saying that "too little has been done to ensure their full protection". With the NGI Initiative, the European Commission is putting its weight behind the Internet community.

Coping with high demand versus technical debt

With an all-out security crisis at the system level on one hand, the technical and operational internet community at the same time has to deal with carrying the weight of enormous growth and expectations.

Policy makers and governments are pushing for more innovation and increased performance in the digital economy. Business is pushing for growth and competitiveness, targeting new markets and new consumers. (Proprietary) technology platforms in for instance mobile and cloud fight for global dominance, knowing that a likely outcome could be 'the winner takes all'.

It should be clear that the massive overall problems with security, scalability, resilience and cost effectiveness need to be fixed yesterday rather than today, as they pose a real and very significant threat to users and to the health of the future internet. The pervasive surveillance adds additional urgency to this, to the point of threatening the autonomy of our community and our economic viability. The cost of cybersecurity is already exponential, and this trend can only continue when not addressing the underlying technical issues. From a societal point of view, every investment made now on new services and products is made on top of instable, insecure and deprecated technology, and

Gartner forecasts that in the next 10 years:

- Through 2020, growth in consulting services will be primarily around digital business; however, after this date, risk management and security will continue to drive growth in the consulting market at between 7% and 8% annual growth. While definitions of digital solutions vary, Gartner expects cloud, mobile, social, analytics solutions, other emerging technologies and integration platforms to make up 60% of consulting and integration services spending by 2019.

will potentially have to be redone in part or in full in the near future. If such is even possible at that point, otherwise it will cost yet more to be kept alive while the rest of the internet is transitioning away.

Delay to act will contribute to grow long term societal cost for the benefit of short term individual profits. The accumulation of the "technical debt" of the internet accelerates over time as we continue to increase dependency at an alarming rate through massive investments in new technologies on top of a fragile basis - such as 5G, IoT, cloud and data. This makes the Next Generation Internet initiative a vital and urgent effort for all of European economy.

Moving ahead strategically

Investments in the infrastructure of the 21st Century are needed in order to provide a privacy-aware decentralized secured environment for open data and open collaboration supporting democracy and innovation "spaces". Distributed architectures and public common frameworks are needed to allow the design of new services underpinned by open protocols, open standards, open formats, regulatory mechanisms and collective governance models based on democratic and participatory processes.

Gartner observes that technology strategy planners focus more and more on peer-to-peer technologies for social system dynamics, moving beyond business models of the "sharing" economy to true decentralized and citizen-owned tools and networks. They work to make it simple for citizens to use, aggregate and benefit from their life data and explore opportunities on behalf of citizens within emerging smart city data marketplaces. They plan to use citizen data to plug gaps in governmental KPIs and leverage marketplace data to improve user experiences and to use semantic technologies to simplify dialogue and processes between citizens and to negotiate with business and government. Leading technology strategic planners are putting in place the conditions to widely use "virtual private assistants", bots and other artificial intelligence (AI) techniques to simplify radically how citizens self-organize as well as monitor and lobby government and business. Furthermore they plan to make it easier for users to capture, develop and shape their environment. City-centric content is maturing from web pages and apps. Vendors explore zero-code Internet of Things (IoT) solutions, augmented and virtual reality, 3D cameras, image and sound recognition, peer-to-peer networks and a more diverse set of sensors.

The Commission and the Consortium team want to create the conditions where digital businesses, new entrepreneurs, incumbents, communities and individuals can thrive with a vision of "connected freedom" and great economic integration, efficiency, opportunities and high rewards for those who compete and innovate successfully. For citizens, the power of cultural values and belonging must be preserved in a global context. Europe is faced with many challenges, including technological change, globalisation, energy and food safety, climate change, transformations of gender roles, migrations, economic and social exclusion and the ageing of the population. These concern key social and ethical values, and technology will be a key factor while the trust of users in the currently dominant actors in the internet industry is at a historic low.

Innovation was one of the main focuses of the Lisbon Agenda which placed knowledge at the core of social and economic development, and remains a core component of the Europe 2020 strategy. The Internet is one of the key enablers for knowledge circulation and for connecting ideas, capabilities, targets and funding at scale. Restarting the innovation engine of the internet through industry-wide collaboration in the NGI initiative will mean new opportunities, a reshuffling of the card deck.

With new technology the business opportunities that respect European values such as privacy and human dignity, as well as restore the trust of users, Europe can reclaim its rightful share of the digital economy. The Internet in 2020 and beyond can enable growth with open connectivity, more and

better services, more intelligence, access to more knowledge and information while allowing the freedom to access, participate and collaborate.

Partnering across the internet community is critical

The vision behind the NGI initiative means addressing the deep underlying technical issues with the core internet technologies (the "plumbing" of the internet) identified earlier and understanding how far it needs to go into the application layer.

However, having the technology on paper is one thing; getting it deployed throughout the fabric of the network is another. The internet is not owned by a single entity, it is a network of network as well as a layer cake of independent protocols - operated in different ways by different communities under different economic circumstances. This 'layer cake' requires that any initiative needs to make a good fit with the operational requirements of the technical and operational communities that have to deploy new technologies while keeping the internet (and the weight of large parts of the economy) running as it is being upgraded.

Unusual needs call for an unusual approach: the collaboration between NLnet, as a not-for-profit deeply interested in keeping the infrastructure of the internet healthy, and Gartner as a global company with a deep understanding of the key trends and market forces and understanding of the business and applications leveraging the infrastructure of the internet, is such a unique approach. But we need more. The ambitions put forward in the NGI initiative are broadly shared among the technical community of the internet. The idea is to engage the technical community, digital civil rights groups and other key communities directly into the scoping of the initiative. And to do so directly in the context of their own activities.

Major European and global platforms and communities see the need for the NGI initiative: the European regional internet registry, the domain name organisations, ISP associations, the open source community, the digital civil rights community and Internet Society. So not just the separate communities that operate different layers of the technology but also the 'ethical guardians' of the internet: communities that aim to protect basic tenets such as accessibility, openness and digital civil rights and the 'users' that expect to continue using it for education, healthcare, citizen services or thriving business activities.

We believe that there is no adequate substitute for the collective engagement and intelligence of these communities - at the risk of missing out on essential input that will make the whole initiative moot. A next generation initiative will simply not happen without proper embedding into the technical internet community that constitutes and run the current generation.

We believe that the aspect continuous collaboration and dialogue is key to the Next Generation Internet initiative, and should make a huge difference.

Traditional funding does not entirely match

Most of today's research cycles in the EC Framework Programmes and elsewhere are multi-year efforts technologically specified entirely upfront, with an involvement of the funding entity more focused on evaluation at the end. That has become a mismatch with the interactive, meritocratic and self-structured bottom up process of the Internet world, as well as with its operational practices.

Running the internet is a major operation involving many actors and high operational demands, and one cannot just throw some technologies at them and expect (let alone demand) these to be adopted in the actual infrastructure.

Without adequate input and early involvement from the right actors in the technical and operational community the chances of getting the technological requirements for a smooth integration and deployment at internet scale right are very low. A project done without any stake in or responsibility for what happens after the project ends is also unlikely to be sustainable. In the sector this type of project is sometimes unaffectionately referred to as "code dump" practices - actually more harmful than not funding anything because it creates confusion and expectation that the problem is being solved while in reality that is not going to be the case.

The fact is that research and development projects need to do a lot more than just produce some running code: they need to have proper licensing management and code governance, use good software quality practices such as secure coding and accessibility guidelines and have test frameworks in place. External security audits for any security-critical code may be a baseline necessity. Most historical projects already have a hard time adhering to even simple best practices such as 'release often, release early'.

In addition, when a project to be actually deployed across the internet one needs to factor in the projected maintenance cost and support available to the community that needs to adopt it. In most cases there will be significant effort and cost, which is only acceptable if there is enough trust in code quality and in integrity. Neither are common to achieve within a traditional short-lived project effort. Who would want to use a technology in any critical infrastructure when the short-lived project that created it will be unable to follow up on any bug reports (or even accept patches from external contributors)? Issues like these and the transformation of project results into value for citizens and business in general will be considered to be part of the design of the NGI initiative.

Technology operates in a complex and fast changing environment.

The methodology of using a top-down gap analysis in combination with long-lasting and broad programmes fulfilled by consortia means some resulting projects will already be outdated the day a call for proposals is published; observations of what happens outside Europe shows that the static type of funding typical for consortia is uneconomical and ineffective in the context of the internet or digital in general where technology is often created in small specialised teams. Global and rapid interaction between engineers from different background and with different use cases is the norm, and is vital to achieve quality. Consortia are limited to the subset of talent they got out of the global talent pool, and only compete with a small set of consortia with equally limited access to talent. The

requirement to set up consortia artificially raises the cost of entry, and it would be better if the NGI would work with a smaller granularity and scale of funding - such as individual grants. Industry will need to be involved to ease adoption and fast deployment into the market. Eligibility criteria will need to be adapted in order to allow start-ups to participate.

In any case, in line with the Juncker Commission focus on results and transparency, the set-up of the NGI initiative programme will need to be adapted in order to allow early validation by the technical and business community as well as dynamic realignment and goal iteration when a project is no longer known relevant. This will allow to rapidly validate approaches and results, to get new people and actors involved and to fail fast. A lot of lessons learned within the Commission and through the analysis of external practices have already generated a lot of other ideas on what could be improved or changed.

The internet as an open technology platform excels with regards to incremental innovation possibilities that enable different stakeholders to iterate in parallel based on different use cases. At the same time, the NGI initiative will have to fit into the trust system that characterises the technical communities, building on trust earned by sustained contribution and fostering continuous dialogue and consultation of external experts, stakeholders during initiatives to increase quality and prepare marketability, while as a consequence increasing transparency.

Next generation Internet should offer more at the service of Europe's people, Europe's communities and to European society as a whole

Rapid technological change has wide-ranging impacts on society and profound implications on unemployment profiles and a potential to increase exclusion, widening the gap between the skilled and unskilled, the Internet businesses and the traditional ones. Just to quote the tender text:

“We need an Internet that is more performing, more open and interoperable, and more conducive of social innovation.”

“Europe needs to develop a holistic, long-term perspective in this evolution, and to grow European competences in terms of technologies, innovation, market and regulation to become a leading provider and user of the next generation Internet. This would aim at enabling and accelerating the emergence of new European industrial leaders, giving Europe digital independence.”

Annex 4: Draft Vision Texts

On developing a compelling Vision, the team made several versions, which finally resulted in the consolidated version as provided in Chapter 4.1

Below these three ‘input-versions’ are provided:

Draft version sent 29/06

A version which focuses on an Internet of values, and articulates around the reason for an NGI (why), how to achieve the NGI, and what to do.

Resilient. Responsible. Reliable. Human.

An EU Vision for a Next Generation Internet

Why: creating an internet of values

The internet has nested itself into the most intimate parts of the very fabric of humankind. It is a remarkable, universal superstructure, built from and interwoven with local private, public and shared infrastructures. The internet bridges ideas and images across languages, cultures, and media. It has become our primary public space, a carrier of our most private communications with loved ones and a global theatre for business, public engagement with citizens and virtually every aspect of human creativity and imagination. And we are just getting started.

We are strongly committed to shaping the next generation internet as a resilient, reliable, responsible and people-centric infrastructure in the knowledge that it will likely shape generations of humans in return. The original technologies that grew into the internet were never designed to perform many of the challenging tasks the internet is expected to perform today and tomorrow. In the light of the ever increasing intimacy and scale of our use of the internet across all domains, it is obvious that we need to urgently address the outstanding issues before accidents start to happen. It is clear we are not just investing in mere technology, but in an internet of human values. An internet that is fair, open and democratic – that embodies, strengthens and protects democracy, human rights and our way of life. Not just in Europe, but across the globe.

How: building on European competence to create a global commons

The internet as a phenomenon really belongs to us all, not vice versa. The internet and its standards and shared applications like email and the world wide web are technology ‘commons’ at a global scale. Anyone has the fundamental right and ability to use the underlying technologies to improve their quality of life, for whatever purpose and without discrimination. To use here also means also to study and incrementally improve upon, to suit ones individual and local needs - and thus the collective ability to spawn newer, better future networks and services over time. As Europe we will build on those capabilities, and even strengthen them by fostering new shared domains, creating new commons. The future of internet innovation depends on the ability to actively avoid the formation of

single points of failure, control or surveillance. So by innovating now, we protect all of innovation in the future.

As Europe we understand that to achieve sustained growth and keep new opportunities open, we need to do better in making sure that the internet as a shared global technical and social infrastructure is able to carry its heavy responsibilities. This is especially relevant as we are about to embark on fascinating new journeys where we depend entirely on a safe, secure and open internet as a carrier - including an expected flood of connected devices on the outside and inside of our bodies, vehicles, buildings and infrastructure.

What: a manifesto for moving forward

Internet is here for the long term, and with the NGI initiative Europe takes the global lead in investing in a technically robust and morally solid internet to rewire our future economy and society. An internet that – by engineering, by spirit and by law– delivers on core principles and ideals of our society like fairness, inclusiveness, diversity, privacy and personal safety. That is robust against manipulation and threats. The right overall growth of the internet cannot be primarily driven by volatile forces of global tech capital or political will, but shall come from a collective bottom-up design. We aim not for short term gain, but for creating the best possible internet that mankind can have. A sustainable and fair internet itself is of immense strategic value, implicitly and explicitly setting the rules and conditions for the entire economy. Fixing the known flaws of the internet is fundamental (in the most literal sense) to rebuilding trust, which in turn is vital to the success of unimaginably huge future investments in our economy, science and culture and collective knowledge - as well as having a major beneficial impact in our social and private lives.

The mere existence of the internet is the undeniable proof of the willingness of societies across the planet to create common understanding and trust in order to live, play and work together. Internet is a tremendous shared benefit for all its users, and Europe is willing and able to take up its responsibility and address the systemic issues that need to be dealt with. We all own the internet together, which also makes us responsible for the brightness of its future. The technology may have been invented by a few, but only the trust and buy in of our society has allowed it to flourish. By our strategic investment in the long term sustainability and openness of our infrastructure, the internet can lead the world and mankind into a future society that safeguards the European values of human rights, of equal chances, of freedom and heart.

Draft version sent 14/07

A version which includes EC recommendations about exemplification and concision; it also articulates around a slogan and aims at inspiring momentum around the NGI initiative.

The Next Generation Internet: resilient, reliable and ready for all.

An EU Vision for 2025

In 2025, a young citizen safely roams the web, always knowing exactly where he is.

In just one evening in 2025, an enterprising woman jumps all bureaucratic hurdles, and turns her innovative idea into a business.

In 2025, companies and citizens routinely use digital assistants, interoperable across brands and services.

In 2025, the Internet is powerful, open and intuitive. It offers all of its users, citizens and companies small or large, the same fair opportunities. People trust this reliable Internet: it works for them, guards their privacy and keeps their personal data safe. The Net's resilience lets new businesses push innovation on all frontiers. Digitalised governments have become enablers of a transformed society, that has overcome geographical, economical and cultural barriers.

Driven by the need to be trustworthy, inclusive, and user-centric, the Internet must be re-engineered to become indestructible. The Next Generation Internet needs this foolproof infrastructure to become a global technology commons that is built on European social and ethical values: free, open and interoperable.

Europe's Next Generation Internet initiative is preparing the roadmap for the reinvention of the Internet. It is setting the goal posts for investments in game-changing research and development. The initiative is tweaking funding methods to reach the best Internet engineers, researchers and innovators. Europe invites them to make the Net our society's enabler: open, inclusive, fair and unbreakable. Let's get ready.

Draft versions "B" and "C" sent 20/07

Versions focusing on the global dimension of the initiative

Draft version sent B

Our society needs the internet. Therefore it has to be indestructible and safe to use. It has to be fair, open and inclusive, so everyone can reap its benefits. And we need to be able to trust it with our lives, meaning that the technology also needs to guard the privacy of users without any compromise.

Citizens do not need others to have the final say on the strength of their security, on the use of their data, on who can observe their behaviour or in fact on other conditions under which they can live their lives. The new Internet will transparently work for the user, giving the individual full control over public and private life online. The guarantee of net neutrality together with an evergrowing open ecosystem of shared technologies - collaborative efforts of science, open standards and open source - have created a virtuous circle that maximises well-being for society as a whole. Business and social innovators can trust the Internet to be there as they move us forward to improve our quality of life.

Read-write access to technology allows for the democratisation of innovation, and powers the broadest possible growth of talent and experience. We want a rich digital cultural dialogue where Europeans can not just consume but also share and take part in living culture and modern art. Our fundamental citizen rights and self-determination should be translated to effective regulation that makes a principled stance, so that users need not fear predatory practises (whatever their profitability). European startups expanding to global markets get a global headstart from the strong

ethical stance, user protection, as well as the linguistic and cultural diversity in their European home market.

By design the new Internet offers the same fair opportunities to all of its users, on all of its layers and in all of its applications. It thrives upon diversity, authenticity and human dignity, rather than nudging people into a generic lifestyle which alienates them from the societies they live in - while hollowing out their self-confidence and reducing agency. Their focus is not on behavioural manipulation, and their However, despite the demise of major players as a consequence of having to respect user rights, consumers never felt as if they had to miss out on something, because they got something better in return: alternatives were created by funding global technology commons modelled after European social and ethical values. These powerful new primitives of the internet are the real long term engines for positive change and growth, allowing society to focus on improving and aligning these with more complex, higher level goals: green ICT, a more inclusive society, social barriers, renewing the principles of democracy.

Draft version C

The mission of the Next Generation Internet initiative is to re-engineer the Internet for the third millennium and beyond, to make it indestructible and safe to use. We aspire the information age to be an era that brings out the best in all of us, that is reliable, inclusive and fair. We want to enable human potential and creativity at the largest possible scale.

Neither waves of disruptive innovation nor incremental steps of steady evolution belong a priori to a privileged few. The renewable power to shape a better future and quality of life lies in each of us.

The invisible hands of market and technology do not by themselves shape the future we want, nor do they protect us from harm or bias. The internet should be above global politics and above competition. Let us not forget that what fuelled the unprecedented growth of the early internet was local ownership and distributed empowerment: a network of networks to unite us all. We shall not tolerate monoculture or single points of failure, just as much as we do not allow for weaknesses that could disrupt the stability of our societies. Whatever part of the planet goes off the grid by some natural or other disaster, the rest of us can count on the resilience of the internet to continue to serve us without interruption. We want universal trust and reliability that isn't just naively handed over by users, but is engineered as an intrinsic quality of the technologies and infrastructure we use.

We do not seek short term advantage for Europe, instead we lead to world in assuming our shared responsibility for the global commons. We re-invent the internet to make it robust and resilient. The internet should respect human rights and improve our quality of life. We believe in self-determination of the individual, in fair markets and human dignity, in the endless opportunities of diversity and permissionless innovation. The internet determines our collective capabilities and lays down the paths over which our global society will grow. The people of this world shall control their own fate. We climb on the shoulders of the giants before us and among us. To rewrite how democracy works. To create social innovation. To set up new businesses. To conceive art. To celebrate togetherness. To enjoy beauty. To light up our spirits and sharpen our mind. The internet has become the memory

of the world, its marketplace, its cultural arena and much more. Lets get to work, so we can hand over an internet to the next generations that they can trust and that gives a wealth of opportunity to all.

Draft version sent 28/07

The text addresses a vision message of human creativity and potential, and is articulated along three key messages – summarized in 3 words chosen for an R alliteration. It also provides data points that we had chosen in our offer.

An EU Vision for the Next Generation Internet: empowering human creativity and potential

The Internet has profoundly change society and business. To empower even further human creativity, the Internet in 2020 and beyond must be improved. The Next Generation Internet gives to all the freedom to innovate, participate and collaborate. It provides more and better services, more intelligence, access to more knowledge and information.

To unleash all our potential, the Next Generation Internet needs to become even more robust, reliable and resilient than the Internet is today. The Internet faces unprecedented security challenges. By 2020, more than five billion people will connect to the Internet globally. The Next Generation Internet is robust, with re-engineered technology that makes it indestructible, fool-proof and safe for all.

The NGI's resilience lets businesses push innovation on all frontiers, overcoming geographical, economical and cultural barriers. By 2020, there will be massive potential for data generation with 21 billion Internet of Things endpoints estimated to be in use. The NGI can face any disruption, and adapt at unimaginable scale. The users are at the heart of these innovations thanks to intuitive digital interactions.

NGI is more than a technological infrastructure. By 2020 already, one-fifth of activities dependent on human expertise will be done using knowledge automatically extracted and codified by observing human activity. The NGI is a partner of ta fast-changing society. This global commons is a people's network built on European social and ethical values. People trust this reliable, open and interoperable Internet: it works for them, guards their privacy and respects values such as human rights, equal chances and digital freedom.

Final version (text)

AN INTERNET OF HUMAN VALUES

Resilient. Transparent. Sustainable.

The overall mission of the Next Generation Internet initiative is to re-imagine and re-engineer the Internet for the next millennium and beyond. We envision the information age will be an era that brings out the best in all of us. We want to enable human potential and creativity at the largest possible scale. In order to preserve and expand the European way of life, we shape a value-centric, human and inclusive Internet for all.

These ambitions need a solid foundation to build on. The legendary robustness of the Internet must become actual reality in the Next Generation Internet. A massive global fleet of connected devices is on its way to enhance and control our homes, factories, offices and vehicles. Technology is embedded in concrete, circling in space and is increasingly entering the intimacy of our human bodies. The Next Generation Internet has to be highly adaptive and **resilient**. Whatever companies or parts of the network go down by some natural or other disaster, the effects on the rest of us should be close to zero.

There is another important dimension to trust, which lies above physical availability. We need a **transparent** technological environment, that is **trustworthy**. The architecture, governance and policies structure how entire societies and economies interact. By design it should protect free speech and private enterprise and much more. The Next Generation Internet is to be designed to avoid any bias or systematic abuse of global trust in the Internet. It shall be a true global commons, rising above international politics and competition. It will guarantee the safety of citizens and strengthen the health and autonomy of our markets and societies.

The enduring success of the Internet lies in permission-free innovation, openness and interoperability. The Next Generation Internet is set up to create wider choice. It fosters diversity and decentralisation, and grows the potential for disruptive innovation. This extends far beyond the technical realm. The Next Generation Internet will achieve a **sustainably open** environment for our cultures and economies, celebrating our values and promoting creativity and well-being.

Let's re-invent Internet to reach the full human potential, for all generations.

Annex 5: Complete H2020 Work programme NGI initiative

This section presents the detailed H2020 work programme as of draft June 22, 2017 with respect to the 'NGI elements':

Next Generation Internet (NGI)

A number of technological trends will thoroughly reshape the internet over the next 10-15 years. Europe should drive this technology revolution while contributing to making the future internet more human-centric. An internet for the people, that contributes to a more sustainable and inclusive society.

Increasingly these technological trends influence each other and a programme targeted towards the Next Generation Internet must consider them in a holistic way.

- Future **Interactive Technologies** will allow internet users to access, process and deliver information in more natural, efficient and less intrusive ways, providing enhanced and personalized experiences;
- Advances in **Artificial Intelligence** are critical to turn information into knowledge and to embed autonomy and intelligence into networks, robots and other connected devices;
- **Internet of Things** technologies and applications are changing the way users, services and applications interact with the real world environment in a trusted way.
- **Future social networks, media and platforms** will transform the way we produce, consume and interact with content and objects, within and across users' groups and will become the way our societies operate for communication, exchange, business, creation and knowledge acquisition.
- The Next Generation Internet will be **multilingual and inclusive**. Advances in **language technologies** will help eliminate language barriers. NGI technologies will also help to provide a new quality in Digital Learning as smart, open, inclusive and **personalised learning** solutions will be tailored to each individual's needs, competences and abilities.

In addition, cutting across technologies, the **Open Internet Initiative**, based on an agile and flexible programme approach, will focus on research teams, hi-tech start-ups, SMEs and social innovators, and will rapidly explore promising avenues for the Internet of the future.

The topics addressed here form a coherent and integrated package. Coordination and support actions will be called upon to cut across topics and benefit from synergies.

Mission: The upcoming digital era and hyper-connected society must be based on principles that are in line with European values of openness, cooperation, inclusion, transparency, protection of data and privacy. This Next Generation Internet should ensure that the immense potential of artificial intelligence, the connection with the physical world, the interactive technologies and immersive environments, as well as the massive networks of people and machines are used to empower people and contribute to sustainable and inclusive societies. It should be an Internet that is dependable and trustable, creating new usage and new business opportunities making Europe a trusted hub globally. The Next Generation Internet has also to be a source of creativity, directly supporting the cultural and creative industries and its media sector. It has to be at the heart of the industry 4.0 revolution and the digitization of industry, being an essential driver for the competitiveness of European industry.

ICT-29-2018-2019: Next Generation Internet - An Open Internet Initiative

Specific Challenge: This initiative aims at developing a more human-centric Internet supporting European values of openness, cooperation across borders, decentralisation, inclusiveness and protection of privacy; giving the control back to the users in order to increase trust in the Internet. It should provide more transparent services, more intelligence, greater involvement and participation, leading towards an Internet that is more open, robust and dependable, more interoperable and more supportive of social innovation.

Scope: Involving today's best Internet innovators to address technological opportunities arising from cross-links and advances in various research fields ranging from network infrastructures to platforms, from application domains to social innovation. Beyond research, the scope includes validation and testing of market traction with minimum viable products and services, of new economic, mobility and social models, and involves users and market actors at an early stage. Multi-disciplinary approaches are encouraged when relevant. Eventually this initiative should influence Internet Governance and related policies.

a) Research and Innovation Actions

Each Research and Innovation Action (R&I Action) will focus on a given research domain supporting the objective of a human-centric Internet. It will build a European ecosystem of researchers, innovators and technology developers by selecting and providing financial support to the best projects submitted by third parties in a competitive manner.

Through an agile and flexible process, 'R&I Actions' will focus their support on third party projects from outstanding academic research groups, hi-tech startups and SMEs, so that multiple third parties will be funded in parallel contributing to the same research area, using short research cycles targeting the most promising ideas. Each of the selected third parties projects will pursue its own objectives, while the 'R&I Action' will provide the programme logic and vision, the necessary technical support, as well as coaching and mentoring, in order that the collection of third party projects contributes towards a significant advancement and impact in the research domain. The focus will be on advanced

research that is linked to relevant use cases and that can be brought quickly to the market; apps and services that innovate without a research component are not covered by this model.

Beneficiaries shall make explicit the intervention logic for their specific research domain, their capacity to attract top Internet talents, to deliver a solid value-adding services package to the third party projects, as well as their expertise and capacity in managing the full life-cycle of the open calls transparently. They should explore synergies with other research and innovation actions, supported at regional, national or European level, to increase the overall impact.

For grants awarded under this topic for Research and Innovation actions beneficiaries may provide support to third parties as described in part K of the General Annexes of the Work Programme. The support to third parties can only be provided in the form of grants. The respective options of Article 15.1 and Article 15.3 of the Model Grant Agreement will be applied.

For the call closing in 2018 'R&I Actions' in the following three sub-topics will be called for. Proposals should address only one of these sub-topics.

- i. Privacy and trust enhancing technologies: as sensors, objects, devices, AI-based algorithms, etc., are incorporated in our digital environment, develop robust technologies to help users increase trust, usability and to achieve greater control when sharing their personal data, attributes and information.
- ii. Decentralized data governance: leveraging on distributed open hardware and software ecosystems based on blockchains, distributed ledger technology, open data and peer-to-peer technologies. Attention should be paid to ethical, legal and privacy issues, as well as to the concepts of autonomy, data sovereignty and ownership, values and regulations.
- iii. Discovery and identification technologies: to search and access large heterogeneous data sources, services, objects and sensors, devices, multi-media content, etc. and which may include aspects of numbering; providing contextual querying, personalised information retrieval and increased quality of experience.

'R&I Actions' should encourage, when relevant, open source software and open hardware design, access to data, standardisation activities, access to testing and operational infrastructure as well as an IPR regime ensuring lasting impact and reusability of results.

The Commission considers that proposals requesting a contribution from the EU of EUR 7 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts. As a reference, 80% of the EU funding should be allocated to financial support to the third parties, through projects typically in the EUR 50 000 to 200 000³⁴ range with duration of 9 to 12 months. Each 'R&I Action' is expected to run several cycles of third party projects, which requires an overall duration of 24 to 36 months. The best performing and most promising third party projects shall be entitled to participate in several funding cycles, thus receiving longer support.

In the call closing in 2018, at least one proposal will be selected in each of the three sub-topics. Another three sub-topics will be identified for the forthcoming call closing 2019; the new sub-topics will be published by the European Commission in the update to the work programme 2019 that will be done before the call is published.

b) Coordination and Support Actions

Coordination and Support Actions are called for in the following three sub-topics. Proposals should address only one of these sub-topics. At least one proposal will be selected in each of the three sub-topics.

- iv. 'Technology Strategy & Policy': will engage leading-edge Internet stakeholders and will identify emerging research trends and policy needs, through a continuous public online consultation, open stakeholder engagement, fora and debates, and data analysis. It should also use the most innovative approaches and technologies, and unconventional ways to maximise involvement of those stakeholders who are new to community programmes and who will actually drive the evolution of the Internet. It should map and cooperate with national/regional initiatives and global activities where relevant. Driven by actors with a solid background and standing in today's NGI community, it aims at sustainability right from the beginning. It will be the intellectual spearhead of the 'Next Generation Internet – An Open Internet Initiative' and will closely engage with the other actions supported in this topic.

