NEXT GENERATION INTERNET
THE EMERGING RESEARCH CHALLENGES

KEY ISSUES ARISING FROM MULTIPLE CONSULTATIONS CONCERNING THE NEXT GENERATION OF THE INTERNET

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Just as citizens are members of a civil society, they are also members of a digital society through their interactions over the Internet. These interactions have and will continue to evolve over time, and the current trends are towards continuous connection to the Internet, interconnectedness, ease of communication and collaboration. Many of these interactions have beneficial societal implications, but clearly there are also emerging dangers to citizens when they use the Internet.

This white paper provides a synthesis of major themes pertaining to the Next Generation of the Internet (NGI) extracted from recent consultations on societal, economic, design and legislative concerns, and their implications for technological developments of the Internet.

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DISCLAIMER

The content of this document is merely informative and does not represent any formal statement from individuals and/or the European Commission, instead is a public document from contributors with visionary perspective and based on years of experience towards Next Generation Internet.

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INTRODUCTION

This white paper provides a synthesis of major research themes pertaining to the Next Generation of the Internet (NGI) extracted from recent existing consultations on the societal, economic, design and legislative concerns, and their implications for technological developments of the Internet. The aim of the synthesis was to find common patterns and consensus, to see where there was agreement between the sources, and to see whether established knowledge was corroborated or disputed by current discussions.

The consultation sources were selected to provide a cross-section of established opinion, current discussions and new knowledge available at the current time, both from experts in NGI-related fields and the general public. The sources are a mix of results from large scale consultations with the general public and expert opinions from themed workshops and a major NGI-focused conference. All the sources are recent, the oldest being from Q4 2016.

TABLE 1. CONSULTATION SOURCE DESCRIPTIONS

#	Source Description	Type
1	Conclusions from a Workshop on Personal Data Spaces and Privacy, 9 December 2016. [Burada 2017]	Experts
2	Conclusions from a workshop entitled "Will we still have a single global Internet in 2025?" held at The Ditchley Foundation, 17-19 November 2016 [Ditchley 2016]	Experts
3	Results from the FIRE STUDY Next Generation Internet (NGI) Digital Innovation Networks Consultation involving a Delphi Study with an expert panel. [FIRE STUDY 2017] [Boniface 2016], [Boniface, Calisti & Serrano 2016], [Boniface et al 2017]	Experts
4	Results from a large-scale survey of European citizens. [Lipparini & Romeo 2017]	Public
7	Opinions expressed at Net Futures 2017, 28-29 June 2