These activities could partially be implemented through small prizes; the maximum budget the project can devote to prizes is Euro 300.000. For grants awarded under this sub-topic beneficiaries may provide support to third parties as described in part K of the General Annexes of the Work Programme. The support to third parties can only be provided in the form of prizes. The respective options of Article 15.2 and Article 15.3 of the Model Grant Agreement will be applied.

The Commission considers that proposals with a duration of three years and requesting a contribution from the EU of EUR 3 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other durations or amounts..

- v. 'Technology Harvest & Transfer': will support 'R&I Actions' and their third parties in ensuring the best use of the outcomes created by delivering specific exploitation strategies, including follow-up investment opportunities, industry relations, IPR/knowledge transfers, tech-transfer services to digital innovation hubs, mentoring / coaching services and linkage to national IPR exploitation programmes, in a most innovative and effective way. It will also support impact assessment at the level of the 'Next Generation Internet – An Open Internet Initiative' topic.

The 'Technology Harvest & Transfer' action shall start no earlier than 6 months after the start of the first 'R&I Actions' in 2018. The Commission considers that proposals with a duration of three years and requesting a contribution from the EU of EUR 2 million would allow this specific challenge to be

addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other durations or amounts.

- iv. 'Outreach Office': will execute the programme communication strategy, branding and marketing activities, including extensive online and social media presence and events, establishing a positive brand image among young researchers, innovators, policy makers and people at large. Centralised, more efficient and professional, it will lead communications towards the outside world but also coach all actions under this topic in effective communications and marketing.

The Commission considers that proposals with a duration of three years and requesting a contribution from the EU of EUR 2 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other durations or amounts.

Expected Impact: Proposals should provide appropriate metrics for the claimed impacts.

- Shape a more human-centric evolution of the Internet.
- Create of an European ecosystem of top researchers, hi-tech startups and SMEs with the capacity to set the course of Internet evolution.
- Generate new business opportunities and new Internet companies with maximum growth and impact chances.
- For sub-topics i, ii and iii: Integrating research and innovation communities; development of common visions and enhanced science – industry collaborations in each of the technology domains..
- For sub-topic iv: European research and innovation leaders driving the debate for a human-centric Internet research and policy strategy..
- For sub-topic v: New Internet applications / services, business models and innovation processes strengthening the position of European ICT industry in the Internet market..
- For sub-topic vi: global visibility in the media of the debate on a human-centric Internet; citizens' priorities influencing the evolution of the Internet.

Type of Action: Research and Innovation action, Coordination and support action,

The conditions related to this topic are provided at the end of this call and in the General Annexes.

ICT-30-2018-2020: Interactive Technologies *

Specific Challenge: Interactive technologies such as Augmented (AR) and Virtual Reality (VR) are set to transform the ways in which people communicate, interact and share information on the internet and beyond. This will directly impact a larger number of European industries ranging from manufacturing, data life cycle, healthcare, engineering, to education, entertainment, media and culture, enabling new

business opportunities. The challenge is to forge a competitive and sustainable ecosystem of European technology providers in interactive technologies.

Scope: The scope includes: 1/ support a pan-European coordination effort to strengthen the collaboration among the constituency; 2/ increase the European innovation capacity through the development of new authoring tools and the access to a broader community;

a) Interactive Community Building (CSA)

To better coordinate European stakeholders the focus should be on:

- elaborating a common research agenda and a technology transfer strategy;
- building a platform to gather and share knowledge, algorithms and tools for the development and use of new interactive technologies. This may include the development of a dedicated open operating system;
- providing broad access and technical support for the platform as well as promoting its existence and establishing links with other existing platforms;
- supporting research and development teams in the integration of their tools into the platform. The task may involve financial support to third parties, in line with the conditions set out in part K of the General Annexes. Maximum 2M€ funding could be dedicated to it, with EUR 50.000 to 100 00036 per party.

This action should result in a unique access point for innovators, SMEs and industrial companies interested in taking-up European interactive technologies in their product and services development. The Commission considers that proposals requesting a contribution from the EU of EUR 3 million would allow this area to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

b) Future interaction (RIA)

To strengthen European research and industrial capacities the research and innovation actions should focus either on:

- Better exploiting opportunities offered by multi-user interactions, researching and developing technologies augmenting human interaction in groups within both professional and private contexts.
- Or developing future interactive systems offering higher quality experiences, for instance through systems which are mobile, support additional senses, have higher accuracy or incorporate bio or environmental sensors.

The Commission considers that proposals requesting a contribution from the EU of between EUR 2 and 4 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Expected Impact:

a) Establish a sustainable competitive ecosystem of European technology and solution providers for interactive technologies.

b) Strengthening European research and industrial capacities to develop future interactive devices.

Type of Action: Coordination and support action, Research and Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

ICT-31-2018-2020: Artificial Intelligence *

Specific Challenge: Artificial Intelligence (AI) is a key technology for the further development of the Internet and all future digital devices and applications. Driven by the wider availability of large amounts of data and increasingly higher performance computing and networking, AI brings additional autonomy to all types of physical and virtual artefacts and opens the door to a wave of innovations and opportunities. It is already transforming important sectors ranging from data analytics and Web platforms up to driverless vehicles and new generation of robots for our homes, hospitals, farms or factories.

The challenge is to fully exploit the potential of AI in the economy and society. Building notably on Europe's Scientific and Technology strengths in the field, the supported activities should reinforce industrial competitiveness across all sectors including for SMEs and non-tech industries and help address societal challenges (e.g. ageing, transport). The focus is on R&I areas in AI where collaborative work at European level can make a difference amidst the fierce world-wide competition in the field. The ambition is therefore to make AI technologies and resources available to developers and innovators in all sectors and actively engage with a wide user community, including non-AI experts.

Scope: The ultimate goal is a European AI-on-demand platform mobilising the European AI community to support businesses and sectors in accessing expertise, knowledge, algorithms and tools to successfully apply AI thereby generating market impact:

- serve as a central point to gather and provide access to AI-related knowledge, algorithms and tools;
- support potential users of AI in order to facilitate the integration of AI into applications;
- facilitate the interaction with existing data portals needed for AI algorithms, and resources, such as HPC or cloud computing, and support interoperability.

Research and Innovation Action - Building a European AI on-demand platform

The goal is to develop a European AI ecosystem bringing together the knowledge, algorithms, tools and resources available and making it a compelling solution for users, especially from non-tech sectors. The action should build on and link to existing relevant initiatives, including for instance existing platforms, data repositories, cloud computing, HPC. Proposals will be expected to plan efforts

to connect and cooperate with the DIHs, Pilots and other relevant activities of this work programme, as appropriate. The action called for is expected to include the following activities:

- Mobilising the European AI community including researchers, businesses and start-ups to provide access to knowledge, algorithms and tools;
- Defining sustainable processes and structures (governance, access, business models, licensing, etc.) as well as developing a suitable software infrastructure (APIs and tools to aggregate existing tools and algorithms and to make them easily deployable in applications, as well as to access data and computing resources);
- Filling important technology gaps through challenge-based and/or user-driven research and innovation efforts. These efforts could have an application or technology focus, covering major domains such as robotics, IoT, CPS, intuitive interfaces, personalised applications, healthcare, manufacturing or agriculture;
- Gathering user requirements: based on representative set of its future users (researchers and industry). In particular, the research and innovation efforts expected from this action will have strong synergies with the platform building (providing user requirements, guiding its development, exploiting its resources, and contributing to its content.) but additional efforts might be necessary to ensure that the needs of the various types of potential users of the platforms are represented;
- Putting in place a comprehensive service layer to facilitate the use and uptake of the platform both by end-users and researchers.
- Reaching out to new user domains and boosting the use of the platform. The task may involve financial support to third parties to fund promising projects using the platform, in line with the conditions set out in part K of the General Conditions. Maximum 3M€ funding could be dedicated to it, with 50k€ to 200k€ per third party;
- Developing a Strategic Research and Innovation Agenda for AI including ELSE aspects, taking into account and building on relevant initiatives and strategies (e.g.: Big Data PPP, Robotics PPP, AIOTI , CPS (CyPhERS), cybersecurity cPPP).

The Commission considers that proposals requesting a contribution from the EU of up to 20 million € would allow this area to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Expected Impact:

- Building a sustainable AI-on-demand platform, becoming a reference, mobilising the entire European AI community, and ensuring a leading position for Europe in AI.
- Reinforcing European excellence and leading position worldwide in major research and application domains, especially through the research and innovation efforts to fill important technology gaps.

- Boosting technology transfer of AI, especially towards SMEs and non-technology sectors, and disseminating the economic benefits of AI to a large user base.

Type of Action: Research and Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

ICT-32-2018-2020: Internet of Things *

Specific Challenge: Internet of Things (IoT) technologies and applications are bringing fundamental changes to all sectors of activity and are therefore an essential element of the Next Generation Internet. The challenge is to leverage EU technological strength to develop the next generation of IoT devices and systems that build on enhanced sensing/actuating, reasoning capabilities and computational power to the edges, but also new capabilities on the backend, such as artificial intelligence, deep semantic interoperability and novel contractual arrangements like Blockchains..

Scope: **Coordination and Support Actions**

A support action which will support IoT policies under the Digitising European Industry strategy especially in the context of human-centered IoT. In particular, it should analyse and evaluate security and privacy concepts across on-going and new European projects and initiatives in the IoT Focus Area and carry out trend scouting for future research and innovation policy through liaising with academic, industrial and policy stakeholders. The approach should include to build and sustain a vibrant network of IoT technology providers in Europe as well as ensuring the end-user trust in the security concerns as well respect for privacy.

The CSA will analyse and compile trends in IoT research and innovation with the aim to define research roadmap for future IoT related activities. The CSA shall evaluate and take into account emerging business models and shall support consensus building both with suppliers and users across Europe. It shall disseminate and seek support for results from a broad range of stakeholders in the IoT domain and relevant areas of the Next Generation Internet (NGI) initiative.

The Commission considers that proposals requesting a contribution from the EU of EUR 1.5 million would allow this area to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Expected Impact:

- Broad consensus on a strategy on human-centred IoT evolution improving usability and user acceptance, notably through strengthened security, privacy and user trust.
- Identified roadmap that enables taking the right measures to put Europe in the lead for IoT research and innovation through a long-term evolution of IoT platform strategy and through scientific progress enabling novel, future semi-autonomous IoT applications.
- Capacity to create and sustain a vibrant technology cluster involving all stakeholders including industry, technology, and end-users.

Type of Action: Coordination and support action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

ICT-33-2018: Future Hyper-connected Sociality

Specific Challenge: Future social networks, media and platforms will become the way our societies operate for communication, exchange, business, creation, learning and knowledge acquisition. The challenge is to mobilise a positive vision as to the role that Social Media will increasingly play in all these areas, and to overcome today's critical issues about trust and governance through democratic reputation mechanisms, and user experience.

Scope: Analysing and building the foundation of next generation Social Media platforms towards a "Global Social Sphere", based on peer-to-peer/decentralised, community approaches and free/open source principles. This foundation shall enhance the role of prosumers, communities and small businesses, mastering technological barriers, introducing innovative and participatory forms of quality journalism, and using various data in a secure manner. These activities should contribute to overcome the current accumulation of power by central intermediaries often located outside Europe. Proposals are invited for one of the following four subtopics:

Innovation Action

Trustful and Secure Data Ecosystem for Social Media and Media.

a) **Content verification** - Development of intermediary-free solutions addressing information veracity for Social Media. The solutions to be developed shall contribute to the understanding of information cascades, the spreading of information and the identification of information sources, the openness of algorithms and users' access to and control of their personal data (such as profiles, images, videos, biometrical, geolocation data and local data). Proposals are expected to develop and pilot solutions with a large existing community of citizens, and consortia may include inter alia partners from media, social media, distributed architectures, security and blockchain developers. Linked to this and in order to allow mastering better the complexity for users of Social Media, a Digital Companion interaction component may also be realised. The actions on this subtopic will cooperate for setting-up the basis of an observatory as described in c).

b) **Secure Data Ecosystem** - Creation of media and social media data business and innovation ecosystem to ensure privacy and secure sharing, as well as fair trade of federated media relevant data produced by media, social media and operators from other industrial sectors across Europe. The involvement of non-media sectors is considered critical to achieve volume and variety of data sets comparable with the ones of leading content aggregators. The action should address the necessary technical, organisational, legal and commercial aspects of data sharing/brokerage/trading to enable data-driven services. The action must also develop pilots to demonstrate the potential and sustainability of the federated data solution.

Research and Innovation Action

c) Support of new Social Media initiatives, and transition to peer-to-peer federated social networks based on smart decentralised architectures. This should be carried out by multidisciplinary and cross-sectorial consortia (technologist, sociologists, artists,...), including inter alia academic and industry partners focussing on web media, platform and application development. Proposals should include the creation of an open decentralised platform exploiting the added value derived from data aggregation and data analytics, exploring possible applications of blockchain technologies and enabling the development of innovative services and novel forms of distribution of media content. This includes research and innovation on open API, interface design, content production, consumer/prosumer business models including crowd-sourcing models for identification and rewarding of user generated content, open management and portability of profiles, gaming and art aspects. Proposals may also consider aspects of a “Social Networks of Objects”, integrating latest European advancements on smart objects, big data, autonomous systems, real-time geolocation⁴² and augmented/virtual reality. Proposals should include demonstrations and validation, also leveraging on concepts and technologies addressed elsewhere in the NGI programme.

Coordination and Support Action -

d) Support of Social Media ecosystem community building between different Social Media actors such as developers, designers, users of all ages, artists, entrepreneurs, researchers, at European and national level, also linking to important international initiatives. This should include a dynamic app-based tool for community-mapping and an analysis of a future hyper-connected society, considering societal, economic, educational, legal and community-based self-regulation aspects. In addition, the action shall establish with actions on Content Verification under subtopic a) the basis for an observatory on information veracity and best Social Media practices.

The Commission considers that proposals requesting a contribution from the EU of maximum 2,5 MEUR for subtopic a), 5 MEUR for subtopic b) and c) and 1 MEUR for subtopic d) would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

At least one proposal will be selected for each subtopic. Proposals should clearly state which subtopic they address.

Expected Impact:

- Increased trust and improved governance and value for Social Media and Media
- New federated Social Media platforms and innovative media data driven services
- Societal change towards digital literacy and citizen participation

Type of Action: Innovation action, Research and Innovation action, Coordination and support action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

ICT-35-2018: A multilingual Next Generation Internet

Specific Challenge: The activities under this topic will support technology-enabled multilingualism for an inclusive Digital Single Market. Every European should be able to access content and engage in written and spoken communication activities without language being a barrier. Content and services, such as those provided by public administrations, are not available in multiple languages. Linguistic fragmentation means that many citizens and businesses cannot fully engage in online activities and benefit from online content and services. The sheer volume of content, the diversity of content types and modalities as well as the diversity of languages in Europe makes the effective roll-out and provision of multilingual solutions challenging.

Scope: The actions will address technological challenges (for language resources and interoperable language tools) and support coordination and networking by exploiting excellences and synergies with activities carried out in the Member States. They will push research results to those who need them and support technology transfer and breakthroughs.

a) Innovation Action: A European Language Grid

The action shall:

- i. develop the architecture and components for a public, open and interoperable grid connecting resources and tools, sharing and combining resources to support effective development and deployment of language technologies (software and services) across Europe. It shall provide easy access to basic natural language processing tools and services for European languages. The action shall cater for both consolidation of existing and a seamless inclusion of new resources and tools available for free or/and for a fee, enabling providers to control access rights reflecting their policies. The end-users of the grid shall be closely involved in the process.
- ii. coordinate the work of the European Language grid and all actions supported under this topic and address the interoperability issues. It shall identify barriers for deploying multilingual services and establishing language infrastructure at European scale, including any skills gap. The action shall address the legal and organisational obstacles, facilitate coordination between various European, national and regional activities through a structured dialogue and the establishment and exchange of best practices.
- iii. pilot the European Language Grid in specific sectors of high commercial and/or societal impact, through small scale demonstrators geared towards an innovative integration of language technologies in specific operating processes/operations. The action shall provide facilities for collaboration, technical and linguistic guidance, access to open-source tools and open language resources (available through the grid), access to venture capital, and promotion and dissemination events. The results of all small scale demonstrators should be made available through the European Language grid under appropriate licensing conditions. The action shall select these small scale demonstrators through the use of financial support to third parties. Up to 30% of the EU funding of the action should be allocated to the financial support of these third parties, typically of the size of

EUR 100 000 to 200 00043 and a duration of about 9 to 12 months. Financial support to third parties should in line with the conditions set out in Part K of the General Annexes.

iv. establish competence centres / nodes in Member State. It shall build on the previous EC-funded actions within the FP7, H2020 and CEF.

The Commission considers that proposals requesting a contribution from the EU of about 7 million would allow this area to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

b) Research and Innovation Action: Domain-specific/challenge-oriented Human Language Technology.

The actions shall advance the state of art in Human Language Technologies through well-identified mission-oriented challenges involving researchers and industrial users of language technologies. Each proposal should address a specific sector of high commercial and/or societal impact or a technological challenge common/relevant to several sectors. Proposers should include a detailed analysis of the expected advances in terms of language technology-related research. The actions should address concrete real-life issues defined by industrial users. The proposals must convincingly argue the demand for the proposed solution and provide clear indicators to benchmark the research results. The projects shall create a sustainable ecosystem of multilingual applications and services tailored for the specific needs of the addressed sector.

The Commission considers that proposals requesting a contribution from the EU of about 3 million would allow this area to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Expected Impact:

- Provide European research and language technology industry with a better access to and usage of quality language resources and tools;
- Increase in the quality and coverage of multilingual solutions used by industrial players in sectors relevant to the emergence of the Digital Single Market;
- Increase in the uptake of language technologies in Europe in various sectors;
- Cost savings for private and public sector users of language technology solutions.

Type of Action: Research and Innovation action, Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

ICT-36-2019-2020: An empowering, inclusive Next Generation Internet *

Specific Challenge: Every citizen, from all walks of life, should be able to fully take part in the Digital Single Market. This means that the Next Generation Internet will have to empower users, including its

most vulnerable or disabled one, to have access to the same digital learning opportunities, in forms that are accessible, perceivable and understandable by everybody.

Scope: The objective is to support actions on smarter, open, trusted and **personalised learning** solutions to optimise digital learning and to allow learners to engage and interact with content and with peers.

a. Innovation Action: Digital Learning Incubator

The objective of this action is to advance **personalised and inclusive digital learning** through a fast-paced adoption cycle of technological and methodological solutions. The work will build on cross-links and advances in the various NGI technologies (such as machine-learning, AR/VR, AI) research fields and foster synergies between all the relevant market players, researchers and educational agents working on promising and innovative products. The action will be based on a "push and pull" strategy whereby the research actors push the best research projects to enter the innovation cycle and the market actors pull for the ideas with best market traction.

The action will:

- set up an Incubator bringing together all relevant stakeholders to form strategic alliances that can jointly achieve fast-paced breakthroughs in the area of personalised and inclusive learning online. The Incubator will allow fast-track experimentations in form of small scale projects, providing access to knowledge, research prototypes, learning resources and data to parties interested to conduct these experimentations..
- launch calls for highly promising small scale projects to work on a topic/challenge set out in a roadmap. It shall foresee suitable arrangements for enabling an environment for conducting the competitive evaluation.

The action shall select these small scale projects through the use of financial support to third parties.. Up to 90% of the EU funding of the action should be allocated to the financial support of these third parties, typically of the size of EUR 100 000 to 200 000⁴⁶ and a duration of about 9 to 12 months. Financial support to third parties should in line with the conditions set out in Part K of the General Annexes.

The Commission considers that up to 1 proposal requesting a contribution from the EU of around 7 million would allow this area to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

b) Coordination and support action in the area of Digital Learning

The action will:

- stimulate the collaboration between all EU-funded FP7 and H2020 projects on digital learning, analyse the outcomes and best practices carried out in these projects, support the

dissemination of their results as well as ensure their integration within the Next Generation Initiative and link with other support measures.

- identify: a) emerging research challenges, notably those arising from digital certification of learning outcomes and blockchain technologies and their uptake for a more inclusive and personalised learning; b) address legal, organisational and technological challenges underpinning the uptake of the proposed solutions, notably in relation to their scalability; c) make policy recommendations in view of the priorities of the next programme for research, innovation and deployment.

The Commission considers that proposals requesting a contribution from the EU of around 1 million would allow this area to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Expected Impact:

- Increase in the overall uptake of technology for personalised and inclusive learning for all.
- Increase in the number of distributed learning solutions for children with special educational needs.
- Increase in the number of start-ups/SME's deploying personalised and inclusive learning solutions to the market.

Type of Action: Innovation action, Coordination and support action,

The conditions related to this topic are provided at the end of this call and in the General Annexes.

ICT-43-2018-2019: EU-US collaboration on NGI

Specific Challenge: Building upon the EU-US collaboration in previous work programmes in the area of research experimentation, the aim is to reinforce cooperation and strategic partnerships in the area of Next Generation Internet, to establish a continuous dialogue among the key actors in the US and European programmes and to implement focused projects for joint developments. Proposals shall foresee twinning with entities participating in projects funded by the US to exchange knowledge and experience and exploit synergies. This collaboration will be implemented in accordance with the "Implementation arrangement between the European Commission and the government of the United States of America for cooperation between researchers funded separately by the European Union's and the United States framework programmes on research and innovation" signed on 17 October 2016.

Scope:

a) Coordination and Support Actions.

Proposals should cover one of the following bullet points:

- Organise workshops and other support activities: to facilitate the coordination of research and innovation initiatives in the EU and US, and to promote collaboration between the research groups. Create a Next Generation Internet open ecosystem engaging relevant initiatives and key actors from the EU and the US.

- Fellowship programme: support 3 to 6 months fellowships for Internet researchers from industry, research centres or academia. The project will only provide financial support for travel and subsistence, and only citizens of the EU and associated countries will be eligible for funding. For grants awarded under this topic for the fellowship programme beneficiaries may provide support to third parties as described in part K of the General Annexes of the Work Programme. The support to third parties can only be provided in the form of grants. The respective options of Article 15.1 and Article 15.3 of the Model Grant Agreement will be applied.

The Commission considers that proposals requesting a contribution from the EU of EUR 1 million for the first area of this sub-topic (Organise workshops and other support activities) and of EUR 1.5 million for the second area of this sub-topic (Fellowship programme) would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts. At least one proposal will be selected in each of the two areas of this sub-topic.

b) Research and Innovation Action.

Common experiments by EU/US teams on emerging topics for the Next Generation Internet / Tomorrow's Internet programmes on top of EU/US experimental platforms.

For grants awarded under this topic for Research and Innovation actions beneficiaries may provide support to third parties as described in part K of the General Annexes of the Work Programme. The support to third parties can only be provided in the form of grants. The respective options of Article 15.1 and Article 15.3 of the Model Grant Agreement will be applied. Only organisations established in the EU and associated countries will be eligible for European Commission funding.

The Commission considers that proposals for Research and Innovation actions requesting a contribution from the EU of EUR 3.5 million would allow this specific challenge to be addressed appropriately. As a reference, 80% of the EU funding should be allocated to financial support for the third parties. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Expected Impact: Proposals should provide appropriate metrics for the claimed impacts.

- Enhanced EU – US cooperation in Next Generation Internet, including policy cooperation.
- Reinforced collaboration and increased synergies between the Next Generation Internet and the Tomorrow's Internet programmes.
- Developing interoperable solutions and joint demonstrators, contributions to standards

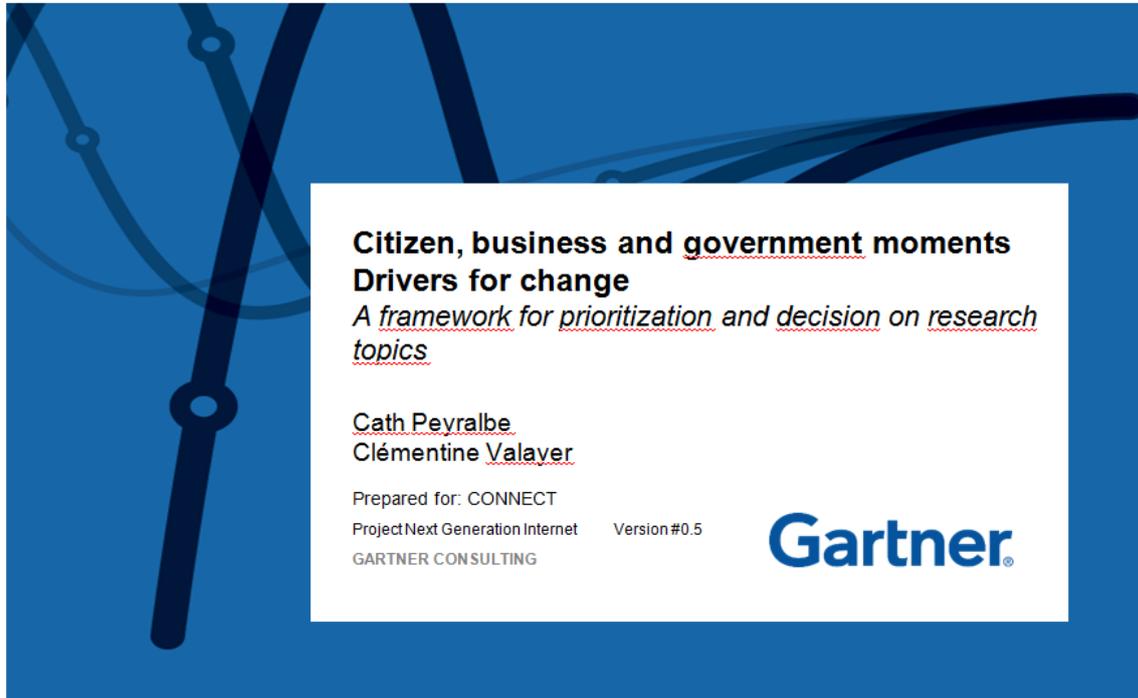
- An EU - US ecosystem of top researchers, hi-tech startups / SMEs and Internet-related communities collaborating on the evolution of the Internet.

Type of Action: Coordination and support action, Research and Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

Annex 6. Presentation of prioritization framework

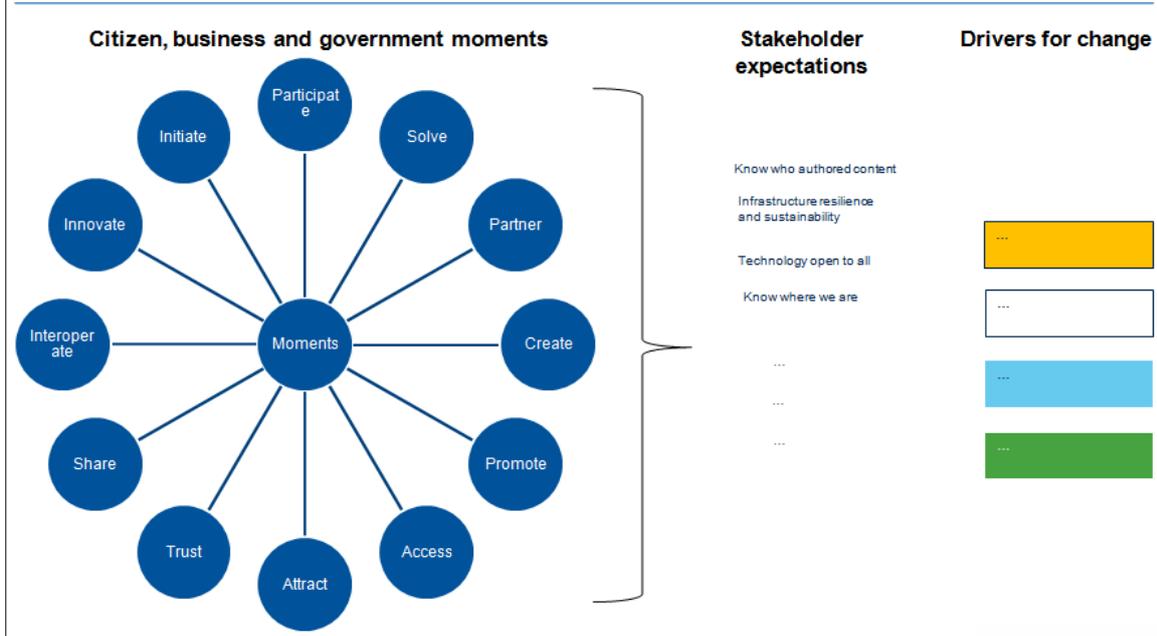
The slides presented below were presented to the European Commission staff on July 12 2017:



A more technology/trend driven ISOC view



Citizen, business and government moments set NGI stakeholder expectations and drivers for change



Citizen, business and government moments

| Citizens | Business | Citizens | Business | Citizens |
|---|--|--|----------|----------|
| | | | | |
| Participate | Solve | Partner | | |
| <p>Citizens actively participate in a the legislation processes and are granted high political self-determination.</p> <p>Examples are easy voting and other participatory and awareness moments leading to inclusive and regular citizen participation in political decisions. Such participation includes creating legislation, reviewing decisions, etc.</p> | <p>Citizens and businesses actively join local communities, which focus on issue solving and community management, and ensure that the main stakeholders can have a say, provide ideas and concrete solutions.</p> <p>Examples are smart cities or regions communities, local citizen communities, schools communities etc.</p> | <p>Government has become a partner of citizens and businesses for all their digital moments.</p> <p>Various levels of authority ensure that regulations and policies exist to enable and foster online exchanges and positive outcomes.</p> <p>Government also builds awareness about them and monitors their effectiveness and efficiency.</p> | | |

Citizen, business and government moments



Create

Citizens, researchers, students can turn an innovative idea into an economic opportunity/ reality.
 Citizens can launch a new business online in a fair way, without discrimination of any kind, for example, by being able to **create new business models** supporting innovation.
 Businesses can generate online revenue, become economically viable, especially at the start.



Promote

Citizen launching a business and/or an innovation are easily able to promote their new business/ service or idea.
 They can manage the **discoverability** of their business/idea efficiently.



Access

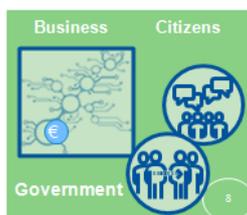
Businesses are granted access to data in a fair way – such as monitoring remote sensor information – to reuse it for delivering services.
 All clients of a business can easily have access to all updates in terms of service in a clear and transparent way.
 Citizens can choose to filter data according to ethical and/or personal preferences.

Citizen, business and government moments



Attract

Business (small, large, old, new) can easily **attract** clients and other businesses to their online information and to their collaborative / community interactions.
 Citizens and businesses stay online and actively use and benefit from the information – this engagement is a consequence of their shared interest in information and its exchange.



Trust

Citizens and business can look for and find reliable information, and have a level of confidentiality related to the subject.
 They know what is reliable and what can be treated with a level of doubt as well as what is not.
 The reliability of the information threads (information and discussions build on other information) is easy to **analyse**.
 For specific information, the author can be recognized as authoritative sources (pollution level measures, other environmental data) either by government or by **authorised** bodies.



Share

Citizens and businesses can decide what they want to share (health information from personal data or patient records, education data for instance) and with whom (specific communities).
 Opting out is possible any time for any online service. Safeguards exist and are clearly understood to diminish privacy risks.
 For specific citizen segments (children, people in need of special care, elderly and non tech savvy people), this can be done by third parties.

Citizen, business and government moments

Interoperate

Businesses and governmental bodies easily **collaborate and partner** with each other. The Internet as a platform allows to create specific business and intra governmental platforms which interoperate with low cost/friction and the freedom to switch vendors.

Innovate

Citizens, students, researchers, businesses can have innovative ideas and simply and securely promote them. Anybody can understand from whom and where the idea came from and follow how it is evolving and spreading. Anybody can comment and enrich Idea generation: people can decide in which communities to expose their ideas to and discuss them with.

Initiate

Citizens or businesses can take initiatives in extending/ improving the Internet infrastructure and experiment on it. Citizens or businesses can easily and without cost barriers extend existing Internet service or introduce new ones. Anybody from anywhere knows who has done what and can leverage it. There are no regulatory barriers limiting the changes as far as they are in line with ethics and privacy

Drivers for change

| Citizen, business and government moments | Drivers for change | | | | | | | | | | | | | |
|--|--------------------------|--|---------------------|---------------------------|------------------------|-------------------------------|-------------------|--|------------------------|--|---|---|------------------------------|--------------------------------|
| | Stakeholder expectations | Infrastructure/ Technical remediation | Trustworthiness | Inclusiveness | User centricity | | | | | | | | | |
| | Technology reliability | Infrastructure resilience and sustainability | Know who someone is | Know who authored content | Chosen to be anonymous | Choose who you are visible to | Know where we are | Anybody can access and use from anywhere at any time | Technology open to all | Low cost of use - no cost or fair cost | Know that transactions and exchanges are secure | Low business entry threshold (internet.com) | Proactive digital assistance | Intuitive - no training needed |
| Participate | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Solve | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Partner | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Create | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Promote | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Access | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Attract | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Trust | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Share | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Interoperate | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Innovate | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Initiate | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |

- ### What's next?
- Stakeholder expectations support the definition of the research agenda
 - ✓ For example, "Know where we are" is a challenging research topic
 - Prioritization of research topics is done based on stakeholder expectations
 - Drivers for change are part of the NGI Vision

Annex 7: Online Platform

Introductory text

In order to support the study, a consultation was held. The consultation had a number of modalities, one of which was an online tool available at <https://nlnet.nl/NGI>.

The online tool starts with a general explanatory text that gives relevant background information on the Next Generation Internet initiative, and what the consultation is about. The text aims to create a sense of urgency, and points out the opportunity that the NGI initiative brings.

Tell us how to change the Internet for the better

Next Generation Internet

[Go to the online tool](#)

Introduction

The internet is a technology 'commons' unlike anything before – a shared benefit and shared responsibility for all of its users. It was never designed to perform the tasks it is expected to perform, and it is certainly not future proof as-is.

We need to do better in making sure that the internet as a shared global technical and social infrastructure is able to carry its heavy responsibility. This is especially relevant as we are about to embark on fascinating new journeys where we depend entirely on a safe, secure and open internet as a carrier - including an expected flood of connected devices on the outside and inside of our bodies, vehicles, buildings and infrastructure.

Trust at a global scale does not come for free: at the heart of sustainable trust lies actual **trustworthiness** that requires significant investment of time and resources. Research shows that while users may not always understand the way the technology works, they understand very well that the internet they want and need is an open, reliable internet that they can trust without any reservation whatsoever.

In recent years it has become all too clear that in addition to the obvious scalability issues there are many unforeseen persistent security and privacy challenges. Many of the challenges can be solved, and in fact working solutions are often known, but the transition at internet scale requires a systemic approach in addressing deep underlying technical issues, creating transition mechanism - as well as (in some cases) changing legal and governance parameters.

Introducing the Next Generation Internet initiative

This complex and precarious situation won't fix itself, and needs significant research investment as well as a concerted strategic effort. If we want people to trust the internet with – in essence – their private and social lives, as well as their business and government, the technology itself needs to be entirely trustworthy. The European Commission's DG CONNECT is therefore embarking on the **Next Generation Internet** initiative.

The NGI initiative wants to support the creation of an internet that supersedes the current internet, which supports citizens and businesses push further the frontiers of technology, an internet which retains people's trust in the online environment as well as their internet engagement, which is more human-centric and which offers the same fair opportunities to everyone (level playing field). Europe aims to shape this future Internet as a powerful, open, data-driven, user-centric, interoperable platform ecosystem.

Which brings us to **you**, to the **here** and **now**. If you were given the opportunity to suggest funded research and development, what would you suggest to make the Internet better? The key thing we ask you to help us with, is to understand the issues and possible approaches to solve them.

In short:

“what do you believe are the actionable issues we as the Internet's stakeholders should collectively solve to be ready for the future?”

[Go to the online tool](#)

Input tool

From the landing page with the introductory text (or directly via <https://nlnet.nl/NGI/yourinput.xml>) the user is presented with the choice of four different types of input:

1. The respondent has knowledge of an issue on the internet that needs to be fixed
2. The respondent can indicate if a solution commonly believed to work will actually fail or cause trouble
3. A solution is available, but an additional effort (such as implementation in specific open source applications) has been identified by the respondent
4. The respondent has a specific scenario he or she wishes to share

Each choice will lead to a unique trajectory for the remainder. No unnecessary or redundant questions should be answered, in order to reduce the time burden on the respondents and avoid that they stop filling out the form. The strategic choice was made to ask for 'deep' input on a single topic, rather than a lengthy form that asks more questions than people are willing to answer in detail. The form responds near-instantly also in circumstances where the connectivity is not so good, through the use of W3C XForms – at the end the data is sent to the server when the user submits. Prior to that the entire form is rendered client-side, so there is no continuous traffic sending each keystroke to the server. As a webstandard, XForms is also *inclusive* and *accessible*.

Next Generation Internet

The internet of our future is an integral part of the very fabric of society.
It acts as a public space, as a carrier of intimate private communication and as the vehicle for large scale business.
If we want to create a Next Generation Internet, we need to understand and solve the most urgent issues of today's internet and how to make it future-proof – and collectively act as technologists, lawmakers and users.

How you can help...

| | | | |
|---|--|---|--|
| You have knowledge of a serious problem that the internet has, which urgently needs to be fixed | You know a 'solution' that is commonly believed to work, but which will actually fail or cause trouble | You know a viable (partial) solution that is not yet in full effect, and would need (specific) support to get more traction | You have a prediction or scenario to contribute. What will happen if certain trends continue |
|---|--|---|--|

Clicking on the **left-most bullet** (“*You have knowledge of a serious problem that the internet has, which urgently needs to be fixed*”) opens the branch where the respondent can identify an issue on the internet within their field of expertise that they know needs to be fixed.

The issue they choose to identify is the choice of the respondent: it could just be a solely technical issue, but could also point out the need for a certain policy or for specific regulatory measures that need to be taken.

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How you can help...

| | | | |
|---|--|---|--|
| You have knowledge of a serious problem that the internet has, which urgently needs to be fixed | You know a 'solution' that is commonly believed to work, but which will actually fail or cause trouble | You know a viable (partial) solution that is not yet in full effect, and would need (specific) support to get more traction | You have a prediction or scenario to contribute. What will happen if certain trends continue |
|---|--|---|--|

You have knowledge of a serious problem that the internet has, which urgently needs to be fixed

What problem do you see

Can you propose a solution or intervention strategy?

Next

Clicking on the **second bullet** from the left (“*You know a ‘solution’ that is commonly believed to work, but which will actually fail or cause trouble*”) opens the branch of the form where the respondent can (from their professional or personal expertise) report a solution that should be classified as ‘false hope’:

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How you can help...

| | | | |
|---|--|---|--|
| You have knowledge of a serious problem that the internet has, which urgently needs to be fixed | You know a 'solution' that is commonly believed to work, but which will actually fail or cause trouble | You know a viable (partial) solution that is not yet in full effect, and would need (specific) support to get more traction | You have a prediction or scenario to contribute. What will happen if certain trends continue |
|---|--|---|--|

You know a 'solution' that is commonly believed to work, but which will actually fail or cause trouble

What 'solution' (or 'solutions') will fail or cause trouble?

Can you propose a resolution?

Next

Clicking on the **third bullet** from the left (“*You know a viable (partial) solution that is not yet in full effect, and would need (specific) support to get more traction*”) opens the branch where the respondent can (from their professional or personal expertise) report a solution that has the potential to work but which needs some extra guidance or attention to deliver the final desired outcome:

Next Generation Internet

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If we want to create a Next Generation Internet, we need to understand and solve the most urgent issues of today's Internet and how to make it future-proof – and collectively act as technologists, lawmakers and users.

How you can help...

| | | | |
|---|--|---|--|
| You have knowledge of a serious problem that the internet has, which urgently needs to be fixed | You know a 'solution' that is commonly believed to work, but which will actually fail or cause trouble | You know a viable (partial) solution that is not yet in full effect, and would need (specific) support to get more traction | You have a prediction or scenario to contribute. What will happen if certain trends continue |
|---|--|---|--|

You know a viable (partial) solution that is not yet in full effect, and would need (specific) support to get more traction

What would need support to get more traction?

Can you propose any intervention strategy?

Next

Clicking on the **right-most bullet** (“*You have a prediction or scenario to contribute. What will happen if certain trends continue*”) opens the branch where the respondent can (from their professional or personal expertise) extrapolate on current trends to share her or his version of the future:

The Internet of our future is a integral part of the very fabric of society.
It acts as a public space, as a carrier of intimate private communication and as the vehicle for large scale business.
If we want to create a Next Generation Internet, we need to understand and solve the most urgent issues of today's Internet and how to make it future-proof – and collectively act as technologists, lawmakers and users.

How you can help...

| | | | |
|---|--|---|--|
| You have knowledge of a serious problem that the internet has, which urgently needs to be fixed | You know a 'solution' that is commonly believed to work, but which will actually fail or cause trouble | You know a viable (partial) solution that is not yet in full effect, and would need (specific) support to get more traction | You have a prediction or scenario to contribute. What will happen if certain trends continue |
|---|--|---|--|

You have a prediction or scenario to contribute. What will happen if certain trends continue

The NGI Initiative is about creating a trusted, reliable and accessible Internet at the service of users. This will not happen by itself. In order to understand what intervention logic is needed to reach that situation, you can help us by providing a scenario where you extrapolate current trends and accumulation of issues in a certain direction. This could involve any actor, whether commercial, public, not-for-profit, academic or civil society engaging (or no longer engaging) with the Internet. If you can contribute ideas for countering negative trends and issues, we are very interested in your approach.

What is your scenario?

How likely is this scenario?

[1] [2] [3] [4] [5]

Who do you believe should address the issues you identify?

Can you propose a solution?

Any further comments?

Next

The next step concerns capturing the self-classification of the input as described in paragraph 4.4, along with some (optional) information provided the respondent on his or her background. In some cases this is helpful or even necessary in order to understand a terse answer or resolve ambiguity. Likely a number of respondents on the form do not have English as a first language.

Note that this is the third step for any of the four branches, happening when the ‘next’ button at the bottom of the form is selected from the second step. One of the questions shows the logo’s for a number of the key communities identified by our study as particularly relevant for the NGI. The question that belongs with this, allows multiple answers on organisations the respondent is active in.

In addition respondents can tip the researchers with interesting persons that might have relevant input for the topic at hand.

Please help us better understand your idea and where it comes from.

How would you label your topic?

Select a suitable classification of your contribution, or select 'Other' to specify if you feel this is necessary.

How would you rate your own experience concerning this particular topic?

For the purpose of this survey, would you label yourself as:

Do you work with, or are you a member of any of these communities?



If we have any questions for further clarification, may we contact you?

by phone:

by email:

Keep me posted about the outcome on the above email address

Anyone we should contact?

Our approach in defining the research programme is as inclusive as possible. Please feel free to suggest the names of other stakeholders who you think should take part in this study.

Name:

Email:

Thanks! If you still have some time left, perhaps you can help us by providing some additional information

At this point the respondent is offered the choice to either finish the form (in case it has taken enough time) or to add some further detail (when the respondent is still motivated) to help the team triage the input:

- Is there any literature or relevant work (even just a blog article) that describes the problem(s) that would be solved in more depth?
- What would be the success criteria if your solution were selected?
- Could you put a ballpark figure price tag/estimate of required effort (in person months) to it?
- Does your idea need collaboration of one or more unique parties, or can multiple actors work on candidate solution(s) in parallel?
- Are there any organisations that should be notified should funding become available?
- Are there any obstacles to mass deployment once the technology is available, and if so, what should be done about them?

Thanks! If you still have some time left, perhaps you can help us by providing some additional information

Yes, I can add some more detail

Optional input to help us triage

Is there any literature or relevant work (even just a blog article) that describes the problem(s) that would be solved in more depth?

What would be the success criteria if your solution were selected?

Could you put a ballpark figure price tag/estimate of required effort (in person months) to it?

Does your idea need collaboration of one or more unique parties, or can multiple actors work on candidate solution(s) in parallel?

Are there any organisations that should be notified should funding become available?

Are there any obstacles to mass deployment once the technology is available, and if so, what should be done about them?

I'm done. Submit

Annex 8: Stakeholders

Stakeholder Associations and Groups

The following stakeholder groups were contacted.

Our starting point are the key stakeholders in the technical and operational community of the internet. As the people who run and maintain the current internet infrastructures across Europe, including the educational and research networks that operate on the cutting edge of technology, they embody the communities that the NGI will have to empower.

RIPE NCC

The RIPE NCC is an independent, not-for-profit membership organisation based in Amsterdam, the Netherlands. It was formed in 1992 and now supports over 14,500 members in its service region. It is the Regional Internet Registry (RIR) for Europe, the Middle East and parts of Central Asia. Its membership consists mainly of Internet service providers (ISPs), telecommunication organisations and large corporations located in Europe, the Middle East and parts of Central Asia. RIPE NCC provides Internet number resources, such as IPv4 and IPv6 address space and Autonomous System Numbers (ASNs) to its members. The RIPE NCC operates k.root-servers.net, one of the 13 Internet root name servers. It also offers other services related to the technical coordination of the Internet, and the benefit of the Internet community at large, such as the ATLAS project.

The RIPE NCC provides administrative support to Réseaux IP Européens (RIPE), a collaborative forum open to all parties with an interest in wide area IP networks and the technical development of the Internet. The RIPE NCC is an open and transparent, neutral and impartial organisation. It has no commercial interests or influences and operates as a bottom-up and self-governing organisation. This means that the policies and procedures that govern the way the RIPE NCC operates are proposed, discussed and accepted by its members and the RIPE community.

Council of European National Top Level Domain Registries (CENTR)

CENTR is the association of European country code top-level domain (ccTLD) registries, such as .de for Germany or .si for Slovenia. CENTR currently counts 53 full and 9 associate members – together, they are responsible for over 80% of all registered domain names worldwide. The objectives of CENTR are to promote and participate in the development of high standards and best practices among ccTLD registries. Full membership is open to organisations, corporate bodies or individuals that operate a country code top level domain registry.

The objectives of CENTR are to promote and participate in the development of high standard of Internet Country Code Top-Level Domain Registries (ccTLDs) for the benefit of its members and the Internet. The organisation has a European focus. Together with similar organisations with focus on other regions of the world, CENTR tries to achieve its objectives through consensus building,

coordination and collaboration; respecting cultural and historical variations amongst the ccTLDs and their Local Internet Communities.

European Internet Exchange Association

The European Internet Exchange Association (Euro-IX) gathers 83 IXPs around the world. It was formed in May 2001 with the intention to develop, strengthen and improve the Internet Exchange Point (IXP) community. A number of IXPs recognised a need to combine their resources in order to coordinate technical standards, develop common procedures, share and publish statistics and other useful information. This would in turn give all interested parties a better insight into the world of IXPs.

As an association of Internet Exchanges, Euro-IX promotes an open interchange of ideas and experiences by offering fora, meetings, mailing lists and online resources. Euro-IX also gathers information on regulatory issues affecting member IXPs within the Euro-IX region and where appropriate from other jurisdictions. With 80 member IXPs and their 7,000 connected customers, Euro-IX represents a large part of the European IP community and thus arouses the interest of politicians, regulators, vendors and other industry related sectors.

GÉANT

GÉANT is the association of European Research Networks. GÉANT is owned by its 36 National Members, which are European national research and education network (NREN) organisations, and one Representative Member - NORDUnet - which participates on behalf of five Nordic NRENs.

The development and progress in Internet technology, infrastructure and services have been led by the education and research community since the very beginning of the Internet. Today, that community is still a key driver of the further development of the Internet. In Europe, this leading role is made possible by the collaboration of network engineers and managers from all over the region, facilitated and supported by GÉANT. GÉANT was formed in 2014 when TERENA and DANTE joined forces and adopted the GÉANT name from the GÉANT Project, which continues to be a major area of the organisation's work.

GÉANT provides practical support for members, educators, researchers and other partners to collaborate, innovate, share knowledge and agree on policies and strategies. Many of the people who participate in GÉANT task forces, projects, conferences or workshops are not employees of GÉANT member organisations but work in the wider research networking community, for example, in universities, research institutes or in industry. This makes GÉANT the leading collaboration on network and related infrastructure and services for the benefit of research and education, contributing to Europe's economic growth and competitiveness.

Internet Society (ISOC.nl, ISOC Europe)

The Internet Society was formed in 1992 by Vint Cerf and Bob Kahn, two of the "Fathers of the Internet". The Internet Society's history and values reflect this founding lineage. Among its leadership and membership one can find many of the Internet's technical pioneers, innovators, and global

connectors. Its mission — to promote the open development, evolution, and use of the Internet for the benefit of all people throughout the world — mirrors the guiding principles that gave rise to and enabled the propagation of the internet. ISOC supports the development of fundamental Internet technology, as well as transparency and a multistakeholder, bottom-up approach in addressing global Internet governance issues. It is the parent organisation for a number of international technical bodies, including the IETF, which are engaged in the development of internet standards.

Internet Society is a member based organisation with more than 80,000 members and supporters, 113 Chapters around the world, as well as more than 143 Organization members, the Internet Society achieves change through partnership and expertise in policy, technology and communications. There is an ISOC chapter in almost every European country, with ISOC.nl being the largest European chapter - established in 1997. In 2010, a dedicated European Bureau was established in Brussels to serve as the focal point for the Internet Society's activities in the region.

EDRi

EDRi (short for "European Digital Rights") is an association that brings together 30 privacy and civil rights organisations from 19 different countries in Europe, and liaises with global organisations such as the Electronic Frontier Foundation. EDRi's objective is to promote, protect and uphold civil rights in the field of information and communication technology. This includes many issues relating to privacy and digital rights, from data retention to copyright and software patents, from the right to data protection and privacy to freedom of speech online, from privatised enforcement to cybersecurity.

EDRi was founded in June 2002 as a result of a growing awareness of the importance of policy making in the digital environment. EDRi was created to bundle expertise in the policy area, and to help identify ethical and legal issues related to the Internet, copyright and privacy with strong effect in Europe. EDRi provides a strong civil society voice and platform to ensure that policies affecting the digital environment are in line with fundamental rights.

Free Software Foundation Europe

Free Software Foundation Europe is a charitable association that empowers users to control technology. Software is deeply involved in all aspects of our lives; and it is important that this technology empowers rather than restricts us. Free Software gives everybody the rights to use, understand, adapt and share software. These rights help support other fundamental freedoms like freedom of speech, press and privacy.

The FSFE helps individuals and organisations to understand how Free Software contributes to freedom, transparency, and self-determination. It enhances users' rights by abolishing barriers to Free Software adoption, encourage people to use and develop Free Software, and provide resources to enable everyone to further promote Free Software in Europe.

FSFE is the driving force behind the Legal Network, the largest global neutral, non-partisan, group of experts in different fields involved in Free Software legal issues. Currently the Legal Network has over

400 participants from different legal systems, from industry, government, civil society and academia. FSFE was established in 2001.

World Wide Web Consortium (W3C)

The World Wide Web Consortium (W3C) is the independent standards setting organization for the World Wide Web that is developing protocols and guidelines that ensure the long-term growth of the Web. In W3C the private and public sector, civil society and other actors and stakeholders collaborate together on new protocols and guidelines. The coordination of web standards is handled by the W3C Technical Architecture Group. The Consortium has one of its four main seats at the European Research Consortium for Informatics and Mathematics (ERCIM) in Sophia Antipolis, France. In addition W3C also has World Offices in sixteen regions around the world. The W3C Offices work with their regional web communities to promote W3C technologies in local languages, broaden the W3C's geographical base and encourage international participation in W3C Activities.

The Internet Engineering Task Force (IETF)

The Internet Engineering Task Force (IETF) is an organized activity of the Internet Society (ISOC). In IETF the private and public sector, civil society and other actors and stakeholders collaborate together on new protocols and guidelines. Any project that is developing next-generation internet technology and wants to see it deployed at internet scale, will at some point have to engage with the IETF. The orthogonality of the design of internet standards within the IETF is enforced by the Internet Architecture Board (IAB). The IETF working groups are grouped into areas, and managed by Area Directors; the AD's are members of the Internet Engineering Steering Group (IESG). The IETF is an open community, and so while no-one can thus speak on behalf of the whole IETF, these committees have been established to lead. We aim to liaise with both IAB and IESG during the course of the study, and to engage European experts from the IAB and IESG throughout the process. This will help provide an up-to-date insight into everything that has come forward.

We believe this is an unprecedented coalition of communities that is willing and able to contribute to making the NGI initiative a success. During the project, additional stakeholders may be identified as well as unique individual experts that hold important expertise. We will seek to have at least two European members of the Internet Hall of Fame involved in an individual capacity, to inspire and provide the long term perspective of the European internet pioneers to this effort.

Other stakeholders

In addition we will seek input and requirements from European thought leaders from science, the hacker/security research community, the creative sector, the open source community, technology industry (including start-ups), think tanks, standards setting organisations and the public sector (such as smart cities and e-health).

The complete list of stakeholders contacted is available in the following section.

Annex 9: List of contacts

The contacts will be delivered separately as vcards, ready to be imported in an expert system. Due to privacy reasons the list is not included in this document.

Annex 10: Stakeholder Information Package

Next Generation Internet Initiative
Background information
regarding the stakeholder consultation



Next Generation Internet 2025

1. Introduction

Introduction

The internet is a technology ‘commons’ unlike anything before – a shared benefit and shared responsibility for all of its users. It was never designed to perform the tasks it is expected to perform, and it is certainly not future proof as-is.

We need to do better in making sure that the internet as a shared global technical and social infrastructure is able to carry its heavy responsibility. This is especially relevant as we are about to

embark on fascinating new journeys where we depend entirely on a safe, secure and open internet as a carrier - including an expected flood of connected devices on the outside and inside of our bodies, vehicles, buildings and infrastructure.

Trust at a global scale does not come for free: at the heart of sustainable trust lies actual **trustworthiness** that requires significant investment of time and resources. Research shows that while users may not always understand the way the technology works, they understand very well that the internet they want and need is an open, reliable internet that they can trust without any reservation whatsoever.

In recent years it has become all too clear that in addition to the obvious scalability issues there are many unforeseen persistent security and privacy challenges. Many of the challenges can be solved, and in fact working solutions are often known, but the transition at internet scale requires a systemic approach in addressing deep underlying technical issues, creating transition mechanism - as well as (in some cases) changing legal and governance parameters.

Introducing the Next Generation Internet initiative

This complex and precarious situation won't fix itself, and needs significant research investment as well as a concerted strategic effort. If we want people to trust the internet with – in essence – their private and social lives, as well as their business and government, the technology itself needs to be entirely trustworthy. The European Commission's DG CONNECT is therefore embarking on the **Next Generation Internet** initiative.

The NGI initiative wants to support the creation of an internet that supersedes the current internet, which supports citizens and businesses push further the frontiers of technology, an internet which retains people's trust in the online environment as well as their internet engagement, which is more human-centric and which offers the same fair opportunities to everyone (level playing field). Europe aims to shape this future Internet as a powerful, open, data-driven, user-centric, interoperable platform ecosystem.

Which brings us to **you**, to the **here** and **now**. If you were given the opportunity to suggest funded research and development, what would you suggest to make the Internet better? The key thing we ask you to help us with, is to understand the issues and possible approaches to solve them.

2. Your contribution

The **NGI vision** will be the main frame of reference for subsequent significant public investment in the Internet, that should have a noticeable impact on its evolution – provided the right choices are made. Certainly, history has proven that such an intervention is very hard to get right. Despite a number of well-funded attempts over a span of even decades, we still have not been able to address many shortcomings of the legacy design of internet – including security aspects that were kept

intentionally weak for strategic purposes. We believe this is a unique opportunity to actually overcome that collective impotence.

During the **stakeholder consultation**, which is open until October 15th 2017 we ask you to bring in your unique perspective and ideas how we can make this collaborative effort work. We have launched a **dedicated online platform**¹, which helps us to structure the many ideas from the different communities of the internet.

Next Generation Internet

The internet of our future is an integral part of the very fabric of society. It acts as a public space, as a carrier of intimate private communication and as the vehicle for large scale business. If we want to create a Next Generation Internet, we need to understand and solve the most urgent issues of today's internet and how to make it future-proof – and collectively act as technologists, lawmakers and users.

How you can help...

- You have knowledge of a serious problem that the internet has, which urgently needs to be fixed
- You know a 'solution' that is commonly believed to work, but which will actually fail or cause trouble
- You know a viable (partial) solution that is not yet in full effect, and would need (specific) support to get more traction
- You have a prediction or scenario to contribute. What will happen if certain trends continue

You have knowledge of a serious problem that the internet has, which urgently needs to be fixed

What problem do you see

Each idea or suggestion is a single submission (so we can keep separate issues separate), and you can provide as much detail for your analysis as you want or need. Obviously, if issues are interconnected you can flag that as well. The whole process works from the browser, and requires no setup. It will take time to think through – what is needed to make an actual difference at internet scale.

If the structured approach of the online platform does not work for you, please send us your ideas by email to NGI@nlnet.nl – the internet really needs your input. We not just want to know solutions, but also why solutions that others believe will work can fail – and to know how you would mitigate if possible. Without at least some level of understanding of the problems of the whole, no meaningful change can be brought about.

We look to you for useful suggestions for new or undervalued research topics, intervention strategies such as open source deployment, legal barriers that should be brought down or erected, as well as motivations for prioritisation and urgency in the context of the next generation internet. Even a short summary of topics you see as essential could be very helpful.

Think free

We encourage you to think free, there does not have to be a solution – **asking the right questions is already a major contribution**. We want to know what it takes to bring the internet forward, how we can reduce its technical debt and increase its resilience, robustness, openness and fairness – as well as its general utility for users. What is needed at the system level to create a better future?

¹ Visit: <https://nlnet.nl/NGI>

Obviously the problems of the internet are manifold, as are the perspectives and strategies towards resolving them. Some issues are known to many, while other technological 'skeletons in the closet' are known to only a few people in very specific roles or to researchers. Sometimes the political or social scope or impact of a certain aspect is not obvious to those that know the technical parameters. This is exactly why we strongly believe the success of the NGI initiative hinges on the ability to involve different communities.

Please **contribute as soon as possible**, if you wish to do so – this will give us the possibility to dig deeper and follow up with other experts.

[HTTPS://NLNET.NL/NGI](https://nlnet.nl/ngi)

Classification

The team will triage all the input, and classify in a number of categories:

- **Bugs** - Errors, flaws, failures or faults in the fabric of the internet which cause it behave in undesired ways.
- **Features** and **services** – Something that adds new generic functionality to the internet without requiring changes to the core
- **Security** and **hardening** – ideas that reduce the attack surface of users
- **Architecture alternatives** – ideas that try to replace problematic parts of the internet architecture with an alternative, in order to increase choice, or allow support of emerging features and services
- **Dependency management/refactoring** – ideas that are necessary to propagate the innovations identified, and help develop/redevelop/sanitize critical software tools at the infrastructural level
- **Dissemination** and **propagation** – ideas to propagate the research innovation outcomes
- **Internet Governance** – ideas that primarily impact the governance of the internet
- **Anti-competitive** and **regulatory issues** - ideas for tackling market obstacles and strengthening opportunities
- **Measurement requirements** – ideas to gain understanding about the value delivered and the assumed severity of certain technical issues
- **Social justice/inclusiveness** – ideas that address universal accessibility and equal rights
- **Transition technologies** – ideas that provide short to mid term practical relief to tackle issues

3. Why Europe needs to invest in the Next Generation of Internet

The Internet is profoundly changing society and business

The Internet has become part of the fabric of society, enabling citizens, businesses and governments to collaborate, exchange and build knowledge and create value. It is providing the main platform for new businesses, enables new ways of doing business and changing business boundaries and dynamics for both large enterprises, small and medium ones and individual businesses. It is one of the key underlying elements for optimizing value chains and business operations. It is changing the way governments interact with citizens, how we educate and learn, how we manage our health. And last but not least: it has enabled collaboration across dispersed communities, and has forever changed the way culture and societal discourse takes place.

What enabled such a large diversity of services is the "permission-less innovation": the internet and the web today are open platforms, without gatekeepers. Even an anonymously created open source-project like Bitcoin can introduce and deliver a new, ground-breaking service without asking anyone for permission. This is an important aspect of inclusiveness, diversity and equal opportunities.

The Internet needs to technically evolve

The NGI vision has clear social and economic objectives that need to be met and articulates into a powerful vision for the internet.

This makes the Next Generation Internet initiative radically different from historical efforts undertaken in this area in Europe and elsewhere, because rather than merely stimulating research and development in a number of interesting technology areas, the NGI initiative aims to affect the whole of the internet - and intends to have an actual impact at the system level.

Policy making in the area of internet research has until now been largely focused on keeping up with the perceived speed of development of "the internet", by which is normally meant the speed of adoption of technology and services on top of the internet. Typically, policy makers and governments are expecting and driving more innovation and increased performance in the digital economy, new opportunities for smart cities and regions and public services, driving on one hand citizen engagement and direct democracy and on the other hand public sector operational efficiency and effectiveness. Industry is pushing for growth and competitiveness, targeting new markets and new consumers. Corporations and small and medium businesses renovate and expand their service and product portfolios leveraging digital technologies while facing new entrants.

The Internet in 2025 and beyond should enable this growth with open connectivity but also provide more and better services, more intelligence, access to more knowledge and information while allowing the freedom to access, participate and collaborate.

A tragedy of the commons

The actual technical fabric of the internet itself is another story entirely: much of today's problems with the internet stem from the fact that its technology stack is ossified. As the internet got catapulted into the mainstream economy in the nineties, it became a victim of its own success: the legacy technology from that era is still entirely dominant. Not a single technology upgrade designed by the Internet Engineering community has actually been adopted at true internet scale since, actually negatively affecting both cost and risks: the old, insecure, technically limited and often very expensive technologies have to be kept up and running.

In 2013, the Internet Architecture Board (the technical committee that provides the architectural oversight of the activities of the Internet Engineering Task Force, and oversees the Internet Standards Process) organised a high level workshop in Cambridge on Internet Technology Adoption and Transition (ITAT).¹ The workshop involved the top of the internet standards world, as well as hand-picked thought leaders from around the world. The conclusion was that the core internet technologies are failing to evolve, due to the complexity of interdependencies and the enormous pressure of the mass use of its legacy technologies. The asymmetry of allocation of cost (who should invest) versus the distribution of benefit creates a 'tragedy of the Commons': society is unable to reap in full the abundance of potential benefits of technology upgrades to the core technologies of the internet because lack of ownership for any solutions.

Unprecedented security challenges

While the observed inability to evolve the most important driver already would be enough to warrant immediate action, the situation became even more urgent in 2013. That year the internet world was shocked by the revelations of a whistle-blower called Edward Snowden, in what is considered by many the biggest IT scandal in history. He revealed fundamental security gaps in the core infrastructure of the internet that were actively exploited at a scale never before experienced in history for intelligence activities conducted by US and UK national intelligence agencies, particularly the US National Security Agency (NSA) and the UK Government Communications Headquarters (GCHQ). Pervasive surveillance capabilities undermined even the most common security measures and thus constituted an immediate attack on the trustworthiness of the Internet.

In response, the technical community started work to address or mitigate the vulnerabilities exploited in these attacks. But the decentralised setup of the original internet – from a technological point great because it allows to adopting new technology on top quickly – remains counterproductive at an economic level. Nobody can be held responsible and the asymmetry of cost and benefit has been halting progress.

The European Parliament demanded action to safeguard citizens' fundamental rights, urging the EC to take the initiative to repair the issue. In 2015 the Parliament repeated this with a motion saying that "too little has been done to ensure their full protection". With the NGI Initiative, the European Commission is putting its weight behind the Internet community.

¹ <https://www.iab.org/activities/workshops/itat>

Coping with high demand versus technical debt

With an all-out security crisis at the system level on one hand, the technical and operational internet community at the same time has to deal with carrying the weight of enormous growth and expectations.

Policy makers and governments are pushing for more innovation and increased performance in the digital economy. Business is pushing for growth and competitiveness, targeting new markets and new consumers. (Proprietary) technology platforms in for instance mobile and cloud fight for global dominance, knowing that a likely outcome could be 'the winner takes all'.

It should be clear that the massive overall problems with security, scalability, resilience and cost effectiveness need to be fixed yesterday rather than today, as they pose a real and very significant threat to users and to the health of the future internet. The pervasive surveillance adds additional urgency to this, to the point of threatening the autonomy of our community and our economic viability. The cost of cybersecurity is already exponential, and this trend can only continue when not addressing the underlying technical issues. From a societal point of view, every investment made now on new services and products is made on top of instable, insecure and deprecated technology, and will potentially have to be redone in part or in full in the near future. If such is even possible at that point, otherwise it will cost yet more to be kept alive while the rest of the internet is transitioning away.

Delay to act will contribute to grow long term societal cost for the benefit of short term individual profits. The accumulation of the "technical debt" of the internet accelerates over time as we continue to increase dependency at an alarming rate through massive investments in new technologies on top of a fragile basis - such as 5G, IoT, cloud and data. This makes the Next Generation Internet initiative a vital and urgent effort for all of European economy.

Moving ahead strategically

Investments in the infrastructure of the 21st Century are needed in order to provide a privacy-aware decentralized secured environment for open data and open collaboration supporting democracy and innovation "spaces". Distributed architectures and public common frameworks are needed to allow the design of new services underpinned by open protocols, open standards, open formats, regulatory mechanisms and collective governance models based on democratic and participatory processes.

The Commission and the Consortium team want to create the conditions where digital businesses, new entrepreneurs, incumbents, communities and individuals can thrive with a vision of "connected freedom" and great economic integration, efficiency, opportunities and high rewards for those who compete and innovate successfully. For citizens, the power of cultural values and belonging must be preserved in a global context. Europe is faced with many challenges, including technological change, globalisation, energy and food safety, climate change, transformations of gender roles, migrations, economic and social exclusion and the ageing of the population. These concern key social and ethical values, and technology will be a key factor while the trust of users in the currently dominant actors in the internet industry is at a historic low.

Innovation was one of the main focuses of the Lisbon Agenda which placed knowledge at the core of social and economic development, and remains a core component of the Europe 2020 strategy. The Internet is one of the key enablers for knowledge circulation and for connecting ideas, capabilities, targets and funding at scale. Restarting the innovation engine of the internet through industrywide collaboration in the NGI initiative will mean new opportunities, a reshuffling of the card deck.

With new technology the business opportunities that respect European values such as privacy and human dignity, as well as restore the trust of users, Europe can reclaim its rightful share of the digital economy. The Internet in 2020 and beyond can enable growth with open connectivity, more and better services, more intelligence, access to more knowledge and information while allowing the freedom to access, participate and collaborate.

Partnering across the internet community is critical

The vision behind the NGI initiative means addressing the deep underlying technical issues with the core internet technologies (the "plumbing" of the internet) identified earlier and understanding how far it needs to go into the application layer.

However, having the technology on paper is one thing; getting it deployed throughout the fabric of the network is another. The internet is not owned by a single entity, it is a network of network as well as a layer cake of independent protocols - operated in different ways by different communities under different economic circumstances. This 'layer cake' requires that any initiative needs to make a good fit with the operational requirements of the technical and operational communities that have to deploy new technologies while keeping the internet (and the weight of large parts of the economy) running as it is being upgraded.

Unusual needs call for an unusual approach: the collaboration between NLnet, as a not-for-profit deeply interested in keeping the infrastructure of the internet healthy, and Gartner as a global company with a deep understanding of the key trends and market forces and understanding of the business and applications leveraging the infrastructure of the internet, is such a unique approach. But we need more. The ambitions put forward in the NGI initiative are broadly shared among the technical community of the internet. The idea is to engage the technical community, digital civil rights groups and other key communities directly into the scoping of the initiative. And to do so directly in the context of their own activities.

Major European and global platforms and communities see the need for the NGI initiative: the European regional internet registry, the domain name organisations, ISP associations, the open source community, the digital civil rights community and Internet Society. So not just the separate communities that operate different layers of the technology but also the 'ethical guardians' of the internet: communities that aim to protect basic tenets such as accessibility, openness and digital civil rights and the 'users' that expect to continue using it for education, healthcare, citizen services or thriving business activities.

We believe that there is no adequate substitute for the collective engagement and intelligence of these communities - at the risk of missing out on essential input that will make the whole initiative moot. A next generation initiative will simply not happen without proper embedding into the technical internet community that constitutes and run the current generation.

We believe that the aspect continuous collaboration and dialogue is key to the Next Generation Internet initiative, and should make a huge difference.

Traditional funding does not entirely match

Most of today's research cycles in the EC Framework Programmes and elsewhere are multi-year efforts technologically specified entirely upfront, with an involvement of the funding entity more focused on evaluation at the end. That has become a mismatch with the interactive, meritocratic and self-structured bottom up process of the Internet world, as well as with its operational practices.

Running the internet is a major operation involving many actors and high operational demands, and one cannot just throw some technologies at them and expect (let alone demand) these to be adopted in the actual infrastructure.

Without adequate input and early involvement from the right actors in the technical and operational community the chances of getting the technological requirements for a smooth integration and deployment at internet scale right are very low. A project done without any stake in or responsibility for what happens after the project ends is also unlikely to be sustainable. In the sector this type of project is sometimes unaffectionately referred to as "code dump" practices - actually more harmful than not funding anything because it creates confusion and expectation that the problem is being solved while in reality that is not going to be the case.

The fact is that research and development projects need to do a lot more than just produce some running code: they need to have proper licensing management and code governance, use good software quality practices such as secure coding and accessibility guidelines and have test frameworks in place. External security audits for any security-critical code may be a baseline necessity. Most historical projects already have a hard time adhering to even simple best practices such as 'release often, release early'.

In addition, when a project to be actually deployed across the internet one needs to factor in the projected maintenance cost and support available to the community that needs to adopt it. In most cases there will be significant effort and cost, which is only acceptable if there is enough trust in code quality and in integrity. Neither are common to achieve within a traditional short-lived project effort. Who would want to use a technology in any critical infrastructure when the short-lived project that created it will be unable to follow up on any bug reports (or even accept patches from external contributors)? Issues like these and the transformation of project results into value for citizens and business in general will be considered to be part of the design of the NGI initiative.

Technology operates in a complex and fast changing environment.

The methodology of using a top-down gap analysis in combination with long-lasting and broad programmes fulfilled by consortia means some resulting projects will already be outdated the day a call for proposals is published; observations of what happens outside Europe shows that the static type of funding typical for consortia is uneconomical and ineffective in the context of the internet or digital in general where technology is often created in small specialised teams. Global and rapid interaction between engineers from different background and with different use cases is the norm, and is vital to achieve quality. Consortia are limited to the subset of talent they got out of the global talent pool, and only compete with a small set of consortia with equally limited access to talent. The requirement to set up consortia artificially raises the cost of entry, and it would be better if the NGI would work with a smaller granularity and scale of funding - such as individual grants. Industry will need to be involved to ease adoption and fast deployment into the market. Eligibility criteria will need to be adapted in order to allow start-ups to participate.

In any case, in line with the Juncker Commission focus on results and transparency, the set-up of the NGI initiative programme will need to be adapted in order to allow early validation by the technical and business community as well as dynamic realignment and goal iteration when a project is no longer known relevant. This will allow to rapidly validate approaches and results, to get new people and actors involved and to fail fast. A lot of lessons learned within the Commission and through the analysis of external practices have already generated a lot of other ideas on what could be improved or changed.

The internet as an open technology platform excels with regards to incremental innovation possibilities that enable different stakeholders to iterate in parallel based on different use cases. At the same time, the NGI initiative will have to fit into the trust system that characterises the technical communities, building on trust earned by sustained contribution and fostering continuous dialogue and consultation of external experts, stakeholders during initiatives to increase quality and prepare marketability, while as a consequence increasing transparency.

Creating an internet of values

The internet has nested itself into the most intimate parts of the very fabric of humankind. It is a remarkable, universal superstructure, built from and interwoven with local private, public and shared infrastructures. The internet bridges ideas and images across languages, cultures, and media. It has become our primary public space, a carrier of our most private communications with loved ones and a global theatre for business, public engagement with citizens and virtually every aspect of human creativity and imagination. And we are just getting started.

The NGI initiative is strongly committed to shaping the next generation internet as a **resilient, reliable, responsible** and **people-centric** infrastructure in the knowledge that it will likely shape generations of humans in return. The original technologies that grew into the internet were never designed to perform many of the challenging tasks the internet is expected to perform today and tomorrow. In the light of the ever increasing intimacy and scale of our use of the internet across all domains, it is

obvious that we need to urgently address the outstanding issues before accidents start to happen. It is clear we are not just investing in mere technology, but in an **internet of human values**. An internet that is **fair, open and democratic** – that embodies, strengthens and protects democracy, human rights and our way of life. Not just in Europe, but across the globe.

The internet as a phenomenon really belongs to us all, not vice versa. The internet and its standards and shared applications like email and the world wide web are technology ‘commons’ at a global scale. Anyone has the fundamental right and ability to use the underlying technologies to improve their quality of life, for whatever purpose and without discrimination. To use here also means also to study and incrementally improve upon, to suit ones individual and local needs - and thus the collective ability to spawn newer, better future networks and services over time. We need to build on those capabilities, and even strengthen them by fostering new shared domains, creating new commons. The future of internet innovation depends on the ability to actively avoid the formation of single points of failure, control or surveillance. So by innovating now, we protect all of innovation in the future.

To achieve sustained growth and keep new opportunities open, we need to do better in making sure that the internet as a shared global technical and social infrastructure is able to carry its heavy responsibilities. This is especially relevant as we are about to embark on fascinating new journeys where we depend entirely on a safe, secure and open internet as a carrier - including an expected flood of connected devices on the outside and inside of our bodies, vehicles, buildings and infrastructure.

Internet is here for the long term, and with the NGI initiative Europe takes the global lead in investing in a technically robust and morally solid internet to rewire our future economy and society. An internet that – by engineering, by spirit and by law– delivers on core principles and ideals of our society like fairness, inclusiveness, diversity, privacy and personal safety. That is robust against manipulation and threats. The right overall growth of the internet cannot be primarily driven by volatile forces of global tech capital or political will, but shall come from a collective bottom-up design. We aim not for short term gain, but for creating the best possible internet that mankind can have. **A sustainable and fair internet itself is of immense strategic value, implicitly and explicitly setting the rules and conditions for the entire economy.** Fixing the known flaws of the internet is fundamental (in the most literal sense) to rebuilding trust, which in turn is vital to the success of unimaginably huge future investments in our economy, science and culture and collective knowledge - as well as having a major beneficial impact in our social and private lives.

The mere existence of the internet is the undeniable proof of the willingness of societies across the planet to create common understanding and trust in order to live, play and work together. Internet is a tremendous shared benefit for all its users, and Europe is willing and able to take up its responsibility and address the systemic issues that need to be dealt with. We all own the internet together, which also makes us responsible for the brightness of its future. The technology may have been invented by a few, but only the trust and buy in of our society has allowed it to flourish. By our strategic investment in the long term sustainability and openness of our infrastructure, the internet can lead the world and

mankind into a future society that safeguards our shared values of human rights, of equal chances, of freedom and heart.

4. The NGI Roadmap

In 2016 the European Commission kicked off its Next Generation Internet (NGI) initiative, aiming for a more human-centric Internet supporting European values of openness, cooperation across borders, decentralisation, inclusiveness, transparency and protection of privacy. The NGI initiative is a broad and long-term initiative, mostly focusing on new technology areas like a better protection for private data, new internet architectures, decentralized data systems and new discovery and identification tools.

More information on the EC NGI initiative is available at:

- <https://ec.europa.eu/digital-single-market/en/next-generation-internet-initiative>
- <https://ec.europa.eu/futurium/en/next-generation-internet>.

5. Contact and questions

Any questions regarding the NGI initiative study MAY be addressed to:

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Annex 11: Workshop Experts Information package

Next Generation Internet Initiative

Background Paper for workshop participants



Next Generation Internet 2025

1. Introduction

This document provides background information about the Next Generation Internet initiative, and the input we would expect from you as expert during this process.

This document is structured in a number of sections:

The first section **Experts – expected contribution** presents the involvement and the type of contributions the experts can make; as well as when and how these contributions can be made.

This second section **Why Europe needs to invest in Next Generation Internet** provides a high level rationale for addressing the Next Generation Internet.

The third section **NGI Roadmap** describes how our study fits in the roadmap of the EC and the **objectives of our study**. It lists the study roadmap stages and deliverables and presents the **quality criteria by which the study will be assessed as successful**.

The fourth section contains **additional information**, including a **summary** and all the **contact details**.

2. Experts – expected contributions

The main contribution we are asking from you is participation in a **one day expert workshop**. This workshop will be organised on **September 28th 2017** in **Amsterdam**. During this workshop which will take place from 11h to 17h (to allow for people to fly in and fly out on the same day) we look to you to:

- help finalise the **main vision document** for the Next Generation Internet initiative. Prior to the event we will circulate two draft versions of the vision document, so you can provide feedback early.
- help us to architect the NGI work programme based on input from the stakeholder consultation, as well provide some notions on **how to organise the funding processes**.

The **NGI vision** will be the main frame of reference for subsequent significant public investment in the Internet, that should have a noticeable impact on its evolution– provided the right choices are made. Certainly, history has proven that such an intervention is very hard to get right. Despite a number of well-funded attempts over a span of even decades, we still have not been able to address many shortcomings of the legacy design of internet – including security aspects that were kept intentionally weak for strategic purposes. The NGI hopes to change that. We look forward to hearing your unique perspective and ideas how we can make this initiative work.

Optional: contributing to technology topics

Note that the stakeholder consultation process for **technology topics** is already ongoing, and harvesting will be completed by the time of the workshop. We do not want to repeat the consultation process inside the workshop, there simply would not be enough time for that. Input of new topics should therefore happen beforehand, and separate from that occasion. Independent from your participation in the workshop you are very likely to have important and useful suggestions for new or undervalued research topics, as well as motivations for prioritisation and urgency in the context of the next generation internet. Even a short summary of topics you see as essential could be very helpful.

Your contribution can happen in a number of ways. You can provide direct input to the team in the form of a e-mail or phone call. Alternatively you can conveniently provide input through the **dedicated platform**¹ that was launched early July. This requires no setup, and should help you structure your submission.

¹ Visit: <https://nlnet.nl/NGI>

We encourage you to think free, there does not have to be a solution – asking the right questions is already a major contribution. We want to know what it takes to bring the internet forward, how we can reduce its technical debt and increase its resilience, robustness, openness and fairness – as well as its general utility for users. Please contribute these as soon as possible, if you wish to do so – this will give us the possibility to dig deeper, and potentially follow up prior to the workshop.

The team will triage all the input, and classify in a number of categories:

- **Bugs** - Errors, flaws, failures or faults in the fabric of the internet which cause it behave in undesired ways.
- **Features** and **services** – Something that adds new generic functionality to the internet without requiring changes to the core
- **Security** and **hardening** – ideas that reduce the attack surface of users
- **Architecture alternatives** – ideas that try to replace problematic parts of the internet architecture with an alternative, in order to increase choice, or allow support of emerging features and services
- **Dependency management/refactoring** – ideas that are necessary to propagate the innovations identified, and help develop/redevelop sanitize critical software tools at the infrastructural level
- **Dissemination** and **propagation** – ideas to propagate the research innovation outcomes
- **Internet Governance** – ideas that primarily impact the governance of the internet
- **Anti-competitive** and **regulatory issues** - ideas for tackling market obstacles and strengthening opportunities
- **Measurement requirements** – ideas to gain understanding about the value delivered and the assumed severity of certain technical issues
- **Social justice/inclusiveness** – ideas that address universal accessibility and equal rights
- **Transition technologies** – ideas that provide short to mid term practical relief to tackle issues

3. Why Europe needs to invest in the Next Generation of Internet

The Internet is profoundly changing society and business

The Internet has become part of the fabric of society, enabling citizens, businesses and governments to collaborate, exchange and build knowledge and create value. It is providing the main platform for new businesses, enables new ways of doing business and changing business boundaries and dynamics for both large enterprises, small and medium ones and individual businesses. It is one of

the key underlying elements for optimizing value chains and business operations. It is changing the way governments interact with citizens, how we educate and learn, how we manage our health. And last but not least: it has enabled collaboration across dispersed communities, and has forever changed the way culture and societal discourse takes place.

What enabled such a large diversity of services is the "permission-less innovation": the internet and the web today are open platforms, without gatekeepers. Even an anonymously created open source-project like Bitcoin can introduce and deliver a new, ground-breaking service without asking anyone for permission. This is an important aspect of inclusiveness, diversity and equal opportunities.

The Internet needs to technically evolve

The NGI vision has clear social and economic objectives that need to be met and articulates into a powerful vision for the internet.

This makes the Next Generation Internet initiative radically different from historical efforts undertaken in this area in Europe and elsewhere, because rather than merely stimulating research and development in a number of interesting technology areas, the NGI initiative aims to affect the whole of the internet - and intends to have an actual impact at the system level.

Policy making in the area of internet research has until now been largely focused on keeping up with the perceived speed of development of "the internet", by which is normally meant the speed of adoption of technology and services on top of the internet. Typically, policy makers and governments are expecting and driving more innovation and increased performance in the digital economy, new opportunities for smart cities and regions and public services, driving on one hand citizen engagement and direct democracy and on the other hand public sector operational efficiency and effectiveness. Industry is pushing for growth and competitiveness, targeting new markets and new consumers. Corporations and small and medium businesses renovate and expand their service and product portfolios leveraging digital technologies while facing new entrants.

The Internet in 2025 and beyond should enable this growth with open connectivity but also provide more and better services, more intelligence, access to more knowledge and information while allowing the freedom to access, participate and collaborate.

A tragedy of the commons

The actual technical fabric of the internet itself is another story entirely: much of today's problems with the internet stem from the fact that its technology stack is ossified. As the internet got catapulted into the mainstream economy in the nineties, it became a victim of its own success: the legacy technology from that era is still entirely dominant. Not a single technology upgrade designed by the Internet Engineering community has actually been adopted at true internet scale since, actually negatively affecting both cost and risks: the old, insecure, technically limited and often very expensive technologies have to be kept up and running.

In 2013, the Internet Architecture Board (the technical committee that provides the architectural oversight of the activities of the Internet Engineering Task Force, and oversees the Internet Standards Process) organised a high level workshop in Cambridge on Internet Technology Adoption and Transition (ITAT).¹ The workshop involved the top of the internet standards world, as well as handpicked thought leaders from around the world. The conclusion was that the core internet technologies are failing to evolve, due to the complexity of interdependencies and the enormous pressure of the mass use of its legacy technologies. The asymmetry of allocation of cost (who should invest) versus the distribution of benefit creates a 'tragedy of the Commons': society is unable to reap in full the abundance of potential benefits of technology upgrades to the core technologies of the internet because lack of ownership for any solutions.

Unprecedented security challenges

While the observed inability to evolve the most important driver already would be enough to warrant immediate action, the situation became even more urgent in 2013. That year the internet world was shocked by the revelations of a whistle-blower called Edward Snowden, in what is considered by many the biggest IT scandal in history. He revealed fundamental security gaps in the core infrastructure of the internet that were actively exploited at a scale never before experienced in history for intelligence activities conducted by US and UK national intelligence agencies, particularly the US National Security Agency (NSA) and the UK Government Communications Headquarters (GCHQ). Pervasive surveillance capabilities undermined even the most common security measures and thus constituted an immediate attack on the trustworthiness of the Internet.

In response, the technical community started work to address or mitigate the vulnerabilities exploited in these attacks. But the decentralised setup of the original internet – from a technological point great because it allows to adopting new technology on top quickly – remains counterproductive at an economic level. Nobody can be held responsible and the asymmetry of cost and benefit has been halting progress.

The European Parliament demanded action to safeguard citizens' fundamental rights, urging the EC to take the initiative to repair the issue. In 2015 the Parliament repeated this with a motion saying that "too little has been done to ensure their full protection". With the NGI Initiative, the European Commission is putting its weight behind the Internet community.

Coping with high demand versus technical debt

With an all-out security crisis at the system level on one hand, the technical and operational internet community at the same time has to deal with carrying the weight of enormous growth and expectations.

Policy makers and governments are pushing for more innovation and increased performance in the digital economy. Business is pushing for growth and competitiveness, targeting new markets and new

¹ <https://www.iab.org/activities/workshops/itad>

consumers. (Proprietary) technology platforms in for instance mobile and cloud fight for global dominance, knowing that a likely outcome could be 'the winner takes all'.

It should be clear that the massive overall problems with security, scalability, resilience and cost effectiveness need to be fixed yesterday rather than today, as they pose a real and very significant threat to users and to the health of the future internet. The pervasive surveillance adds additional urgency to this, to the point of threatening the autonomy of our community and our economic viability. The cost of cybersecurity is already exponential, and this trend can only continue when not addressing the underlying technical issues. From a societal point of view, every investment made now on new services and products is made on top of instable, insecure and deprecated technology, and will potentially have to be redone in part or in full in the near future. If such is even possible at that point, otherwise it will cost yet more to be kept alive while the rest of the internet is transitioning away.

Delay to act will contribute to grow long term societal cost for the benefit of short term individual profits. The accumulation of the "technical debt" of the internet accelerates over time as we continue to increase dependency at an alarming rate through massive investments in new technologies on top of a fragile basis - such as 5G, IoT, cloud and data. This makes the Next Generation Internet initiative a vital and urgent effort for all of European economy.

Moving ahead strategically

Investments in the infrastructure of the 21st Century are needed in order to provide a privacy-aware decentralized secured environment for open data and open collaboration supporting democracy and innovation "spaces". Distributed architectures and public common frameworks are needed to allow the design of new services underpinned by open protocols, open standards, open formats, regulatory mechanisms and collective governance models based on democratic and participatory processes.

The Commission and the Consortium team want to create the conditions where digital businesses, new entrepreneurs, incumbents, communities and individuals can thrive with a vision of "connected freedom" and great economic integration, efficiency, opportunities and high rewards for those who compete and innovate successfully. For citizens, the power of cultural values and belonging must be preserved in a global context. Europe is faced with many challenges, including technological change, globalisation, energy and food safety, climate change, transformations of gender roles, migrations, economic and social exclusion and the ageing of the population. These concern key social and ethical values, and technology will be a key factor while the trust of users in the currently dominant actors in the internet industry is at a historic low.

Innovation was one of the main focuses of the Lisbon Agenda which placed knowledge at the core of social and economic development, and remains a core component of the Europe 2020 strategy. The Internet is one of the key enablers for knowledge circulation and for connecting ideas, capabilities, targets and funding at scale. Restarting the innovation engine of the internet through industrywide collaboration in the NGI initiative will mean new opportunities, a reshuffling of the card deck.

With new technology the business opportunities that respect European values such as privacy and human dignity, as well as restore the trust of users, Europe can reclaim its rightful share of the digital economy. The Internet in 2020 and beyond can enable growth with open connectivity, more and better services, more intelligence, access to more knowledge and information while allowing the freedom to access, participate and collaborate.

Partnering across the internet community is critical

The vision behind the NGI initiative means addressing the deep underlying technical issues with the core internet technologies (the "plumbing" of the internet) identified earlier and understanding how far it needs to go into the application layer.

However, having the technology on paper is one thing; getting it deployed throughout the fabric of the network is another. The internet is not owned by a single entity, it is a network of network as well as a layer cake of independent protocols - operated in different ways by different communities under different economic circumstances. This 'layer cake' requires that any initiative needs to make a good fit with the operational requirements of the technical and operational communities that have to deploy new technologies while keeping the internet (and the weight of large parts of the economy) running as it is being upgraded.

Unusual needs call for an unusual approach: the collaboration between NLnet, as a not-for-profit deeply interested in keeping the infrastructure of the internet healthy, and Gartner as a global company with a deep understanding of the key trends and market forces and understanding of the business and applications leveraging the infrastructure of the internet, is such a unique approach. But we need more. The ambitions put forward in the NGI initiative are broadly shared among the technical community of the internet. The idea is to engage the technical community, digital civil rights groups and other key communities directly into the scoping of the initiative. And to do so directly in the context of their own activities.

Major European and global platforms and communities see the need for the NGI initiative: the European regional internet registry, the domain name organisations, ISP associations, the open source community, the digital civil rights community and Internet Society. So not just the separate communities that operate different layers of the technology but also the 'ethical guardians' of the internet: communities that aim to protect basic tenets such as accessibility, openness and digital civil rights and the 'users' that expect to continue using it for education, healthcare, citizen services or thriving business activities.

We believe that there is no adequate substitute for the collective engagement and intelligence of these communities - at the risk of missing out on essential input that will make the whole initiative moot. A next generation initiative will simply not happen without proper embedding into the technical internet community that constitutes and run the current generation.

We believe that the aspect continuous collaboration and dialogue is key to the Next Generation Internet initiative, and should make a huge difference.

Traditional funding does not entirely match

Most of today's research cycles in the EC Framework Programmes and elsewhere are multi-year efforts technologically specified entirely upfront, with an involvement of the funding entity more focused on evaluation at the end. That has become a mismatch with the interactive, meritocratic and self-structured bottom up process of the Internet world, as well as with its operational practices.

Running the internet is a major operation involving many actors and high operational demands, and one cannot just throw some technologies at them and expect (let alone demand) these to be adopted in the actual infrastructure.

Without adequate input and early involvement from the right actors in the technical and operational community the chances of getting the technological requirements for a smooth integration and deployment at internet scale right are very low. A project done without any stake in or responsibility for what happens after the project ends is also unlikely to be sustainable. In the sector this type of project is sometimes unaffectionately referred to as "code dump" practices - actually more harmful than not funding anything because it creates confusion and expectation that the problem is being solved while in reality that is not going to be the case.

The fact is that research and development projects need to do a lot more than just produce some running code: they need to have proper licensing management and code governance, use good software quality practices such as secure coding and accessibility guidelines and have test frameworks in place. External security audits for any security-critical code may be a baseline necessity. Most historical projects already have a hard time adhering to even simple best practices such as 'release often, release early'.

In addition, when a project to be actually deployed across the internet one needs to factor in the projected maintenance cost and support available to the community that needs to adopt it. In most cases there will be significant effort and cost, which is only acceptable if there is enough trust in code quality and in integrity. Neither are common to achieve within a traditional short-lived project effort. Who would want to use a technology in any critical infrastructure when the short-lived project that created it will be unable to follow up on any bug reports (or even accept patches from external contributors)? Issues like these and the transformation of project results into value for citizens and business in general will be considered to be part of the design of the NGI initiative.

Technology operates in a complex and fast changing environment.

The methodology of using a top-down gap analysis in combination with long-lasting and broad programmes fulfilled by consortia means some resulting projects will already be outdated the day a call for proposals is published; observations of what happens outside Europe shows that the static type of funding typical for consortia is uneconomical and ineffective in the context of the internet or digital in general where technology is often created in small specialised teams. Global and rapid interaction between engineers from different background and with different use cases is the norm, and is vital to achieve quality. Consortia are limited to the subset of talent they got out of the global talent pool, and only compete with a small set of consortia with equally limited access to talent. The

requirement to set up consortia artificially raises the cost of entry, and it would be better if the NGI would work with a smaller granularity and scale of funding - such as individual grants. Industry will need to be involved to ease adoption and fast deployment into the market. Eligibility criteria will need to be adapted in order to allow start-ups to participate.

In any case, in line with the Juncker Commission focus on results and transparency, the set-up of the NGI initiative programme will need to be adapted in order to allow early validation by the technical and business community as well as dynamic realignment and goal iteration when a project is no longer known relevant. This will allow to rapidly validate approaches and results, to get new people and actors involved and to fail fast. A lot of lessons learned within the Commission and through the analysis of external practices have already generated a lot of other ideas on what could be improved or changed.

The internet as an open technology platform excels with regards to incremental innovation possibilities that enable different stakeholders to iterate in parallel based on different use cases. At the same time, the NGI initiative will have to fit into the trust system that characterises the technical communities, building on trust earned by sustained contribution and fostering continuous dialogue and consultation of external experts, stakeholders during initiatives to increase quality and prepare marketability, while as a consequence increasing transparency.

Creating an internet of values

The internet has nested itself into the most intimate parts of the very fabric of humankind. It is a remarkable, universal superstructure, built from and interwoven with local private, public and shared infrastructures. The internet bridges ideas and images across languages, cultures, and media. It has become our primary public space, a carrier of our most private communications with loved ones and a global theatre for business, public engagement with citizens and virtually every aspect of human creativity and imagination. And we are just getting started.

The NGI initiative is strongly committed to shaping the next generation internet as a **resilient, reliable, responsible** and **people-centric** infrastructure in the knowledge that it will likely shape generations of humans in return. The original technologies that grew into the internet were never designed to perform many of the challenging tasks the internet is expected to perform today and tomorrow. In the light of the ever increasing intimacy and scale of our use of the internet across all domains, it is obvious that we need to urgently address the outstanding issues before accidents start to happen. It is clear we are not just investing in mere technology, but in an **internet of human values**. An internet that is **fair, open and democratic** – that embodies, strengthens and protects democracy, human rights and our way of life. Not just in Europe, but across the globe.

The internet as a phenomenon really belongs to us all, not vice versa. The internet and its standards and shared applications like email and the world wide web are technology ‘commons’ at a global scale. Anyone has the fundamental right and ability to use the underlying technologies to improve their quality of life, for whatever purpose and without discrimination. To use here also means also to study and incrementally improve upon, to suit ones individual and local needs - and thus the

collective ability to spawn newer, better future networks and services over time. We need to build on those capabilities, and even strengthen them by fostering new shared domains, creating new commons. The future of internet innovation depends on the ability to actively avoid the formation of single points of failure, control or surveillance. So by innovating now, we protect all of innovation in the future.

To achieve sustained growth and keep new opportunities open, we need to do better in making sure that the internet as a shared global technical and social infrastructure is able to carry its heavy responsibilities. This is especially relevant as we are about to embark on fascinating new journeys where we depend entirely on a safe, secure and open internet as a carrier - including an expected flood of connected devices on the outside and inside of our bodies, vehicles, buildings and infrastructure.

Internet is here for the long term, and with the NGI initiative Europe takes the global lead in investing in a technically robust and morally solid internet to rewire our future economy and society. An internet that – by engineering, by spirit and by law– delivers on core principles and ideals of our society like fairness, inclusiveness, diversity, privacy and personal safety. That is robust against manipulation and threats. The right overall growth of the internet cannot be primarily driven by volatile forces of global tech capital or political will, but shall come from a collective bottom-up design. We aim not for short term gain, but for creating the best possible internet that mankind can have. **A sustainable and fair internet itself is of immense strategic value, implicitly and explicitly setting the rules and conditions for the entire economy.** Fixing the known flaws of the internet is fundamental (in the most literal sense) to rebuilding trust, which in turn is vital to the success of unimaginably huge future investments in our economy, science and culture and collective knowledge - as well as having a major beneficial impact in our social and private lives.

The mere existence of the internet is the undeniable proof of the willingness of societies across the planet to create common understanding and trust in order to live, play and work together. Internet is a tremendous shared benefit for all its users, and Europe is willing and able to take up its responsibility and address the systemic issues that need to be dealt with. We all own the internet together, which also makes us responsible for the brightness of its future. The technology may have been invented by a few, but only the trust and buy in of our society has allowed it to flourish. By our strategic investment in the long term sustainability and openness of our infrastructure, the internet can lead the world and mankind into a future society that safeguards our shared values of human rights, of equal chances, of freedom and heart.

4. The NGI Roadmap

In 2016 the European Commission kicked off its Next Generation Internet (NGI) initiative, aiming for a more human-centric Internet supporting European values of openness, cooperation across borders, decentralisation, inclusiveness, transparency and protection of privacy. The NGI initiative is a broad and long-term initiative, mostly focusing on new technology areas like a better protection for private

data, new internet architectures, decentralized data systems and new discovery and identification tools.

More information on the EC NGI initiative is available at:

- <https://ec.europa.eu/digital-single-market/en/next-generation-internet-initiative>
- <https://ec.europa.eu/futurium/en/next-generation-internet>.

How our study fits into the NGI Initiative

The NGI initiative should support the European internet sector **as a collective** to capture opportunities offered by new technology breakthroughs. This should be a rich, heterogeneous and competitive area where users can easily switch – in the realm of networked technology the risk of natural monopolies is to be actively avoided. Open source is seen as the dominant R&D mechanism, as a business agnostic accelerator able to push technological drivers as ‘raw materials’ to the economy and to society.

The overall objective is for Europe to become a leading provider and user of the next generation Internet and for the NGI initiative to enable and accelerate the emergence of a new European industrial leadership, based on new business models, giving Europe digital independence.

The European Commission has asked us to:

- Develop a vision for the Internet in 2025 including the technological aspects, the service innovations expected, the socio-economic shifts, the point of views from the users (citizens, business, public sector, etc.) taking into account trends and other impacting factors.

The vision will build on the values that the internet shall align with, as expressed by the Commission: freedom, interoperability, openness and inclusiveness.

The study will support the EC in understanding how to build trust in the post-Snowden internet through R&D as well as identify policy areas to support this.

- Identify the specific **technological** topics upon which a Next Generation Internet initiative should focus.
- Start building out the **relevant communities** around these specific technological topics.
- Map ongoing **relevant initiatives**, including initiatives in the Member States and at global level.
- Fine-tune the Commission’s current **operational model** to implement the initiative most effectively.

Another key objective of the NGI initiative is to develop a **holistic** and **long-term perspective** on the Internet evolution, and to contribute to this evolution by **sanitizing** and **stabilizing** core internet technologies that currently put the users at risk, as well as offering “radically new functionalities

closely based on common values of creating a more human-centric Internet for people” and to grow European competences in terms of technologies, innovation, market and regulation.

The roadmap for our project contains the following stages:

- **May/June:** Inception, onboarding of Stakeholders and Experts
- **July 1st to October 15th:** stakeholder contribution on technology topics through online platform
- **Mid July:** first draft of the Vision for Next Generation Internet available for Experts to comment through a dedicated online platform
- **Mid September:** second draft of the Vision for Next Generation Internet available online taking into account comments from Experts
- **End September:** Expert workshop for finalisation of the Vision for Next Generation Internet and validation of technology topics from stakeholder contribution

The deliverables of our project are the following:

- **June 1st:** An **Inception report**, specifying the methodology, resources and objectives
- **September 15th:** An **Interim study report**, including in particular a preliminary list of research topics and a first draft design of a possible Next Generation Internet programme
- **October 21st:** The **post-workshop report**, including a 2nd draft design of the Next Generation Internet programme
- **December 20th:** The **public consultation report**
- **February 1st:** The **Final study report**

The estimated time line for delivery is Q1 2018.

Our quality criteria

This section covers the different criteria which we ourselves set to define a successful outcome of the study.

A first criterion is to ensure that the NGI research will bring the technologies to make the internet free, interoperable and open.

The second criterion is that the study provides **double loop learning** by identifying blocking issues with historical ‘next generation internet’ efforts in these areas, and (per topic or across topics) propose **relevant new instruments and approaches** through which these may best be addressed.

Thirdly the study should also establish if there are **significant interdependencies** that can be identified among the topics as well as **known dependencies** that need to be practically addressed – and how these are best dealt with, including the need for R&D efforts aimed at transitional technology. This may impact the **definition of priorities** and **timing** for specific parts of the NGI initiative (e.g.: some R&D results are a precondition to other R&D).

A fourth criterion for success is broad **recognition for the holistic approach** for our study methodology, among the very wide range of key actors and stakeholders.

5. Further information

Summary

- **July 1st to October 15th:** stakeholder contribution on technology topics through online platform
- **Mid July:** first draft of the Vision for Next Generation Internet available for **Experts** to comment through a dedicated online platform
- **Mid September:** second draft of the Vision for Next Generation Internet available online taking into account comments from Experts
- **End September:** Expert workshop for finalisation of the Vision for Next Generation Internet and validation of technology topics from stakeholder contribution

Contact and questions

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Annex 12: Conference and Workshop Reports

Stakeholder community conferences and works

Conference 1: Annual GEANT conference TNC, Linz, May 29th - June 2nd 2017

Team member attending: Michiel Leenaars

Short Report: TNC is a large scale event with many parallel sessions happening. There was already a BOF session planned on NGI by the HUB4NGI project, however the main goal of participation was to talk to many individual different researchers, engineers, and power users from the Research and Education networking community. GEANT leadership introduced several interesting people from the community to us, which showed great interest in the NGI program. The rest of Throughout the entire week several dozens of people provided input.

Overall the NGI initiative is eagerly greeted by the GEANT community.

Conference 2: Euro-ISPA, Brussels, June 20 and 21st 2017

Team member attending: Clementine Valayer

Short Report: The presentation was welcome, there were already some contributions lined up:

- IoT is driving a lot of issues, such as the upgrade of software is Things (dolls, etc...) and the problems arising when the upgrades are not happening
- There are areas with difficult tensions with players with competing interests. One issue is Wi-Fi, with the need to optimize the use of frequency space/bandwidth - and to manage "old" standards such as 802.11b which has a wide spectrum, limiting the number of connecting devices, and which is still widely used in the field.
- Software liability: there is a real importance of high quality software in some areas. How do you reconcile the need to live up to defined standards? This includes the massive contribution from the OSS community. How do you protect the spontaneous innovation while maintaining security and reliability?

They welcomed the stakeholders of the study, as they highlighted the need to know what is happening and where is the actual gap to fill.

Conference 3: EDRi Workshop in Vienna , June 24th-25th 2017

Team member attending: Michiel Leenaars

Short Report: This was a dedicated brainstorming workshop inside a two day event for EDRi representatives from across Europe. We had a rich, interactive and informed discussion.

Conference 4: IETF in Prague , July 16th - 21st 2017

Team member attending: Bert Wijnen (on behalf of NLnet)

Short Report: The IETF meeting is a very busy working event, the culmination of work done within over 100 working groups over the last trimester. Due to the late start of the project, it was not possible to organise a dedicated BOF. The main goal was to spread the word, and lever the personal network of the experts spoken to.

Conference 5: SHA2017 in Zeewolde, Aug 4th – Aug 8th 2017

Team member attending: Michiel Leenaars

Short Report: SHA2017 was the largest outdoor hacker event of Europe this year. The volunteer-led event has been happening every four years since 1989. It brought together about 4000 security experts, hackers, school kids, policy makers, NGO's and other stakeholders. A lightning talk was given about the NGI effort, which was well received, as well as many individual conversations and interviews with previously identified experts as well as regular attendees. In the days after the event itself, the opportunity of the presence of a number of foreign experts was taken to conduct additional interviews around a.o. the protection of whistleblowers, freedom of expression and the web ecosystem.

EU organised or initiated NGI conferences and workshops

Conference 6: NGI Summit Brussels, June 6th - 7nd 2017

Team member attending: Michiel Leenaars, Clementine Valayer

Short Report: This was an event organised in the European Parliament. The team actively participated in the various workshops and debates, and approached a number of experts to provide input to the open consultation.

Conference 7: EuroDig, Talinn, June 7th 2017

Team member attending: Kristian Billeskov

Short Report: EuroDIG is an annual conference on internet governance. It provided a suitable environment to talk with a broad, informed audience about requirements for the NGI.

Conference 8: Net Futures, Brussels, June 28th - 29th 2017

Team member attending: Michiel Leenaars, Clementine Valayer

Short Report: NetFutures conference is an annual conference related to the Net Futures unit of the European Commission. The team attended a workshop on research collaboration between the USA and Europe, and spoke to interested stakeholders on the floor, alerting them to the consultation. In addition there were fruitful talks with the team from the EC.

Conference 9: NGI Workshop, Twente, July 6th 2017

Team member attending: Michiel Leenaars, Clementine Valayer

Short Report: This was one of the regional NGI workshops, organised at the University of Twente. It also meant a good way to connect to the local internet community that was well represented at the event. The team participated in the group discussions, spoke extensively with attendees (including students, who were well represented) and speakers about the NGI initiative and the consultation and the EC staff attending.

Conference 10: COST-CONNECT, September 12th-13nd 2017

Team member attending: Michiel Leenaars

Short Report: This event brought together a broad audience of interested experts and stakeholders. During the part of the workshop attended on the 13nd the diversity of input became clearly visible. Once more, there were fruitful discussions about possible topics for NGI, and a number of people were pointed to the open consultation. The results of all the brainstormings were captured by the team for further study.

Annex 13: Desk Research

The mapping of ongoing initiatives

European Commission

As stated in the request for proposal, the Next Generation Internet (NGI) initiative will make use of ongoing research and policy activities, notably the roadmap-based research ongoing in areas such as 5G, IoT, cloud, data and cybersecurity. Note that these should be looked at very critically: an effort may look reasonable and relevant on paper, but (given that the NGI initiative has already identified flawed approaches, wrong incentives in the traditional funding mechanisms and lack of engagement of the right actors and stakeholders which is likely to lead to weak results) can not just have **little or no effect** but can even have a **negative effect** by drawing away critical resources and creating confusion and fatigue in technical circles. Not all of these activities will be successful or desirable in terms of the NGI vision, and so these efforts might need to be restarted with the NGI approach and vision.

From the Commission, the team counted 84 funded projects related to the Internet of Things (IoT) in the current portfolio of H2020 projects.¹The majority of projects are specific developments to apply the idea of Internet of Things in a specific setting or to solve problems required to realize IoT. The total invested amount in projects related to IoT is 477 M€. The total H2020 portfolio of projects is 19.033 M€. IoT thus constitute 2,5% of the portfolio.

10 projects on “Future Internet Architecture” devising generic architectural solutions to fix current issues with e.g., Internet security as well as preparing it for Internet of Things. These are funded with 33 M€ constituting 0,17% of the H2020 portfolio of research projects.

Table 1. H2020 Projects with an objective associated with the Future Internet Architecture

| Title | Funding |
|--|-------------|
| Measurement and Architecture for a Middleboxed Internet | € 2.901.500 |
| architectuRe for an Internet For Everybody | € 3.185.001 |
| Road-, Air- and Water-based Future Internet Experimentation | € 8.319.384 |
| Resolving the Tussle in the Internet: Mapping, Architecture, and Policy Making | € 1.499.875 |
| BIG IoT — Bridging the Interoperability Gap of the Internet of Things | € 7.999.883 |
| Securing Internet Routing from the Ground Up | € 1.468.200 |

¹ Based on text analysis of H2020 project titles and objectives. Based on data from Cordis.

| | |
|---|--------------|
| Automated Synthesis of Dynamic and Secured Choreographies for the Future internet | € 3.057.549 |
| A Disruptive Router Platform for the Internet of Things — TrustNode | € 71.429 |
| A New, Evolutive API and Transport-Layer Architecture for the Internet | € 3.957.001 |
| Revolutionary trustworthy platform for seamless authentication of Internet users | € 71.429 |
| Total funding for Future Internet Architecture | € 32.531.251 |

Another major relevant cluster of expertise about research on the internet lies with the technical and operational communities identified in chapter Annex 8: Stakeholders. Especially GÉANT as the European association of National Research and Educational Networks is deeply connected with the academic research on internet topics in Europe.

Private sector

There are a number of private foundations operating in Europe providing larger and smaller funding for (applied) research in the area of internet. The Internet Hardening Fund (<https://nlnet.nl/internethardening>) is a new European based thematic fund. It is primarily focussed on improving transport layer security and encryption. The programme is run by NLnet foundation, and funded by the Netherlands government for half a million euro for the first year. NLnet also runs an open call allowing independent researchers to identify and improve security issues in the internet.

Other relevant funds include:

- Awesome Foundation
- Cisco Impact Cash Grant program
- Comcast Tech Fund
- Ford Foundation
- FreeBSD Foundation
- Freedom2Connect Foundation
- Digital Defenders Program (HIVOS)
- Knight Foundation Journalism & Media Innovation
- Internet Society community grants
- Linux Foundation

- MacArthur Foundation
- Media and Democracy Fund
- Mozilla WebFWD
- Nominet Trust
- Omidiyar Network
- Open Internet Tools Project (OpenITP)
- Open Society Foundations (OSF/OSI)
- Open Tech Fund
- Renewable Freedom Foundation
- Shuttleworth Foundation
- SIDN Fonds
- Wau Holland Stiftung
- World Wide Web Foundation
- Web We Want
- Open Technology Institute

Additionally, there are likely many other initiatives which are not European in origin, but which have at least some relevance. An example of such an initiative is Hewlett Foundation's Cyber Initiative, a 65 million dollar private effort around topics that impact the security, stability, and resilience of a free and open Internet and connected devices. This way, it tries to capture not only more traditional notions of computer and information security, but also the full range of related policy issues, such as Internet governance, net neutrality, encryption, surveillance, and privacy. So far they have made two sets of grants: large institutional grants of \$15 million each to UC Berkeley, MIT, and Stanford; and, more targeted grants to individual think tanks, civil society groups, and US academic centers. The former funded the creation of new cyber policy centers on each campus to educate American students in a multidisciplinary fashion and pursue new policy-relevant research. The latter focus on specific policy challenges and outputs.

Research in the member states

Some of the European Member States and Associated Countries have local initiatives that are relevant to the NGI initiative. This section lists the data that was delivered through the national contacts points. Note that whenever a hyperlink to underlying initiatives was available, this link was made available. [Links can be recognised](#) by their use of font and color.

Austria

| Title | Funding institution | Duration | Funding size |
|--|---------------------|----------|--------------|
| Forschung, Innovation, Technologie - Informationstechnologie | BMVIT | annual | M€ 10 |

Contributor(s):

David Kolman

Germany

| Title | Funding institution | Duration | Funding size |
|---------------------------|-------------------------------------|----------|--------------|
| German Internet Institute | Ministry for Education and Research | 5 years | M€ 50 |

The German Internet Institute (<https://vernetzung-und-gesellschaft.de>) is a new initiative funded by the German Ministry for Education and Research, which has committed up to €50 million over a period of five years to the new Institute which bears the official title "Internet-Institut für die vernetzte Gesellschaft" (Internet Institute for the networked society). The institute is a joint-venture of seven institutions: WZB Berlin Social Science Center, Berlin's four universities (Freie Universität Berlin, Humboldt-Universität zu Berlin, Berlin University of the Arts, and Technische Universität Berlin), the University of Potsdam, and the Fraunhofer Institute for Open Communication Systems (FOKUS). Its key focus is on how society is dealing with the (current and possibly future) internet, e.g. researching the social and societal implications of Internet use, rather than addressing technological or regulatory aspects.

Contributor(s):

(study team)

Iceland

No initiatives

Contributor(s):

Marcel Kyas, Tölvunarfræðideild/School of Computer Science, Háskólinn í Reykjavík/Reykjavik University

Latvia

No initiatives.

The most prominent NGI stakeholders in Latvia are:

- **Lattelekom**, largest telco in Latvia
- **University of Latvia**, IMCS, Research in Computer Networks, CC TLD, CERT, GEANT
- **Latvian Mobile Phone**, carries out 5G network tests
- **Association of Latvian ISPs**
- **Latvian Association for Information and Communication Technologies**

Contributor(s)

Guntis Barzdins (in coordination with Maris Vegeris), University of Latvia

Norway

| Project Name | Funding institution | Duration | Funding size (mill NOK) MK) |
|---|---------------------|-----------|-----------------------------|
| The Basic Internet Foundation | RCN | 2017-2019 | M€ 1,589 (14,9 MK) |
| NumaMultiConnect: Cost-efficient HPC technology with mainframe | RCN | | M€ 1,077 (10,1 MK) |
| Security in Internet Governance and Networks: Analysing the Law | RCN | 2015-2019 | M€ 1,269 (11,9 MK) |
| RFID in Society | RCN | 2010-2017 | M€ 0,575 (5,4 MK) |
| RHYME - Co-creation through tangible interaction and music | RCN | 2010-2017 | M€ 1,066 (10 MK) |
| Traffic behaviour of interactive time-dependent thin streams on the modern Internet | RCN | 2012-2017 | M€ 1,173 (11 MK) |
| SOCRATES: Self-Organising Computational substrATES | RCN | | M€ 0,053 (0,5 MK) |
| Telenor NTNU AI: Lab | Telenor & NTNU | 2017- | M€ 5,332 (50 MK) |

| | | | |
|--|-------------------|-------------|-------------------|
| Telenor StartIoT | Telenor | | M€ 0 (MK) |
| 3C // Co-Constructing city futures | RCN | 2016-2020 | M€ 0,746 (7 MK) |
| Centre for Artificial Intelligence Research (CAIR) | Partner consortia | 2017- | M€ 8,531 (80 MK) |
| SARDS: Secure and Reliable Distributed Storage Systems | RCN | 2015-2018 | M€ 0,938 (8,8 MK) |
| MUSEC - Music on demand: Economy and copyright in a digitised cultural | RCN | 2018-2020 | M€ 0,746 (7 MK) |
| ExiBiDa: Exploring new dimensions in Big Data | RCN | 2015-2019 | M€ 0,767 (7,2 MK) |
| Semantics-Based Analyses for Cloud-Aware Computing | RCN | 2015-2019 | M€ 0,959 (9 MK) |
| DIGICOM - Communicating Risk in the Digital Age | RCN | 2014-2018 | M€ 0,597 (5,6 MK) |
| Protecting Shared Data with Privacy Automaton | RCN | | M€ 1,066 (10 MK) |
| SIRIUS - Centre for Scalable Data Access | RCN | 2015-2023 | M€ 10,238 (96 MK) |
| UMOD: Understanding and Monitoring Digital Wildfires | RCN | 2017-2020 | M€ 0,959 (9 MK) |
| Protecting Shared Data with Privacy Automaton | RCN | 2017 - 2020 | M€ 1,066 (10 MK) |
| Optimizations to Compel Adoption of RINA | RCN | 2016 - 2021 | M€ 0,746 (7 MK) |
| Security in IoT for Smart Grids | RCN | 2015 - 2020 | M€ 2,666 (25 MK) |
| ARTEMIS project ARROWHEAD | RCN - ARTEMIS | 2013 - 2017 | M€ 0,799 (7,5 MK) |
| DOMINOS: Dissecting and Modeling Interdependencies in Communication Networks | RCN | 2015 - 2019 | M€ 0,746 (7 MK) |
| Fluid Service Abstraction for Large-Scale Cloud IoT | RCN | 2017 - | M€ 0,767 (7,2 MK) |

| Systems | | 2021 | |
|--|-----|-------------|-------------------|
| Wireless Social Devices Enabled by Self-Organized Spectrum Cartography | RCN | 2016 - 2021 | M€ 1,279 (12 MK) |
| Better Video workflows via Real-Time Collaboration and AI-Techniques in TV and New Media | RCN | 2017 - 2020 | M€ 0,895 (8,4 MK) |

Contributor:

Pål S. Malm, National NGI contact point
 Senior Adviser The Research Council of Norway

Ireland

| Title | Funder | Duration | Funding Size |
|--|---------------------------------------|-----------|--------------|
| CONNECT Centre for Future Networks and Communications Science Foundation Ireland | Science Foundation Ireland + industry | 2014-2020 | M€ 50 |
| ADAPT Centre for Digital Content Technology | Science Foundation Ireland + industry | 2014-2020 | M€ 24 + 26 |
| INSIGHT Centre for Data Analytics | Science Foundation Ireland + industry | 2013-2019 | M€ 58 + 30 |

Some other initiatives to consider:

- Irish Medtech association : <http://www.irishmedtechassoc.ie>
- Technology Ireland : <http://www.technology-ireland.ie/>
- The A-IoT Technology Gateway Cluster: <https://www.technologygateway.ie/network/applied-iot-cluster/>

Contributor(s):

Jim Clarke (Waterford IT, H2020 FIF, NGI Contact Point), Leo Clancy (Irish Development Authority – IDA Ireland, H2020 FIF), William Donnelly (WIT, NGI Contact point) Patrick Neary (Dept. of Communications - Gov't of Ireland, NGI Contact point), Stephen O'Reilly, Enterprise Ireland.

Luxembourg

Luxembourg delivered a (non exhaustive) list of future internet projects in Luxembourg : Saint, Privacy, Exciting, F-Interop, Atena. These are all EC-funded.

| Title | Duration | Funding Size |
|--------------|-----------|--------------|
| Saint | 2017-2019 | M€ 1,999 |
| Privacy Flag | 2015-2018 | M€ 3,143 |
| Exciting | 2016-2018 | M€ 0,999 |
| F-Interop | 2015-2018 | M€ 2,998 |
| Atena | 2016-2019 | M€ 6,889 |

Contributors:

Younis Hijazi

Poland

| Title | URL | Funding institution | Duration | Funding size (total budget) |
|-----------------|---|---|-------------------------------|-------------------------------|
| Start In Poland | http://www.mr.gov.pl/strony/aktualnosci/rusza-program-startinpoland-pakiet-instrumentow-dla-innowacyjnych-firm/ | Umbrella initiative coordinated by Ministry of Economic Development | Launched in 2016 (continuous) | 2.800.000.000 PLN (till 2020) |
| | | | | Support for scalable startups |
| e-Pionier | http://www.ncbr.gov.pl/fundusze-europejskie/program-operacyjny-polska-cyfrowa/pierwszy-konkurs-e-pionier/dokumentacja | National Centre for Research and Development, NCBR (www.ncbr.gov.pl) | 2016-2020 | 100.000.000 PLN |

konkursowa/

Increasing potential of digital solutions in administration and commercial use through innovative formula of PCP (Pre Commercial Procurement)

| | | | | |
|------------------------------|---|---|--|-----|
| Polish Platform Industry 4.0 | https://www.mr.gov.pl/strony/aktualnosci/powstanie-polska-platforma-przemyslu-40/ | Umbrella initiative coordinated by Ministry of Economic Development | In preparation (to be launched in Q1'2018) | TBC |
|------------------------------|---|---|--|-----|

Country level initiative coordinating efforts around Industry 4.0. Initiative coordinated by Ministry of Economic Development

| | | | | |
|---|---|--|-----------|-----------------|
| Development of modern research infrastructure of the science sector | http://www.ncbr.gov.pl/fundusze-europejskie/poir/dzialanie-42/ | National Information Processing Institute, OPI (https://www.opi.org.pl/en/) | 2014-2020 | 804.000.000 PLN |
|---|---|--|-----------|-----------------|

Scientific entities may use the financing from the Smart Growth programme funds for investments from the so-called

Polish Roadmap for Research Infrastructure, i.e. selected projects concerning large, strategic research infrastructure.

Some infrastructures use ICT technologies and offer advanced services to industry/startups/spinoffs to help them to validate their products in close-to-real environments.

| | | | | |
|---------------|---|---|-----------|----------------|
| CyberSecident | http://www.ncbr.gov.pl/programy-krajowe/cybersecident/ | National Centre for Research and Development, NCBR (www.ncbr.gov.pl) | 2016-2020 | 70.000.000 PLN |
|---------------|---|---|-----------|----------------|

The main goal of the Programme:

“Raising the level of cyberspace security by increasing the availability of hardware and software tools by 2023”

| | | | | |
|-------------------------|---|---|-----------|-------------------|
| Industrial research and | http://www.ncbr.gov.pl/fundusze-europejskie/poir/dzialanie-42/ | National Centre for Research and Development, NCBR (www.ncbr.gov.pl) | 2016-2020 | 2.950.000.000 PLN |
|-------------------------|---|---|-----------|-------------------|

development work implemented by enterprises **sze-europejskie/poir/konkursy/dzialanie-11/** Research and Development, NCBR (www.ncbr.gov.pl)

The entrepreneurs searching for resources for developing new or improved solutions can apply for financing of industrial research or experimental development. In order to obtain co-financing, the applicant has to prove that there is a demand on the market for the results of the applicant's R&D work and if the research is successfully completed, the implementation of its results will be possible (in own economic activity of the entrepreneur, in the form of granting licenses or sale of the project results to implement them in the economic activity of other enterprise).

Examples of regional initiatives in Poland

| URL | Funding institution | Duration | Funding size (total budget) |
|------------------------------|---------------------|------------|-----------------------------|
| Various Regional initiatives | N/A | Continuous | N/A |

Regional initiatives driven by market needs and expectations of local investors, start-ups, individuals. Usually these initiatives are related to regional operational programmes, like ESF (European Social Fund), or launched as collaboration between public authorities and industry.

1. **Poznań FutureLab** includes several laboratories: future education lab, social e-inclusion, human-computer interaction, digital immersion, cultural heritage, telerehabilitation and media lab 3D. The laboratories are located in a newly refurbished (2015) 5-story tenement house in a very heart of Poznan. FutureLab is a place where stakeholders involved in various initiatives related to the development of the city and the region can meet and discuss (among others, there are meetings of the Poznań Thinktank group, which seeks to solve societal problems - including the use of the Internet and modern technologies by citizens). In this space, among others, the "Wielkopolska Social Innovation" project (WINS) is implemented, financing 27 micro ideas for innovation in care services. Some of these projects face the challenges of the New Generation Internet - <http://www.inkubatorwins.pl/>.
2. **Kraków Living Lab** (KTP), hosted by Kraków Technology Park and developed under a signed agreement with the City of Kraków is aimed to support companies in product and services development in the scope of smart city solutions. It is a participatory driven process of designing city infrastructure and functions including the city's ICT ecosystem. KTP is actively using a regional eco-systemic approach to innovation, based on the quadruple helix model involving in each initiative stakeholders and users from all four areas (research, industry, public administration and citizens) focusing on the co-creation of innovation through a citizen-driven approach.
3. The **WARP** NB-IoT Program by hub:raum Kraków and Deutsche Telekom provides an industry ecosystem which enables startups, B2B partners and customers to develop NB-IoT applications and solutions at an early stage. The program is open to IoT startups developing products with NarrowBand-IoT technology. The program gives a great opportunity to join the Deutsche Telekom fast-track NB-IoT network roll-out in 8 European countries: Austria, Croatia, Germany, Greece, Hungary, Poland, Slovakia and the Netherlands.
4. **3S Starter** is a direct consequence of workshops organized by 3S in the summer of 2016 with participation of Startups.Garden and Business Link Katowice. The program is addressed primarily to new companies that base their activity and development on access to modern IT services and infrastructure (including cloud computing,

dedicated servers). The organizers primarily invite companies operating in the areas of e-commerce, IoT (Internet of Things), Big Data, Marketing Automation, Business Intelligence, etc. Any company that qualifies for the program will be able to count on continued support and advice from 3S Data Center engineers. At the same time, a 3S Starter program participant will be able to use a 1,000 PLN to 5000 PLN cash voucher to use within the next 12 months for services available throughout the 3S Data Center cluster. In addition, the beneficiary of the program can count on marketing support using 3S resources.

5. **CYBERSEC HUB** builds on the synergy between stakeholders from the Małopolska Region in Poland, with the city of Krakow as its strategic center. Krakow is one of the largest start-up hubs in Europe with over two hundred ICT businesses, unparalleled investment opportunities, and access to talent, funding and the entire EU market. This unique environment is what attracts global IT companies to the area, many of whom have already moved their Research, Development and Security Operations Centres to Małopolska. The main goal of the platform is to harvest accumulated in the region technology, investment and research in order to boost innovations and create a new European “Cyber-Silicon Valley” in Krakow.
6. The “**Kampus+**” innovation ecosystem project is a result of the cooperation under the Kreatywne Mazowsze initiative. The project partners are Pro-Development, the Kreatywne Mazowsze Foundation, the Warsaw University of Technology, the Centre for Innovation and Technology Transfer Management of the Warsaw University of Technology, and the CEZAMAT Central Laboratory (a research centre enabling interdisciplinary research on future-oriented materials and technologies). Kampus+ is a method of creating centres of progress and development with comprehensive and well-designed space, providing scientists, inventors and entrepreneurs with the best conditions to implement collaborative and innovative projects.
7. **Polish Cluster of IoT Research and Development** was set up on 22 September 2015 as a voluntary agreement between entrepreneurs, scientific and research institutes and business environment institutions, who want to work together to increase Poland's innovation and competitiveness in the key area of today's Internet of Things (IoT). The cluster includes entities dealing with Internet of Things from all over Poland. The goal of the cluster is first and foremost to create a solid platform for collaboration that will facilitate the transfer of knowledge, experience and innovation between participants and allow them to make the most of their potential in the area of the Internet of Things.

1. <http://www.futurelab.pl/>
2. <http://www.kpt.krakow.pl/park-technologiczny/livinglab/>
3. <https://warpaccelerator.com/nb-iot/>
4. <http://www.3s.pl/pl/209,3s-starter.html>
5. <http://cybersechub.eu/>
6. <http://kampusplus.pl/>
7. <http://www.iofthings.pl/>

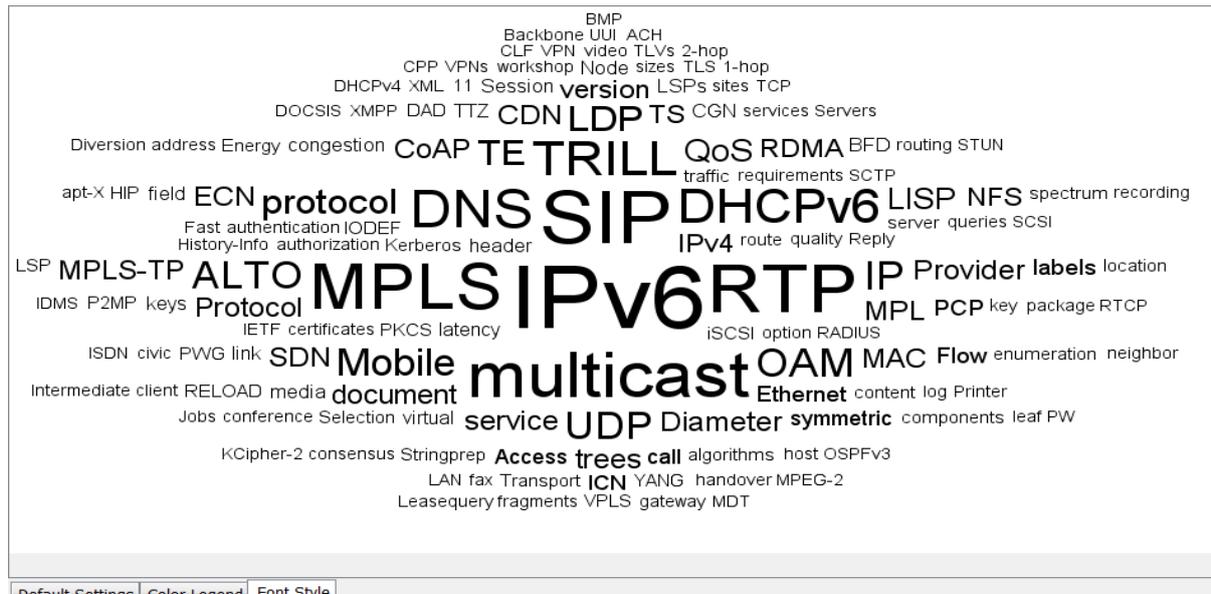
Contributors:

NGI Contact Points (Bartosz Belter & Tomasz Mazuryk) with help of representatives of Polish NCP and Ministry of Science and Higher Education.

Research subjects in H2020

The following word clouds shows the subjects research related to the future internet and is illustrated by word clouds.

2013 – 2017



2008 – 2012



- “NEXT GENERATION INTERNET INITIATIVE – CONSULTATION” (10 nov 16 – 9 jan 2017),
 David Overton,
 Date: March 2017
- *Consultation for a Next Generation Internet Initiative*, Questionnaire David Overton
 Date March 2017
- *Firestudy: The Next Generation Internet (NGI) white paper survey results*
 Date: March 2017
- Centre for Science and Policy, Cambridge Computer Laboratory, European
 Commission, Policy Report, Makoto Takahashi,
 Date: Workshop March 1 and 2, 2017
- *Next Generation Internet Experimentation*, Michael Boniface/Monique Calisti/Martin
 Serrano
 Date: June 2016
- Speech by Andrus Ansip, Commission Vice-President for the Digital Single Market, at
 the Next Generation Internet Summit
 Date: 6 june 2017
- *Internet of Humans - How we would like the internet of the future to be*
 ‘Bruno Kessler Lecture ‘ by Roberto Viola, Director-General for Communications
 Networks, Content & Technology at the EC
 Date: June 30, 2017
- *Citizen Engagement And Media Campaign On The Next Generation Internet*,
 Atomium European Institute / REI-search
 May 31, 2017
- *Horizon 2020 Draft Work Programme 2018-2020*,
 Date: June 22, 2017 (Draft)

In the below table the short list of the results of this desk research are provided :

| Research Topics , As derived from Horizon 2020, Work programme 2018 - 2020 | | |
|---|------------------|---|
| Programme name: | Ref nr: | Specific Topics raised: |
| Next Generation Internet - An Open Internet Initiative | ICT-29-2018-2019 | <ul style="list-style-type: none"> ■ A more human-centric Internet |

| | | |
|---|------------------|--|
| Interactive Technologies * | ICT-30-2018-2020 | <ul style="list-style-type: none"> ■ Interactive community building ■ Future interaction |
| Artificial Intelligence * | ICT-31-2018-2020 | <ul style="list-style-type: none"> ■ Artificial Intelligence |
| Internet of Things * | ICT-32-2018-2020 | <ul style="list-style-type: none"> ■ Internet Of Things |
| Future Hyper-connected Sociality | ICT-33-2018 | <ul style="list-style-type: none"> ■ Next generation Social Media platforms |
| A multilingual Next Generation Internet | ICT-35-2018 | <ul style="list-style-type: none"> ■ Interoperable language tools |
| An empowering, inclusive Next Generation Internet * | ICT-36-2019-2020 | <ul style="list-style-type: none"> ■ Digital Learning |
| EU-US collaboration on NGI | ICT-43-2018-2019 | <ul style="list-style-type: none"> ■ EU-US collaboration on NGI |

*= considered to proceed after 2020

| Research Topics, As derived from earlier Reports , Presentations and Workshops | |
|--|---|
| Report/workshop Name, Author, Date: | Specific Topics raised: |
| NEXT GENERATION INTERNET CORE (NGI), CONSULTATION ON METHODOLOGY (nov/dec 2016), 'FINAL REPORT' Author: Puja Abbassi, University of Cologne. Date: 30 January 2017 | <ul style="list-style-type: none"> ■ Open software, firmware, and hardware design ■ Access to network data, ■ Open standardisation activity ■ Access to testing and operational infrastructure |
| "Next Generation Internet" (Presentation), Author: Fabrizio Sestini, Senior Expert (Advisor) in Digital Social Innovation, DG CONNECT Date: end 2016 | <ul style="list-style-type: none"> ■ Open software, firmware, and hardware design ■ Access to data, ■ Open standardisation activity ■ Access to testing and operational infrastructure ■ IPR regime ensuring lasting impact ■ Reusability of Results <p>-----</p> <ul style="list-style-type: none"> ■ An Open Internet Initiative ■ Interactive Technologies ■ Artificial Intelligence ■ Internet of Things ■ Future Hyper-connected Sociality ■ Next Generation Media ■ A multilingual, inclusive Next Generation Internet ■ Privacy and trust enhancing technologies ■ Decentralized data governance ■ Discovery and identification technologies ■ Additional topics from Summarizing Slide (slide 2): ■ Artificial Intelligence, Immersive Interfaces ■ New Search Engines and data crawlers, ■ Distributed architectures ■ Blockchains ■ Personal Data Spaces, ■ Decentralised (Data) Governance ■ Discovery and Identification technology |
| Report/workshop Name, Author, Date: | Specific Topics raised: |

| | |
|---|--|
| <p>“NEXT GENERATION INTERNET INITIATIVE – CONSULTATION” (10 nov 16 – 9 jan 2017),</p> <p>Author: David Overton</p> <p>Date: March 2017</p> | <ul style="list-style-type: none"> ■ Discovery and identification tools ■ New forms of interactions and immersive environments ■ Personal data spaces ■ Distributed architectures and decentralized data governance ■ Software defined technologies ■ Networking solutions beyond IP ■ Artificial Intelligence |
| <p>Report/workshop Name, Author, Date:</p> | <p>Specific Topics raised:</p> |
| <p>Firestudy: The Next Generation Internet (NGI) white paper survey results</p> <p>Author: Firestudy Consortium</p> <p>Date: March 14, 2017</p> | <ul style="list-style-type: none"> ■ Internet Of Things ■ 5G ■ Trust, Security and Privacy ■ Big Data ■ Edge Computing ■ Interoperability and Open standards ■ International collaboration ■ SMEs competitiveness ■ Intelligent Spaces ■ Cooperative Autonomous Machines ■ Collective Human Experience ■ Key Networking Technologies ■ Multi-actor protocol/system design principles ■ Methodologies for cooperating machines and people ■ Networking protocols robust to and adaptable to variations of outcomes and with transparent constraints ■ Technology drivers that facilitate the emergence of new business models |
| <p>Report/workshop Name, Author, Date:</p> | <p>Specific Topics raised:</p> |
| <p>Centre for Science and Policy, Cambridge Computer Laboratory, European Commission, Policy Report,</p> <p>Author: Makoto Takahashi,</p> <p>Date: Workshop March 1 and 2, 2017</p> | <ul style="list-style-type: none"> ■ Transparency ■ Concentration of data and power ■ Sovereignty over personal data ■ e-ID ■ Collective online security ■ Multi-disciplinary teams |
| <p>Report/workshop, Name, Author, Date</p> | <p>Specific Topics raised:</p> |
| <p>Next Generation Internet Experimentation,</p> <p>Authors: Michael Boniface/Monique Calisti/Martin Serrano,</p> <p>Date: June 2016</p> | <ul style="list-style-type: none"> ■ SME competitiveness ■ Pioneering concepts ■ Interoperability and standardisation ■ International collaboration ■ Productivity ■ Intelligent Spaces ■ Autonomous Cooperative Machines ■ Collective User Experience ■ Key Networking Technologies |
| <p>Report/workshop Name, Author, Date</p> | <p>Specific Topics raised:</p> |
| <p>Speech by Andrus Ansip, Commission Vice-</p> | <ul style="list-style-type: none"> ■ Cybersecurity and online privacy, |

| <p>President for the Digital Single Market, at the Next Generation Internet Summit 6/7 June 2017</p> <p>Date: 6 June 2017</p> | <ul style="list-style-type: none"> ■ Common technical standards and interoperability ■ Internet of Things. ■ High-performance and quantum computing, ■ Big data ■ Cloud services. ■ Data deluge ■ Intelligent machine learning. ■ Robotics ■ Artificial intelligence ■ Single e-identity ■ Digitisation's effect on society and jobs ■ Online power being concentrated in the hands of a few big companies and platforms |
|--|---|
| Report/workshop Name, Author, Date | Specific Topics raised: |
| <p>Internet of Humans - How we would like the internet of the future to be</p> <p>‘Bruno Kessler Lecture ‘ by Roberto Viola, Director-General for Communications Networks, Content & Technology at the EC</p> <p>Date: June 30, 2017</p> | <ul style="list-style-type: none"> ■ A more human-centric Internet. ■ Artificial Intelligence ■ Robotics ■ Internet of Things ■ Security and Trust ■ Man-Machine Interactive Technologies: Speech Recognition / Augmented Reality / Virtual Reality ■ Language technologies ■ Inclusion ■ Blockchain ■ Personal information management services (PIMS) (= "personal data spaces") ■ Electronic ID standards ■ Security and the authentication of the communications ■ Encryption standards ■ Quantum Technology ■ Data compression ■ Eco-friendly data centres and data storage |
| Report/workshop Name, Author, Date | Specific Topics raised: |
| <p>Citizen Engagement And Media Campaign On The Next Generation Internet,</p> <p>Atomium European Institute / REI-search</p> <p>May 31, 2017</p> | <ul style="list-style-type: none"> ■ Inclusion ■ Participation and Interest ■ Net neutrality ■ Privacy and Surveillance ■ Data ownership ■ Fintech ■ Security -with respect to cybercrime ■ Security- with respect to critical infrastructure ■ Virtual Reality ■ Augmented Reality ■ Blockchain ■ Distributed Ledgers ■ Dominant American Platforms ■ Connected European Poles of Excellence ■ Development of business excellencies ■ Job automatization ■ SMEs’ and civil society organisations’ ability to profit from NGI technologies |

| Report/workshop Name, Author, Date | Specific Topics raised: |
|---|---|
| | <ul style="list-style-type: none"> ■ Innovative teaching ■ Methods, supporting skills exchanges and ICT-enabled learning. ■ Tackle eco-chambers, filter-bubbles, fake news and hate-speech ■ Fair balance between right to access information and freedom of speech ■ Improve awareness about the potential of NGI ■ access to fast broadband |
| Horizon 2020 Draft Work Programme 2018-2020, version Draft June 22, 2017 Date: June 22, 2017 Author: EU Member States representatives | <ul style="list-style-type: none"> ■ Next Generation Internet - An Open Internet Initiative ■ Interactive Technologies * ■ Artificial Intelligence * ■ Internet of Things * ■ Future Hyper-connected Sociality ■ A multilingual Next Generation Internet ■ An empowering, inclusive Next Generation Internet * ■ EU-US collaboration on NGI *= considered to proceed after 2020 |
| Report/workshop Name, Author, Date | Specific Topics raised: |
| Euro-ISPA, Brussels, June 21st 2017 | <ul style="list-style-type: none"> ■ How to ensure the upgrade of software is timely ■ Things (dolls, etc...) and the problems arising when the upgrades are not happening ■ Optimize the use of frequency space/bandwidth - and addresses. How to manage "old" standards such as 802.11b which has a wide spectrum, limiting the number of connecting devices ■ How do you protect spontaneous innovation while maintaining security and reliability? |
| Report/workshop Name, Author, Date | Specific Topics raised: |
| EuroDig, Talinn, June 7th 2017 | <ul style="list-style-type: none"> ■ Role of government: "Regulatory mechanisms are severely outdated" ■ What should be the future role of civil society ■ local language capabilities is becoming increasingly important. ■ Trade agreements and the Internet ■ Privacy is a concern (1 in 2 users are limiting their online presence due to privacy concerns) ■ How to increase Inclusiveness ■ How to create a Human-centric internet – serving other interests than that of the corporations. ■ Right to control data for persons |

In the below table the full list of the results of this desk research are provided

Research Topics,
 As derived from earlier Reports , Presentations and Workshops

| Report/workshop Name, Author, Date: | Specific Topics raised: |
|--|--|
| NEXT GENERATION INTERNET CORE (NGI), CONSULTATION ON METHODOLOGY (nov/dec 2016), 'FINAL REPORT' Author: Puja Abbassi, University of Cologne, Date: 30 January 2017 | <ul style="list-style-type: none">■ Open software, firmware, and hardware design■ Access to network data■ Open standardisation activity■ Access to testing and operational infrastructure |

https://ec.europa.eu/futurium/en/system/files/ged/next_generation_internet_validation_report_final.pdf

Excerpts from the 'Executive Summary' (pg 3, bottom):

The new programme should encourage open software, firmware, and hardware design, access to network data, open standardisation activity (with longer timeframes), and access to testing and operational infrastructure, to ensure that new technologies do not result in individual solutions that create fragmentation, but rather contribute to a global inclusive Internet based with equal values and opportunities for all.

Excerpts from the 'Main Conclusions' on 'NGI core programme characteristics' (page 4, 5, and 6)

1. *There is a very broad consensus that a new programme targeting Internet development should address small scale focused projects with short lifecycle.*
2. *Moving from deliverable-based accountability and associated paperwork towards what make Internet researchers really "tick": new ideas, decisive contributions to Internet development, gaining seniority in the community.*
3. *The question of risk taking is complex as some view large H2020 projects as very risky, while, according to the EC review process, they always succeed. The debate would gain from moving from risk to accountability on both self-defined Key Performance Indicators (KPIs) and programme level KPIs.*
4. *Infrastructure is important for testing (VMs, hardware, links) however there is no clear set of common requirements that could drive a shared testing infrastructure and this is treated on an ad-hoc basis e.g. depending on the source of funding.*
5. *Access to real network data (traffic, events) is essential to test the limits of proposed ideas; however, there is a clear issue in accessing such data today.*
6. *Open standard activities (notably through IETF) is both valuable for removing fragmentation and for individual's reputation. However, it requires relatively longer time-frames. NGI core should address this concern.*
7. *Although a foundational aspect of the Internet, hardware platforms are practically not funded. Open hardware development using COTS (Commercial off-the-shelf) components is very much valued.*
8. *There is also an interest to use NGI funds to contribute to multi-funding source projects as an (eligible) contribution.*
9. *Finally, there is a rich set of funding sources for Internet researchers on a project basis (industry, national funds, international organisations such as Internet Society, ERC grants...) or non-project*

basis (universities, research institutes both public and private): NGI core must differentiate through its framing conditions.

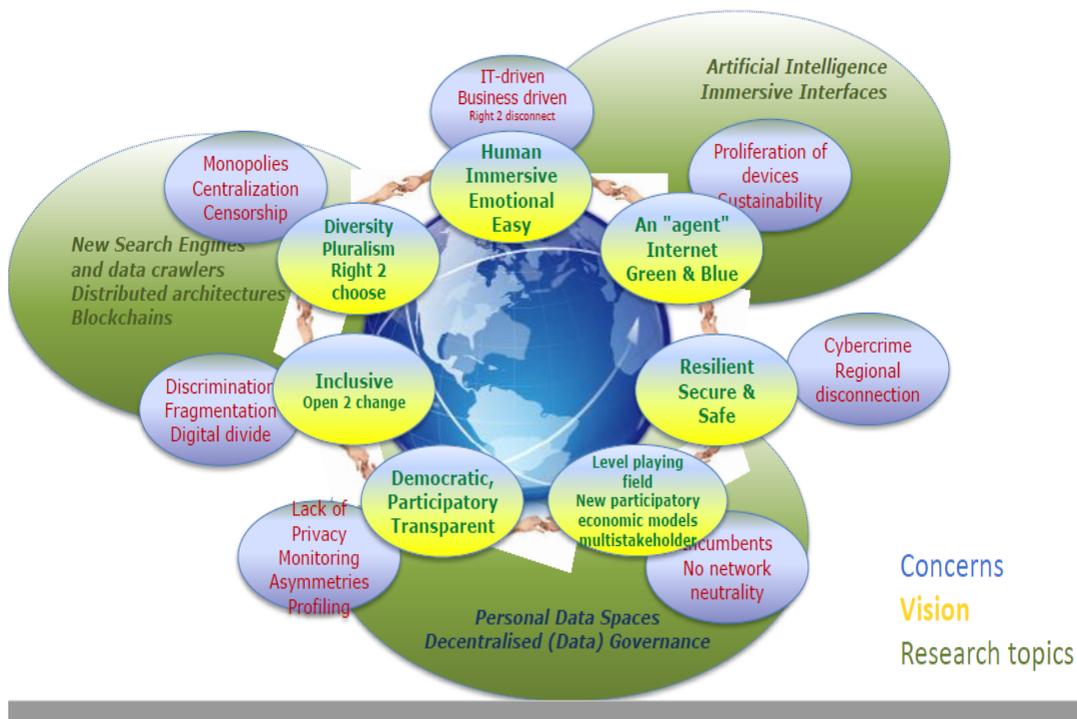
10. *Broad appreciation of the effort of the EC to identify new routes for supporting NGI with more focus on smaller teams, short life-cycles, smaller size projects, less bureaucracy.*

| Report/workshop Name, Author, Date: | Specific Topics raised: |
|--|--|
| <p>“Next Generation Internet” (Presentation),</p> <p>Author: Fabrizio Sestini, Senior Expert (Advisor) in Digital Social Innovation, DG CONNECT</p> <p>Date:: end 2016</p> | <ul style="list-style-type: none">■ Open software, firmware, and hardware design■ Access to data,■ Open standardisation activity■ Access to testing and operational infrastructure■ IPR regime ensuring lasting impact■ Reusability of Results■ -----■ An Open Internet Initiative■ Interactive Technologies■ Artificial Intelligence■ Internet of Things■ Future Hyper-connected Sociality■ Next Generation Media■ A multilingual, inclusive Next Generation Internet■ Privacy and trust enhancing technologies■ Decentralized data governance■ Discovery and identification technologies■ Additional topics from Summarizing Slide (slide 2):■ Artificial Intelligence, Immersive Interfaces■ New Search Engines and data crawlers,■ Distributed architectures■ Blockchains■ Personal Data Spaces,■ Decentralised (Data) Governance■ Discovery and Identification technology |

https://ec.europa.eu/futurium/en/system/files/ged/ngi_bcn_digital_sovereignty.pdf

Extracts from Slides (slide 2, 4, 5 and 6):

Vision for a "Next Generation Internet"



#NGI in wp 2018-2020? *first draft*

- An Open Internet Initiative
- Interactive Technologies
- Artificial Intelligence
- Internet of Things
- Future Hyper-connected Sociality
- Next Generation Media
- A multilingual, inclusive Next Generation Internet

1. Research Modules (focused on specific research domains):

- To provide support to third party projects by individual research groups /organisations (80% of their budget)
- focus on advanced research that can be brought quickly to the market; (not on apps and services that innovate without a research component)
- Size of funding to third parties: 100k€-200k€, 9-12 months
- The proposers should encourage, when relevant, open software, firmware and hardware design, access to data, open standardisation activity, access to testing and operational infrastructure as well as IPR regime ensuring lasting impact and reusability of results

Research areas (*first draft*)

- a) **Privacy and trust enhancing technologies:** to help users increase trust, usability and to achieve greater control when sharing their personal data, attributes and information (for academic oriented research groups)
- b) **Decentralized data governance:** explore new light-weight in-device data management and awareness systems, paying attention to ethical, legal and privacy issues, as well as to the concepts of autonomy, values and regulations (by academic research groups, and highly relevant start-ups, hackers or social innovators)
- c) **Discovery and identification technologies:** to access heterogeneous data sources, services, objects and sensors, devices, multi-media content, etc. (hi-tech startups, or other organisations)

| Report/workshop Name, Author, Date: | Specific Topics raised: |
|--|--|
| <p>“NEXT GENERATION INTERNET INITIATIVE – CONSULTATION” (10 nov 16 – 9 jan 2017),</p> <p>Author: David Overton</p> <p>Date: March 2017</p> | <ul style="list-style-type: none">■ Discovery and identification tools■ New forms of interactions and immersive environments■ Personal data spaces■ Distributed architectures and decentralized data governance |
| <p>Consultation for a Next Generation Internet Initiative, Questionnaire</p> <p>Author: David Overton</p> <p>Date: March 2017</p> | <ul style="list-style-type: none">■ Software defined technologies■ Networking solutions beyond IP■ Artificial Intelligence |
| <p>https://ec.europa.eu/futurium/en/system/files/ged/ec_ngi_final_report_1.pdf</p> | |
| <p>https://ec.europa.eu/futurium/en/system/files/ged/141116survey_final.pdf</p> | |
| <p>Excerpts from ‘Technology Areas’ (pg 3 – 5):</p> | |
| <p><u>Technology Areas</u></p> | |
| <p><i>Technology Area 3 (Personal Data Spaces) and Technology Area 7 (Artificial Intelligence) were the most important areas as recognised by researchers and the bulk of the other groups that took part in the consultation.</i></p> | |
| <p>Personal data spaces</p> | |
| <p><i>There is a trade-off between the benefits of innovation possible with the Internet of Things and Big Data and the need to prevent abuse of personal data. The NGI needs to keep personal data secure and this means educating and enabling citizens regards criminals and big business. Systems that allow assurance, transparency and freedom for citizens to control the data that's held on them should not limit access to innovative services.</i></p> | |
| <p><i>Infrastructures are needed to both enable benefits and minimise exploitation of using personal data. This will include enabling privacy aware access control and enforcing accountability for responsible use of personal data.</i></p> | |
| <p><i>The values this group related most to were those of sovereignty over data and diversity, pluralism and the right to choose.</i></p> | |
| <p>Artificial Intelligence</p> | |
| <p><i>Despite only a few respondents actually working in this area, many more believed they had a good understanding of the area. Their visions are strongly in line with retaining data sovereignty, diversity and pluralism and not allowing the data to become concentrated in proprietary platforms.</i></p> | |
| <p><i>Technical challenges top the list, requiring interdisciplinary approaches and a top-down vision and application of strong use cases (e.g. autonomous vehicles) to shape the needed activities. The impact of greater autonomy and increasing "responsibilities" placed on systems requires work on communication, ethics and the inclusion of human factors within these decision "making" mechanisms. A proper and actionable ethical framework for Artificial Intelligence regarding algorithms becomes essential and deserves long-term project commitments to put some already well documented theory into practice.</i></p> | |

Distributed architectures and decentralised data governance

Participants expressed the potential for a financial revolution from these technologies. A number of specific requirements including the continuance of work on blockchain in particular and the need to deal with the power demands for this technology area proposed.

The main challenges identified were in Communicating the business benefits of these digital ledger technologies to existing businesses in a compelling way and collaborating on new decentralised algorithms. Control for citizens over their own data becomes increasingly important yet challenging in a distributed architecture. Investment is needed into a diverse future-proof infrastructure that will enable ever greater autonomy.

For all this technology investment is needed to support effective governance that balances rights and supports legislation. A multi-disciplinary approach is essential.

Other technology areas proposed in the consultation

Discovery and identification tools need to provide assurance that the use and security of personal data is standardised and respected far beyond the initial commercial interest. Non-proprietary, extensible, future-proof, trustworthy standards for the Internet of Things are needed to support end to end connectivity between the Internet and the edge networks connecting all these devices. Semantic repositories are needed.

New forms of interactions and immersive environments face the issues of data privacy, diversity and the concentration of data into proprietary platforms. Intuitive interfaces necessitate work on understanding the psychological & biological effects and the threats and opportunities for industry and citizens of the constant Virtual Reality world. Supporting industry 4.0, embracing immersive distant collaboration and creating market driven products and service are required. An NGI is needed that deals with the packets reliably and with minimal latency. Work is needed in developing the tools for work-flow and process improvements including the advancement of battery technology.

*The NGI can be made robust if the agility possible with the **Software defined technologies** is embraced and the right methodologies are employed for small and medium-sized enterprises to take a role in this. Co-developments may fulfill requirements for virtualisation and self-adapting algorithms. The protection of such created knowledge will be important. Work on new software specifications is essential as more functionality becomes embedded in soft rather than hardware. Standards need to be future-proofed to accommodate unknown future functionalities that will be required.*

Networking solutions beyond IP impact the values of sovereignty of data and pluralism and diversity most strongly. An emphasis on security aspects alongside the palpable need for an improvement over the current IP is justified. The Next Generation Internet may benefit from a non-packet-based approach, but backward compatibility issues must be addressed and an optimal migration path proposed. Higher throughput, low latency and secure communications will place significant challenges upon the NGI infrastructure and architecture. A new high-speed TCP protocol and tools are important areas in need of development. New networking approaches may demand that security is built within the protocol. Maximising security and resilience while assuring good interoperability are key technical challenges.

Report/workshop Name, Author, Date:

Firestudy: The Next Generation Internet (NGI) white paper survey results

Author: Firestudy Consortium

Specific Topics raised:

- Internet Of Things
- 5G
- Trust, Security and Privacy
- Big Data
- Edge Computing

Date: March 14, 2017

- Interoperability and Open standards
- International collaboration
- SMEs competitiveness
- Intelligent Spaces
- Cooperative Autonomous Machines
- Collective Human Experience
- Key Networking Technologies
- Multi-actor protocol/system design principles
- Methodologies for cooperating machines and people
- Networking protocols robust to and adaptable to variations of outcomes and with transparent constraints
- Technology drivers that facilitate the emergence of new business models

https://ec.europa.eu/futurium/en/system/files/ged/the-fire-study-ngi-white-paper-survey-results_01.pdf

Excerpt from Section 1.3 'The FIRE STUDY Survey vs. the NGI Consultation 2016 results' (pg 6, middle) :

It is important to note that the FIRE STUDY survey results, which have been elaborated and reported in more detail in the remaining of this document, are pointing into the same direction(s) as indicated by the Final Report of the Next Generation Internet Consultation 2016, despite the fact that the time-scale explicitly referred by the STUDY Survey and by the NGI Consultation are different, i.e., the NGI consultation extends the time horizon until 2030, while within the FIRE STUDY survey we focused on 2018-2020.

Excerpt from Section 1.4 'The FIRE STUDY Survey major outcomes – a summary overview' (pg 7, 8)

1. The priority service / technology drivers for the evolution of experimentation-driven efforts for a Next Generation Internet are:

- *Internet Of Things* is considered by far the key technology driver (selected by almost 80% of respondents), followed by *5G* (selected by almost 40% of the survey participants), *Trust, Security and Privacy, Big Data and Edge Computing* (selected by about 30% of the respondents).

2. The three biggest elements to impact to European ecosystem experimentation are:

- *Interoperability and Open standards* is clearly the most relevant factor for the respondents selected by almost the 80% of participants to the survey. *International collaboration* and *SMEs competitiveness* follow as very relevant impact factors for more than 50% of the respondents.

3. The biggest roles in the NGI experimentation were identified as follows:

- *Intelligent Spaces*. Interoperability management considering the large array of “standards” that are emerging in the IoT space will be crucial (for more than 50% of the respondents). This is a very central issue that many reserachers and innovators are focusing on; see for instance several efforts within the AIOI, IoT Forum and ETSI groups. This is followed by 1) engagement of larger numbers of users/communities and 2) addressing increasingly important security, anonymity and privacy issues for about 30-35% of survey’s participants.
- *Cooperative Autonomous Machines*. A paradigm shift will occur within the Industrial Internet of Things domains towards Edge Computing, in which programmable, autonomous IoT end-devices can communicate with each other and continue to operate without connectivity. The degree of autonomy delegated to virtual (either software or hardware) components is an aspect central to many Artificial Intelligence frameworks and debates nowadays. This directly relates to NGI consultation outcomes. Notice that answers to the survey indicate that among the suggested R&D

challenges in this domain, almost all are considered as equally relevant, a part from aspects related to machines operating in natural open and uncertain environments and active security design, monitoring and mitigation aspects that seem to have less relevance to the audience.

- **Collective Human Experience.** Experimenters' participatory involvement in collective awareness / intelligence production is the core challenge for over 50% of survey participants. This is of particular relevance to a number of R&D efforts that are putting human participation and social innovation as key challenges for realizing the Digital Society vision. This is followed by aspects related to decentralised and distributed social networks, wikis, sensors, blockchains value networks (were considered over 40% of respondents) as central to a number of R&D efforts (see in particular the CAPS initiative and projects – www.capssi.eu).
- **Key Networking Technologies.** Convergence of new 5G scenarios with new IoT capabilities and technologies will be at the core of future R&D communication networks efforts (selected by over 50% of respondents). This will also entail a more indepth understanding and analysis of how software defined technologies can provide effective solutions to manage and operate the infrastructure of the networks of the future. This requires focus on a number of technology challenges related to slicing of network topologies, end-to-end integrated radio-network-application/service experimentation, NFV/VNF applications, etc.

4. Topics which are expected to create the biggest impact in the NGI Collective Human Experience are:

- **Multi-actor protocol/system design principles and methodologies for cooperating machines and people** – for more than 50% respondents.
- **Networking protocols robust to and adaptable to variations of outcomes and with transparent constraints** – for more than 50% respondents.
- **Very relevant are also technology drivers that facilitate the emergence of new business models that may also operate under a collaborative economy based model** – for about 35% of respondents

| Report/workshop Name, Author, Date: | Specific Topics raised: |
|--|--|
| Centre for Science and Policy, Cambridge Computer Laboratory, European Commission, Policy Report, Author: Makoto Takahashi, Date: Workshop March 1 and 2, 2017 | <ul style="list-style-type: none">■ Transparency■ Concentration of data and power■ Sovereignty over personal data■ e-ID■ Collective online security■ Multi-disciplinary teams |

https://ec.europa.eu/futurium/en/system/files/ged/report_of_the_csap_policy_workshop_on_next_generation_internet.docx

Excerpts from the section 'Conclusion' (pg 14):

This workshop was not structured to generate a list of key conclusions. Nevertheless, an attempt to pick out a short selection of salient themes and actionable suggestions has been made below.

Key themes:

- **Transparency:** Participants did not object to the use of personal data per se, but emphasised that users should understand how data is collected and processed, and to what ends. Recognising the value of personal data in optimising services, participants proposed a future in which individuals

“donate” or “pay” for access to services with their data.

- **Concentration of data and power:** *The concentration of data on a handful of online platforms (e.g. Google, Facebook, etc) places them in a prime position to exploit advances in machine learning, further locking in their competitive advantages. It was noted that anti-trust agencies will be responsible for preventing the emergence of monopolies, but have limited expertise in the technological sector. Investing in developing this capacity is therefore a priority.*
- **Sovereignty over personal data:** *There is a clear tension between the desire to promote sovereignty over personal data and the potential benefits that data analytics can deliver (e.g. optimising healthcare, preventing crime, etc.). It was particularly clear that there is a need to establish whether meta-data is owned by the individuals who have contributed their personal data, or the person who has aggregated and transformed the data.*

Actionable suggestions:

- **e-ID:** *Repeated references were made to up-sizing Estonia’s model of e-citizenship to the European scale. This would allow EU citizens greater freedom of movement and choice of services.*
- **Collective online security:** *A transition from private online security (i.e. purchasing security software individually) to collective online security (i.e. the state provides or subsidises security software) would lower barriers to access. This would also be consistent with our understanding of physical security.*
- **Multi-disciplinary teams:** *Investing in drawing technical experts into legal institutions generally, and antitrust agencies specifically, was suggested as essential to ensuring that these organisations are effective.*

| Report/workshop, Name, Author, Date | Specific Topics raised: |
|---|---|
| Next Generation Internet Experimentation, Authors: Michael Boniface/Monique Calisti/Martin Serrano, Date: June 2016 | <ul style="list-style-type: none"> ■ SME competitiveness ■ Pioneering concepts ■ Interoperability and standardisation ■ International collaboration ■ Productivity ■ Intelligent Spaces ■ Autonomous Cooperative Machines ■ Collective User Experience ■ Key Networking Technologies |

https://ec.europa.eu/futurium/en/system/files/ged/drivers_transforming_ngi_experimentation_whit_epaper_v1.0-release.pdf

Excerpts from the section ‘European ecosystem experimentation impacts’ (pg 4):

Ecosystem experimentation and trials using open platforms are a major contributor to the success of European research and innovation programmes investigating the future of the Internet. Initiatives such as Future Internet Research and Experimentation (FIRE), the Community Awareness Platforms for Sustainability and Social Innovation (CAPS/CAPSSI), the Future Internet-Public Private Partnership (FIPPP), the 5G-Public Private Partnership (5G-PPP), European Institute of Innovation & Technology (EIT) Digital, and the European Network of Living Labs (ENoLL) have all been delivering platforms and ecosystems that have advanced Internet-based technologies towards markets and society. Each flagship initiative has been designed to fulfil specific complementary socio-economic and technical objectives. For example, CAPS enables societal innovation through open platforms supporting new forms of social interaction, FI-PPP enables innovation through accelerator ecosystems building on the open platform FIWARE, whilst FIRE enables innovation

through highly configurable technology infrastructures and services. In particular, selected FIRE examples show that significant long lasting European impacts can be delivered:

- **SME competitiveness:** experimentation has enhanced 100's of companies' product and service offerings have benefited by validating performance, acceptance and viability using experimental platforms. Examples include: Televic Rail launching their SilverWolf passenger information product on more than 22,000 railcars following complex end-to-end networking performance tests; Evolaris GmbH launching Europe's 1st Smart Ski Goggles service in the Ski Amadé, Austria, Europe's 2nd largest ski area based on user-centric networked media experiments; Incelligent proactive network management products building on cognitive radio experiments, involving realistic conditions and actual testbeds leading to the company being selected as one of the 12 startups awarded to work with Intel, Cisco and Deutsche Telekom, through the next phase of their joint ChallengeUp! Program.
- **Pioneering concepts:** experimentation has demonstrated ground-breaking results that the world has never seen before. Examples include: Open platforms to transforming the education of the next generation of Internet scientists and engineers through remote experimentation on top of FIRE facilities and open online courses supporting over 1,000s of students and more than 16 courses across several countries (e.g. Belgium, Greece, Ireland, Spain, Brazil and Mexico) by allowing the creation, sharing and re-use of learning resources based on real experiments and data, accessible anytime/anywhere learning [Jourjon15]; The World's 1st mixed reality ski competition broadcast across European television (BBC, ORF, etc.) radio and online to a global audience of over 700 million [BBC15]; the first generation of networked Internet of Things technologies for pervasively monitoring the underwater environments; validation of HBBTV technology in European broadcast events [HbbTV]
- **Interoperability and standardisation:** experimentation has established evidence and contributed to the development of new international standards, many of those adopted by the market. Examples include: Licensed Shared Access (LSA) technology to maximize mobile network capacity in LTE (4G) communications presented to the ETSI TC Reconfigurable Radio Systems WG1; Transceiver API for a hardware-independent software interface to a Radio Front-Ends developed by Thales Communications and Security SAS standardised in Wireless Innovation Forum (WInnF); Contributions to standardisation fora (Wireless Innovation Forum, ITU-R, ETSI, IEEE 802, IEEE P1900.6, DySPAN); Simplifying spectrum sensing measurements through a common data collection/storage format, based on the IEEE 1900.6 standard, enabling sharing of experiment descriptions, traces and data processing script for heterogeneous sensing hardware; Establishment of the W3C Federated Infrastructures Community Group to start the standardization of according semantic information models and facilitate collaboration with other groups such as the IEEE P2302 Working Group - Standard for Intercloud Interoperability and Federation (SIIF) – or the OneM2M Group on Management, Abstraction and Semantics (MAS).
- **International collaboration:** experimentation has raised the global profile and reputation of European research and innovation initiatives. Examples include: Establishment of the Open-Multinet Forum to facilitate the international collaboration between FIRE and GENI and other members for harmonizing interfaces and information models; Global reconfigurable and software defined networks between Europe, Korea, Brazil, South Africa, Japan and US.
- **Internet regulation and governance:** experimentation has delivered results driving the evolution of policies regulating networks and services; Examples include: interaction with national regulators (BIPT- Belgium, National Broadband Plan NBP - Ireland, BNetzA – Germany, ANFR – France, ARCEP – France, AKOS – Slovenia, Ofcom - UK); PlanetLab Europe supports the Data Transparency Lab

(<http://www.datatransparencylab.org/>), an initiative of Telefónica I+D, together with Mozilla and MIT, to understand data policies around the world; Internet measurement testbeds are observing the efforts of network regulators around Europe as they implement the European Network Neutrality mandate.

- **Productivity:** experimental platforms have delivered methodologies, tools and services to accelerate Internet research and innovation. Examples include: evaluation of novel concepts (5G, cognitive radio, optical networks, software-defined networks, terrestrial and underwater IoT, cloud) through pathways from laboratory to real-world settings (i.e. cities, regions and global); Easy access to different individual testbeds through a common portal with a comprehensive description of the and guidelines on how to access and use the federated testbeds; Increasing the reproducibility of experiments through experimentation descriptors linked to provisioning policies supported by benchmarking methodologies and tools to execute experiments, collect and compare results;

Excerpts from the section 'Drivers transforming the Next Generation Internet experimentation' (pg 6).

The drivers expected to transform the NGI can be categorised into advances in intelligent spaces, autonomous cooperative machines and collective user experiences supported by key networking technologies are summarised as follow:

- **Intelligent Spaces:** enabling computers to take part in activities in which they never previously involved and facilitate people to interact with computers more naturally i.e. gesture, voice, movement, and context, etc. Internet of Things (IoT) enrich environments in which ICTs, sensor and actuator systems become embedded into physical objects, infrastructures, the surroundings in which we live and other application areas (e.g. smart cities, industrial/manufacturing plants, homes and buildings, automotive, agrifood, healthcare and entertainment, marine economy, etc.).
- **Autonomous Cooperative Machines:** intelligent self-driven machines (robots) that are able 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.
- **Collective User Experience:** human-centric technologies supporting enhanced user experience, participatory action (e.g. crowd sourcing), interaction (e.g. wearables, devices, presentation devices), and broader trends relevant to how socio-economic values (e.g. trust, privacy, agency, etc.) are identified, propagated and managed.
- **Key Networking Technologies:** physical and software-defined infrastructures that combine communications networks (wireless, wired, visible light, etc.), computing and storage (cloud, fog, etc.) technologies in support of different models of distributed computing underpinning applications in media, IoT, big data, commerce and the enterprise.

| Report/workshop Name, Author, Date | Specific Topics raised: |
|--|--|
| Speech by Andrus Ansip, Commission Vice-President for the Digital Single Market, at the Next Generation Internet Summit 6/7 June 2017 Date: 6 June 2017 | <ul style="list-style-type: none"> ■ Cybersecurity and online privacy, ■ Common technical standards and interoperability ■ Internet of Things. ■ High-performance and quantum computing, ■ Big data ■ Cloud services. ■ Data deluge ■ Intelligent machine learning. ■ Robotics ■ Artificial intelligence |

- Single e-identity
- Digitisation's effect on society and jobs
- Online power being concentrated in the hands of a few big companies and platforms

https://ec.europa.eu/commission/commissioners/2014-2019/ansip/announcements/speech-vice-president-ansip-next-generation-internet-summit_en

Excerpts from the speech:

“ There would seem to be a choice of two paths:

Is Europe to remain a mere consumer of internet technology, services and applications – and perhaps be progressively dominated by other countries, or companies?

Or should Europe become more pro-active? To develop internet tech that will better serve its people and put them more in control of the digital society where they live?

I think this is the choice that we should prefer – in partnership with other like-minded countries. “

“ We are looking into this, to anchor technology as a firm priority in the EU's next seven-year funding period. The next generations of tech innovators represent Europe's digital future. I strongly believe in investing in startups and hi-tech research, both politically and financially: to build a new class of internet innovators, to help them grow and compete globally.

The Digital Single Market has a strong focus on data in all its aspects. This is vital, given how much we already depend on data– and will increasingly depend in the future. It also recognises the importance of **cybersecurity and online privacy, common technical standards and interoperability**, especially in areas like the **Internet of Things**.

And it addresses emerging growth technologies that will define our digital future – like **high-performance and quantum computing, big data and cloud services**. But we need to look even further ahead than that.

Nobody really knows how the internet will look by 2050, although we can see some trends that promise to turn today's global internet landscape upside down.

Data will need to be instantly available whenever - and wherever - anyone needs it. Big data and metadata will touch nearly every aspect of our lives. Data flows will be all-important, as they are now - but even more so. Global volumes are already huge. They are set to rise further, coming from both public and private sectors. The age of the zettabyte – or one trillion gigabytes – has already arrived.

Some forecasts put the global datasphere rising 10 times from current levels by 2025, to 163 zettabytes.

But by 2050, who knows? After the zettabyte comes the yottabyte.

We have to prepare for this **data deluge**: storage, infrastructure, security, transferability - to name

just a few issues to tackle.

In the next 30 years, if not sooner, the **Internet of Things** should be a widespread reality. Analytic and processing capabilities will have progressed and offer **intelligent machine learning**. **Robotics and artificial intelligence** will be more system-embedded and mainstream.

We could imagine depending less on specific connected devices, and more on the most appropriate one that is immediately to hand. In the years to come, that is unlikely to be a home or office desktop, and perhaps not a laptop either.

Most forms of future computing infrastructure and networks will be defined by software, not hardware.

We may be using keyboards far less, perhaps relying more on voice or gesture recognition. Or something else entirely.

Sensors will become more widespread - on our bodies, in homes and vehicles.

The cloud will dominate, based on high-speed mobile access – as well as its on-the-go convenience. “

“Why not create a **single e-identity**? Individuals would be in full control, using it to connect securely to different technologies and platforms.

This would also give people confidence, since we know that they have a lot of different concerns about the digital age:

- about **digitisation's effect on society and jobs**, about **cybersecurity and privacy**;
- about **online power being concentrated in the hands of a few big companies and platforms**;
- about the impact of **artificial intelligence**. “

“ With the Next Generation Internet, I would sum up our aim as this:

- to put Europe at the heart of internet technology developments;
- to help Europeans push farther the frontiers of tech;
- and to retain people's trust in the online environment as well as their internet engagement. “

Report/workshop Name, Author, Date

Specific Topics raised:

Internet of Humans - How we would like the internet of the future to be

‘Bruno Kessler Lecture ‘ by Roberto Viola,
Director-General for Communications

- A more human-centric Internet.
- Artificial Intelligence
- Robotics
- Internet of Things
- Security and Trust

Networks, Content & Technology at the EC

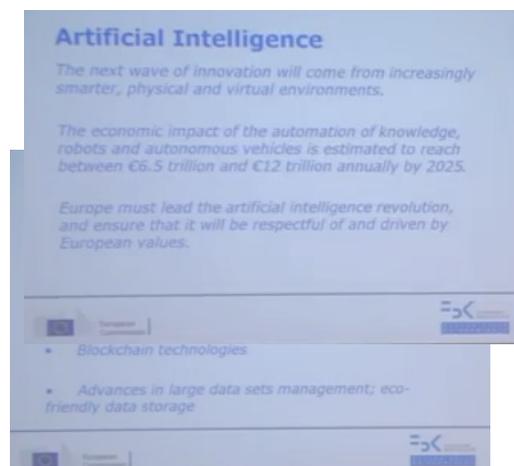
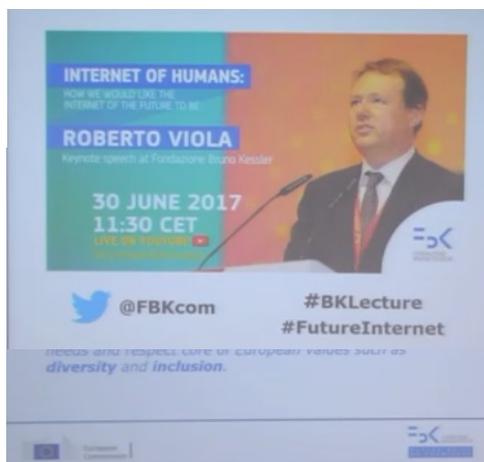
Date: June 30, 2017

- Man-Machine Interactive Technologies: Speech Recognition / Augmented Reality / Virtual Reality
- Language technologies
- Inclusion
- Blockchain
- Personal information management services (PIMS) (= "personal data spaces")
- Electronic ID standards
- Security and the authentication of the communications
- Encryption standards
- Quantum Technology
- Data compression
- Eco-friendly data centres and data storage

<https://ec.europa.eu/digital-single-market/en/news/internet-humans-how-we-would-internet-future-be>

<https://youtu.be/zUqnA0-cDml>

Excerpts from the slides:



Excerpts from the speech:

“I am delighted to address in this lecture a topic that is very important to me and I think to you all: the Internet; the great opportunities it provides, the concerns it raises and how we as Europeans can contribute to the development of a **more human-centric Internet**. “

“ Recent advances in **Artificial Intelligence** will be critical to turn the increasingly growing mass of information into knowledge and to provide autonomy and intelligence into networks, robots and connected objects. Indeed, a next wave of innovation will come from our seamless immersion in increasingly smarter physical and virtual environments powered by Artificial Intelligence. “

“**Artificial Intelligence** and **robotics** are key drivers of future economic and productivity growth. Many sectors including health and agriculture will benefit from these technologies, be it faster and more accurate diagnosis of diseases or a more favourable environmental footprint that can reduce pesticide usage. The economic impact of the automation of knowledge work, robots and autonomous vehicles is estimated to reach between €6.5 trillion and €12 trillion annually by 2025.”

“ It is essential for Europe to make the necessary efforts to lead the **Artificial Intelligence** revolution, to ensure that it will be respectful of and driven by the core European values that characterise our society. “

“ What about **Internet of Things** and **AI**? In this case, it is not only about extracting information from data collected by sensors and devices, but how to use such information to increase the level of autonomy of the systems around us, such as cars, robots or connected devices, and make them more useful to their users.”

“The deployment of the Internet of Things might create scenarios which go beyond the scope of existing legislation. We need to develop a framework that facilitates citizen acceptance, notably in terms of **security and trust**.”

“ Another area where we are witnessing a technological revolution is **Man-Machine Interactive Technologies** that is producing a paradigm shift in the way humans interact. **Speech Recognition** and **Augmented Reality** are two of the most noteworthy examples of this evolution and are uncontested game changers.”

“Interactive technologies are delivering information in more natural, efficient and less intrusive ways, providing enhanced and personalised user experiences. In **Augmented Reality**, Pokemon Go hit the market less than a year ago, In **Virtual Reality** we have seen recently the first general public headsets hitting the market with consumer applications that are so far mainly limited to the entertainment area.”

“A human centric Next Generation Internet shall reflect the **openness, diversity** and the **inclusion** that are at the core of European values. We want an open Internet that allows every citizen to interact and, from all walks of life, to take part in the online society. We want an internet that empowers citizens not discriminates them.

Let me mention two very concrete hurdles faced by citizens today every time they go on the Internet:”

“Today, **Language Technologies** are increasingly embedded in mobile communications, in intelligent assistants. They have allowed a multitude of innovative IT products and services in wide range of industries. The use of Language Technologies in the automotive sector for example will witness considerable growth as more and more (connected) cars are being fitted with voice-activated controls of various kinds. We are only at the beginning of an ever more, intelligent, deeper human-machine interaction.”

“The second core value is **inclusion**. The Internet has been, justifiably, regarded as having enormous potential for promoting the inclusion of people with disabilities. The challenge of the Next generation Internet will be to serve the needs of these consumers”

“I also want to address other related aspects that will have a strong influence in the future developments of the Internet:

- **Privacy, security and identity management** in the Internet;
- **Blockchain** driving Next Generation Internet developments;

“An emerging offer of **personal information management services (PIMS)**, also referred to as **"personal data spaces"**, may be able to make consent work and thus give companies legal certainty on what they can do with the data. Companies that require good quality, up-to-date personal data for their operations and want to be sure that they comply with the GDPR may take PIMS as an opportunity. This includes online retailers, consumer brands, banks and insurance companies.”

“Along with management of personal information, there is the need for internet users to be identified regardless of the platform they use when and if needed. This brings up the issue of **electronic ID standards – ideally leading to universal public eID**. An ID that is platform independent, standardised and perhaps global. Identification of individuals is a key feature of citizen-centric society – the same applies online. “

“**Security and the authentication of the communications** are also critical for the Internet, given the ubiquity of electronic platforms and systems in today's world. Cybersecurity, attacks, fishing and leaks are making the news regularly. As policy makers should look at these aspects very seriously and with a long term perspective.”

“Some of the best known **encryption standards** used worldwide were invented in Europe. But there is a constant race against hackers, so new techniques keep developing”

“You probably know **Quantum Technology**. It is a very promising field that uses quantum effects of particles and their very specific properties. “

“Another technology I want to touch upon is **blockchain** as a driver for Next Generation Internet developments. Blockchain is, quite simply, a digital, decentralized ledger that keeps a record of all transactions that take place across a peer-to-peer network. The major innovation is that the technology allows market participants to transfer assets across the network in a verifiable and permanent way without the need for a centralized third party.”

“I want to address recent advances on **data compression** that are critical to handle large data sets (big data).”

“Large data sets need to be processed and stored. **Eco-friendly data centres and data storage**, are part of a more human centric vision of the future.

“What lies ahead of us?”

In my vision of the Next Generation Internet, research has to lead technology development but it has also an important role in identifying emerging issues that will steer the policy debate. In the remaining of the Horizon 2020 research and innovation programme we proposed under the Next Generation Internet umbrella a set of technology areas that will drive the developments towards a **more human-centric Internet: Artificial Intelligence, Internet of Things, interactive technologies,**

future media and social networks, as well as language technologies and inclusion. Universal identity and personal data spaces are also expected to play a major role. And one could foresee the Next Generation Internet continuing to be a very ambitious initiative also in the successor of the Horizon 2020 programme.”

| Report/workshop Name, Author, Date | Specific Topics raised: |
|--|--|
| Citizen Engagement And Media Campaign On The Next Generation Internet, Atomium European Institute / REI-search Date: May 31, 2017 | <ul style="list-style-type: none"> ■ Inclusion ■ Participation and Interest ■ Net neutrality ■ Privacy and Surveillance ■ Data ownership ■ Fintech ■ Security -with respect to cybercrime ■ Security- with respect to critical infrastructure ■ Virtual Reality ■ Augmented Reality ■ Blockchain ■ Distributed Ledgers ■ Dominant American Platforms ■ Connected European Poles of Excellence ■ Development of business excellencies ■ Job automatization ■ SMEs’ and civil society organisations’ ability to profit from NGI technologies ■ Innovative teaching ■ Methods, supporting skills exchanges and ICT-enabled learning. ■ Tackle eco-chambers, filter-bubbles, fake news and hate-speech ■ Fair balance between right to access information and freedom of speech ■ Improve awareness about the potential of NGI ■ access to fast broadband |

<https://ec.europa.eu/futurium/en/system/files/ged/report-campaign2017.pdf>

Excerpts from the section ‘Executive Summary’ (pg 2 - 8):

ENGAGEMENT AND INCLUSION

1. In terms of **participation and interest**, it is clear that the discourse around technology, and particularly around the next generation internet, is limited to a relatively small group of highly educated and invested people. It is also remarkably male dominated, and young people are hugely underrepresented. This suggests that targeted communication and awareness raising actions are needed at EU as well as at national and local level if we want to extend the debate on the Next Generation Internet to EU citizens and, most importantly, if we want them to fully benefit from the positive socio-economic potential of internet technologies.

2. In our sample, most people expressing their opinions on NGI technologies and their impacts are aware of both risks and opportunities implied by the ongoing digital revolution. They are genuinely interested in

several issues, and looking for further information and dialogue, beyond both technocratic optimism and pessimism. This is particularly evident from our network and sentiment analysis, where many conversations are about preserving **net neutrality** and **equal access to the internet**, or making sure that user **privacy, security, and data ownership** are preserved, and that data based profiling doesn't result in manipulation of people or the democratic process.

BUSINESS, JOBS AND SKILLS

3. Both our online consultation and network/sentiment analysis show that it will be key to invest and catalyse investment in promising areas. This includes stepping-up efforts to develop the European Data Economy according to the Digital Single Market Strategy, and building on European excellence such as the increasingly well-established **Fintech** sector. It also includes capitalizing on the need – and space – to develop cutting-edge solutions and businesses in the privacy protection and cyber-security areas. Indeed **security (Cybersecurity, Cyberattacks, Malware...), Privacy and Surveillance** are at the centre of Europeans' concerns.

The potential of **AI, Virtual Reality (VR) and Augmented Reality (AR)** in the customer management and marketing field should also be leveraged. Emerging technologies such as the **blockchain** and **distributed ledgers** – which are still not familiar to most people - should be supported, and funding should be devoted to the creation of European platforms based on open source and democratic principles which could provide a decentralized alternative to the **dominant American platforms** that aggregate data at a worldwide level. Supporting the creation of **connected European poles of excellence** in the abovementioned areas could also contribute to raise citizens' confidence in our economy. Designing actions to support the **development of business excellencies** answering priorities which are typically European could greatly contribute to bring Europe at the centre of the Next Generation Internet.

4. In line with the Reflection Paper on the Future of Social Europe, Member States and local governments should be supported in the effort to adjust their social protection systems to the ongoing technological revolution. More research and experimentation is needed to pilot and scale new institutional arrangements and governance models to compensate employment or revenue losses caused by ongoing **automatization processes**.

5. Policy interventions and investments should aim to increase **SMEs' and civil society organisations' ability to profit from NGI technologies**. Indeed, SMEs and civil society organisations are not currently perceived as well placed to take full advantage of NGI technologies, in stark contrast to established tech companies and start-ups.

6. It is important to raise people's awareness of the significance of acquiring ICT skills throughout their lives, encouraging collaboration among public and private institutions to develop and disseminate **innovative teaching**

methods, supporting skills exchanges and ICT-enabled learning.

SOCIAL MEDIA, DEMOCRACY AND THE PUBLIC SPHERE

7. The relationship between internet technologies and democracy is highly conflicted and uncertain, with users wondering if and to what extent recent elections (particularly the US Presidential elections and the Brexit referendum) were influenced by big-data based profiling and targeting of voters, often based on fake-news. Fears about collusion between government and tech companies to spy on citizens and implement social control policies are also recurrent, and from this point of view Europe - with its advanced Personal Data Protection regulations - appears particularly well placed to re-establish trust in the internet for connecting with public debate and democratic processes. Europeans highly value their

right to access reliable, well documented and diverse contents, and are hugely concerned by the possibility of being profiled and manipulated via targeted messages. Indeed, nearly 80% of our online survey participants agreed that action is needed to **tackle phenomena such as eco-chambers, filter-bubbles, fake news and hate-speech.**

8. Making sure that there is a **fair balance between right to access information and freedom of speech** is also a key point. Further research is needed to validate this hypothesis, but from our network/sentiment analysis and online consultation it seems that while a majority of people support a “hard-regulation” approach to issues such as data/privacy protection, most people are against the idea of regulating tech-companies on fake-news, since this would imply a high-risk of censorship and social control.

9. Particularly from our online consultation, there seems to be relatively **little awareness about the potential of NGI** technologies to address and overcome a broad set of socio-economic challenges. The potential to foster financial inclusion, increase SMEs and social enterprises’ competitiveness, or encourage civic engagement and social solidarity are all underestimated across Europe. This would call for specific awareness raising and communication actions, as well as for exchange of knowledge and best practices in this area.

IMPACT OF NEW TECHNOLOGIES ON CITIZENS’ LIVES

10. Our network analysis shows that **privacy** is tightly connected to all the major topics of discussion around NGI technologies and their socio-economic impacts, including health, traffic, home automation, Internet of Things (IoT), Apps, cloud computing, and the use of personal data for commercial or political purposes. People’s overarching sentiment is one of open fear and nervousness regarding the protection and promotion of privacy and net neutrality.

11. The network/sentiment analysis shows that security is most often discussed in relation to the topics of **data security, cybersecurity, and data protection including encryption, ransomware, and malware.** The online consultation confirmed that as citizens and machines become increasingly interconnected and applications “running” the Internet of Everything (IoE) proliferate, we will need new approaches to avoid potential **system breakdowns that could threaten critical infrastructure.** This is particularly the case for AI systems, where security (i.e. how we keep AI safe, secure, and protect ourselves against unintended AI consequences) and control (how we stay in control of AI) were identified as the two most important issues to address.

12. As **access to fast broadband** becomes increasingly necessary for both our personal and working life, it will be key to ensure that the right infrastructure is in place and that citizens and organisations are not discriminated against based on their economic background. It will also be key to create adequate digital infrastructure across the single

market by: (i) rapidly adopting and implementing relevant legislation; (ii) ensure that more funds are allocated to digital infrastructures via the Europe Connecting Facility, EFSI and structural funds; and (iii) implementing the 5G Action Plan.

| Report/workshop Name, Author, Date | Specific Topics raised: |
|---|---|
| Horizon 2020 Draft Work Programme 2018-2020, version Draft June 22, 2017 Date: June 22, 2017 Author: EU Member States representatives | <ul style="list-style-type: none"> ■ Next Generation Internet - An Open Internet Initiative ■ Interactive Technologies * ■ Artificial Intelligence * ■ Internet of Things * ■ Future Hyper-connected Sociality ■ A multilingual Next Generation Internet ■ An empowering, inclusive Next Generation Internet * |

■ EU-US collaboration on NGI

**= considered to proceed after 2020*

(Report not publicly published)

See Chapter 4.1, and Annex 5 of this report with all the detailed references to this Work Programme

Annex 14: List of individuals

In addition to the participants of the workshop (see Annex 16), the study team especially thanks the following individuals for their cooperation while this report was being written. Note that inclusion in the list below in no way means that any of the contents of this report is endorsed by themselves or their organisation.

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Annex 15: Top 10 Strategic Technology Trends for 2017

Gartner Research Highlights Intelligent: AI and Advanced Machine Learning Enhance Systems

AI and machine learning have reached a critical tipping point in capability, and will augment and extend virtually every technology-enabled service, thing and application.

Creating systems that learn, adapt and potentially act autonomously will be a major battleground for technology vendors through at least 2020. The ability to use AI and machine learning to enhance decision making, reinvent business models and ecosystems, and remake the customer experience will drive the payoff for digital initiatives through 2025.

Three tightly linked trends form the intelligent theme for our 2017 strategic technology trends:

- AI and advanced machine learning
- Intelligent apps
- Intelligent things

AI and advanced machine learning include technologies such as deep learning, neural networks and natural-language processing. They also enable more advanced systems that appear to understand, learn, predict, adapt and even operate autonomously, rather than being programmed only for a finite set of prescribed actions. For example, machine learning can create probabilistic models from wind turbines, solar panels and soil actuators to predict when failures will occur.

Intelligent apps deliver advanced analytics, autonomous business processes, and immersive, conversational and continuous interfaces. AI-powered natural-language recognition makes possible new categories of apps, such as virtual personal assistants (VPAs), driven by voice interfaces. These have the potential to transform the workplace by making everyday tasks easier and users more effective. Every software category, from security tools to enterprise applications such as ERP, will be infused with AI-enabled capabilities. By 2018, Gartner expects that most of the world's largest 200 companies will exploit intelligent apps and use the full toolkit of big data and analytics tools.

Intelligent things are computing devices and Internet of Things (IoT) sensors and things that make use of AI and advanced machine-learning capabilities embedded in the thing or in a connected cloud service. These enhanced capabilities make possible new intelligent things, such as advanced robots. They create opportunities in industries such as retail, where robots are acting as store greeters, and farming, where self-driving tractors, robots and drones could increase farm yields and efficiencies. Existing things, including IoT devices, will become intelligent, potentially delivering the power of AI-enabled systems everywhere, including the home and medical facilities. As intelligent things evolve, they will shift from a stand-alone to a collaborative model in which they communicate with one another and act together. However, non-technical issues such as liability and privacy, along with the

complexity of creating highly specialized assistants, will slow embedded intelligence in some scenarios.

Anthropomorphic AI will simplify the world for users and shape choices across all areas of their lives, including family, friends, health, finance, travel, work and life goals.

Digital: Bringing Together the Real and Virtual Worlds

The lines between the digital and physical worlds continue to blur, creating new opportunities for European businesses.

Gartner analysts predict that the digital world will be an increasingly detailed reflection of the physical world, and the digital world will appear as part of the physical world, creating fertile ground for new business models and digitally enabled ecosystems. Three loosely related areas form the digital theme in Gartner 2017 top strategic technology trends:

- Virtual reality (VR) and augmented reality (AR)
- Digital twins
- Blockchains and distributed ledgers

VR and AR transform the way individuals interact with each other and with software systems, creating an immersive environment. For example, VR can be used for training scenarios and remote experiences. AR, which blends the real and virtual worlds, enables businesses to overlay graphics onto real-world objects. Immersive experiences with AR and VR are reaching tipping points in terms of price and capability, but they won't replace other interface models. Over time, AR and VR will expand beyond visual immersion to include all human senses. Enterprises should look for targeted applications of VR and AR through 2020.

The IoT has climbed to the top of the Gartner "Hype Cycle for the Internet of Things, 2016." Many sub-trends are emerging that build on the broad notion of the IoT. One such trend is digital twins. Within three to five years, billions of things will be represented by digital twins, which are dynamic software models of physical things or systems. Using physics data on how the components of a thing operate, as well as data provided by sensors in the physical world, organizations can use a digital twin to analyze and simulate real-world conditions, respond to changes, improve operations and add value. Virtually every IoT thing could have a digital twin. This opens a new set of opportunities for AI-based analysis or control of the physical asset, although organizations will consider potential cost and complexity, particularly in the near term. Identifying clear business objectives and targeted value propositions will be crucial.

The digital world is spawning new techniques such as blockchains to digitize value transfer models. Blockchains are a type of distributed ledger in which value-exchange transactions (in bitcoin or other token) are sequentially grouped into blocks. Blockchain and distributed-ledger concepts are becoming more popular because they have the potential to transform industry operating models in areas such as music distribution, identity verification, the pharmaceutical supply chain and title

registry. They offer the promise of adding trust to untrusted environments and reducing business friction by providing transparent access to information in the chain. Most blockchain initiatives are in alpha or beta phases, and significant technology challenges exist. Enterprises will explore the long-term potential for disruption, but be cautious about implementations through 2019.

Mesh: Making the Connection

Digital businesses are evolving into digital ecosystems that drive value through increased interactions between business, people and things.

The mesh theme in Gartner top strategic technology trends for 2017 refers to exploiting connections between the expanding set of people and businesses — as well as devices, content and services — to deliver digital business outcomes. Dealing with the increasing complexity of connections and capitalizing on digital business ecosystems require fundamental changes to the user experience, as well as the underlying platforms, architectures and technologies.

Four of our top strategic technology trends deal with different aspects of the mesh:

- Conversational systems
- Mesh app and service architecture (MASA)
- Digital technology platforms
- Adaptive security architecture

Conversational systems can range from simple, informal, bidirectional text or voice conversations (such as that beginning with the question "What time is it?") to more complex interactions (such as collecting oral testimony from crime witnesses to generate a sketch of a suspect). Conversational systems shift from a model in which people adapt to computers to one in which the computer "hears" and adapts to a person's desired outcome. Conversational systems enable people and machines to use multiple modalities (such as sight, sound and touch) to communicate across the digital device mesh (through devices — including sensors, appliances and IoT systems).

The MASA is a multichannel solution architecture. It uses cloud and server-less computing, containers and micro-services, as well as APIs and events, to deliver modular, flexible and dynamic solutions. Solutions ultimately support multiple users in multiple roles, using multiple devices and communicating over multiple networks. MASA is a long-term architectural shift that requires significant changes to development tooling and best practices.

Digital technology platforms are the building blocks for a digital business and are necessary to create digital ecosystems.

Every organization will have a mixture of five digital technology platform elements:

- Information systems
- Customer experience

- Analytics and intelligence
- The IoT
- Business ecosystems

New platforms and services for the IoT, AI and conversational systems will be a key focus through 2020. Everything is opened up through APIs, integrated and made programmable. By 2020, 75% of integration platforms will use machine learning to automate integration between application APIs, reducing the need for integration specialists. Organizations will identify how industry platforms will evolve and devise ways to adapt their platforms to meet the challenges of digital business.

Adaptive security architecture deals with the security ramifications of the digital business, with particular emphasis on the security needed to support flexible digital ecosystems, the IoT and AI based systems. Security has to become fluid and adaptive. Security in the IoT environment is particularly challenging. Security teams need to work with application, solution and enterprise architects to consider security early in the design of applications and IoT solutions. Almost every enterprise will have to use multilayered security and user and entity behaviour analytics.

Annex 16: Workshop participant biographies

Moritz Bartl serves as the director of the **Renewable Freedom Foundation** in Germany and is co-founder of the **Center for the Cultivation of Technology**. Moritz has been active in the free software and hacker community for over 15 years; he's a core member of the **Tor** project, a fellow at the **Hermes Center for Transparency**, co-founder and board member of the **OpenLab Augsburg** hackerspace, and a board member of the **CypherChaikana** project for Central Asian citizen infrastructure projects. As director of a digital human rights foundation, he works in close partnerships with many international NGOs in technology, open source advocacy, and tech policy areas. Moritz studied computer science at **TU Dresden**, with a focus on privacy and anonymity, software engineering, project management, and machine learning.



Lars Eggert is Technical Director for Networking in **NetApp's Office of the CTO**, based in Munich, Germany. He is a senior networking technologist with deep expertise in areas such as architectures, system and protocol design, and virtualization. Lars has been leading Internet standardization as part of the steering group, architecture board and as working group chair of the **IETF** for over a decade, and has chaired the **IRTF**, the **IETF's** research arm. He is a senior member of the **ACM** and the **IEEE**, and serves on the program and organization committees of academic conferences such as **ACM SIGCOMM** and **IEEE Infocom**, as well as other boards, such as **ACM SIGCOMM's** Industrial Advisory Board. Lars received his Ph.D. from the **University of Southern California (USC)** in 2003. Before joining **NetApp** in 2011, he was a Principal Scientist at **Nokia** and served on the corporation's CTO and CEO Technology Councils of senior technology experts. From 2009-2014, Lars was an Adjunct Professor at **Aalto University**, Finland's top technical university. From 2003-2006, he was a senior researcher at **NEC Labs**.



Stephen Farrell is a research fellow in **CONNECT**, a **Science Foundation Ireland** research institute and the school of Computer Science and Statistics at **Trinity College Dublin**, where he **teaches and researches** on security and delay/disruption-tolerant networking (DTN), and in 2006 co-authored the first **book on the latter topic**. He is a co-founder of **Tolerant Networks Limited**, a TCD campus company. Stephen has been a security area director in the **Internet Engineering Task Force** since 2011.

The main funding that supports Stephen in his role as area director comes from the **CONNECT** centre, with additional support from IE Domain Registry Limited (**IEDR** - the .ie ccTLD) and Google.



Mat Ford joined the **Internet Society's** Standards & Technology Department in September 2008. As Technology Programme Manager, he organizes and leads aspects of the Internet Society's work in advancing the development and deployment of open standards and promoting the Internet's collaborative development and operational management model. Mat is the Internet Society liaison to the **Internet Architecture Board** and has contributed to the **IETF** for many years. Mat has led collaborative research projects and chaired the cluster of IPv6 research projects supported by the European Commission. Mat is the Editor of the **IETF Journal** and works closely with the **Internet Research Task Force** to promote greater collaboration between the networking research community and the IRTF. Mat's background includes development of network security designs for a range of platforms, research and development in IP mobility and IPv6, as well as developing platforms to demonstrate research results. Prior to joining the Internet Society Mat was Principal Researcher at **BT's** Networks Research Centre.



Sarah Grant is a NYC + Berlin-based media artist and teacher. She has been a Research Fellow at the **Tow Center for Journalism** at **Columbia**, Adjunct Professor at **NYU Polytechnic** in Digital Media. Currently she is an Impact Resident at the **Eyebeam Art and Technology Center**. She makes art with computer networks and radio technology while researching and developing educational tools and workshops that demystify these concepts for the ordinary citizen. She is the author of **Subnodes** and organizes the **Radical Networks** conference in Brooklyn. Together with Danja Vasiliev she runs a studio for commercial work called **cosmic.berlin**.



Dr. Nana Karlstetter has studied Philosophy, Mathematics and Psychology and holds a PhD in Applied Economics. She is a project developer and manager mostly in the fields of digital security/free software and environmental protection/climate change. At the moment she works for the **p≡p Foundation** (Winterthur) and the **Forschungsgruppe Ethisch-Ökologisches Rating** (Goethe University Frankfurt a. M./Agentur Zukunft, Berlin). She has been in the context of the **Chaos Computer Club Berlin** since the 1990s. Since 2012 e.g. in projects with **Wau Holland Stiftung** and other organisations close to them, for instance in the project group **youbroketheinternet** (YBTI). With the input of others she developed this **project map**. The YBTI group formulated a **vision for the Internet of the 21st century**. The YBTI initiative made a start in identifying issues to be solved and jobs to be done in order to realise a free, open, reliable and trustworthy Internet. And then find the right people and projects to fix them, e.g. also by diversifying and connecting more between different communities.



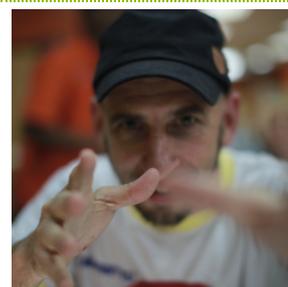
Lousewies van der Laan is member of the board of **ICANN**. She is a former member of the **European Parliament** for **D66**, and served as Vice-president of the Budget Control Committee and the Committee on Justice and Civil Liberties. She was also a member of the Committee for Equal Opportunity and Women's Rights and co-founder of the Intergroup for LGBT Rights and the Campaign for Parliament reform, working to make the Parliament more transparent and accountable. She was also a member of the Dutch **House of Representatives**. She has had an international career, working for the **European Commission**, the **European Bank for Reconstruction and Development**, and as chief of staff of the President of the **International Criminal Court** in The Hague, which was set up by governments to fight impunity worldwide. She currently works as an **independent consultant** on strategy, communication, public affairs and politics, democracy, human rights, rule of law and good governance. She currently serves as vice-president of the Alliance of Liberals and Democrats for Europe.



Taeho Lee is a Ph.D. student in the **Network Security Group** led by Adrian Perrig at ETH Zürich. His main research area is designing a secure future Internet architecture. Specifically, he is interested in designing a network architecture that aims to support both privacy and accountability. Before joining ETH Zürich, he worked as a researcher at **Electronics and Telecommunications Research Institute** (ETRI) in South Korea. In ETRI, he was part of the future Internet research team that worked on a mobility-oriented network architecture.



Carlo von Lynx is the architect behind **secushare.org** and a promoter of technologies that try to build a kind of Internet that by design respects the Rights of the People. Carlo is critical of attempts to try to use the **existing infrastructure**. A complete overhaul of the Internet architecture is needed, and it is coming so late, it has to be **imposed by regulation**. One that is end-to-end encrypted, forward secure, scalable and distributed in a mesh architecture free of points of failure such as servers. One that protects metadata, the information of who is connected to whom. That doesn't mean that law enforcement is entirely cut out from doing its job, however! **The right balance is feasible**. Carlo has a background in network protocol design and high scalability systems. His best-known contribution to the Internet is however rather harmless: It's IRC's **/me** command.



Nicholas Merrill is an American system administrator, computer programmer and entrepreneur. He is the founder of **Calyx Internet Access**, an Internet and hosted service provider founded in 1995, and of the non-profit **Calyx Institute**. He was the first person to file a **constitutional challenge against the National Security Letters statute** in the **USA PATRIOT Act** and consequently the first person to have a National Security Letter gag order completely lifted. Merrill subsequently founded the nonprofit Calyx Institute to provide education and research on privacy issues. The advisory board of the Calyx Institute includes many notable people in the fields of telecommunications, cryptography, privacy advocacy and computer security, including **John Perry Barlow**, **Laura Poitras**, **Susan Herman** and **Bob Barr**. The Calyx Institute is a member of the **torservers.net** network, an organization of non-profits which specializes in the general establishment of **Tor** anonymity network exit nodes via workshops and donations.



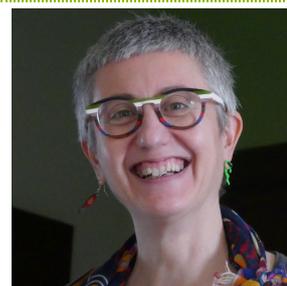
Stefan Marsiske is a free software developer who cares about human rights in the Internet context, he supports various organizations dealing with such issues. He is a founder of startups, a few hackerspaces, and the **Asimov Foundation**. He served as the VP for infrastructure in the Hungarian Open Standards Alliance. He has ten years of telecommunication industrial background. Among others.



Pablo Neira Ayuso is head of the core team of **Netfilter**, packet filtering framework inside the Linux 2.4.x and later kernel series. The Netfilter Core Team are the people who make the decisions, have commit access to the master Source Control Management (SCM) tree. He works for the **University of Seville**.



valentina hvale pellizzer¹ is an activist that connects women rights, sexual rights, and the Internet politically and practically and advocate for the **feminist principles of the Internet** and the commons and, since 2007 regular contributor of the **Global Information Society Watch**. She is serving pro-bono as president @ **OneWorld Platform**, an organization that tackles and researches the intersection between Internet Rights, Women Rights and the Transformative power of technology. She has a background in law studies. Her encounter with the Balkans date back to 1994 and humanitarian aid, working with women refugees, displaced persons and



returnees in Croatia, Macedonia, Kosovo, Albania and Bosnia, and again back on the Refugees Balkan Route in 2015. In 2014 she led the first regional training on ICT and Violence against Women, Privacy and Security online **Women Rock IT**, which is now at its 4rd edition. Her engagement with internet and digital rights varies from policy advocacy to capacity. Facilitator on strategic use of ICTs, digital security, privacy, citizen journalism and visual methodology for social change that combine solidarity with **digital storytelling** and its powerful peer-to-peer co-production, distribution and outreach. She is Coordinator for the **Erotics South Asia** and Movement Building at the **Association for Progressive Communication** (APC) - Women's Rights Program. Prior to that she served for ten years on the Board of Directors of APC.

¹(small letters as per bell hooks)

Rick van Rein is the lead architect for the **ARPA2** project, and founder of **InternetWide.org**. After having gone through an extensive educational career that led him from vocational school in electrical engineering to a engineer title and a PhD degree in computer science from the **University of Twente**, he obtained a doctoral thesis on **proof methods for process models**. He worked as a researcher and teacher at Icon Computing (Austin TX) and at Twente University before he launched his own company **OpenFortress** as an independent cryptographer. His company works on the security of network protocols and privacy-related technologies. Inside the internet world he is involved with technologies like IPv6, DNSSEC, SIP, Kerberos, TLS, OpenPGP and X.509. He is a prolific open source contributor, ranging from the Linux kernel to projects such as **OpenDNSSEC**, **TLS Pool**, **Ocpm** Firmware and **6bed4**.



Liz Steininger is the CEO/Managing Director of **Least Authority** in Berlin, a company supporting people's right to privacy through the development and support of free and open source software and providing security audits to other projects. Prior to joining Least Authority, Liz was an independent strategist focusing on sustainability for digital-rights friendly projects and a Senior Program Manager at the **Open Technology Fund** (OTF) at **Radio Free Asia**, where she utilized public funds to support internet freedom projects and the community structures that support them. Liz has worked for local and federal US governments to adopt digital systems and foster innovation from within, including open source software implementations and local community partnerships. She's been a Project Manager, Program Manager and Analyst on numerous tech development projects over her 16 years in both public organizations and private companies. She is passionate about diversity in tech and founded the DC chapter of **Rails Girls** in 2012. She holds an M.S. in Management & Technology from **Carlow University** (2007) and B.S. in Digital Media from **Drexel University** (2001).



Brian Trammell is a Senior Researcher at the **Networked Systems** and **Network Security** groups at **ETH Zürich**, where his research focuses on Internet architecture, Internet measurement, and the deployable evolution of Internet protocols. He is a member of the **Internet Architecture Board**, where he leads the Board's **IP Stack Evolution Program**, and co-chairs the IETF's **IP Performance Measurement** (IPPM) working group.



Lea Verou is currently busy researching how to make web programming easier at **MIT CSAIL**. She is the author of bestselling advanced CSS book **CSS Secrets** and has worked as a Developer Advocate at **W3C**. She has a long-standing passion for open web standards, and is one of the few Invited Experts in the **CSS Working Group**. Lea has also started **several popular open source projects and web applications**, such as **Mavo**, **Prism**, and **-prefix-free** and maintains a technical blog at **lea.verou.me**. She holds a MSc in Computer Science from MIT. Despite her academic pursuits in Computer Science, Lea is one of the few misfits who love code and design equally.



Klaas Wierenga has an extensive background in innovation management, with an emphasis on identity, mobility and security. He oversees **GÉANT's trust & identity program** and manages the project development officers team. Before joining GÉANT as Chief Community Support Officer, Klaas was a senior consulting engineer and identity architect at respectively **Cisco Systems'** Research and Advanced Development group and Cloud Infrastructure Services group. Before that, Klaas was an innovation manager and manager of middleware services at **SURFnet**, the Netherlands NREN. There, Klaas built the first generation of federated identity systems at SURFnet and was the creator of the **eduroam** service for WiFi roaming in research and education. In 2012 Klaas was the recipient of the first GÉANT (then TERENA) Community Award for creating eduroam. Klaas served as chair of the GÉANT Task Force on Mobility for more than 10 years, as chair of the IETF **Abfab** working group, as a member of the **IETF Security Directorate** and as a TNC programme committee member and chair. Klaas is (co-)author of '**Building the Mobile Internet**' (Cisco Press, 2011) and '**Wireless Networking in the Developing World**' (2013), as well as three RFCs. He also holds five US patents.



Hans de Zwart is a member of European Digital Rights (EDRi) and the Executive Director of the Dutch digital civil rights organisation **Bits of Freedom**, fighting for freedom of communication and privacy on the internet. In the past he was Senior Innovation Adviser for Global HR and Learning Technologies at **Shell**, before that a Moodle consultant for Stoas Learning (recently renamed to **Up Learning**) and he started his career as a Physical Education teacher at a high school in Amsterdam. He operates on the intersection between technology (which he prefers to be “open”) and society, often viewing issues through a civil rights lens. He knows that



technology is always political and believes in the power of design.

Lizzie O'Shea is an Australian-Irish human rights lawyer, **broadcaster** and writer living in London. She has worked with indigent prisoners on death row in the Deep South of the US and at the United Nations in Geneva. She was a fellow at **Witness**, an organization that trains activists to use video for justice and advocacy. She has also run **Copwatch** workshops in Australia, working with Aboriginal communities to use mobile phones to film police interactions for accountability. She represents **Blueprint for Free Speech**, a non-profit charity that works internationally to promote the right to freedom of expression without undue interference or intrusion. It specializes in the right to publish, whistleblower protection, government transparency, data privacy and Internet freedom.

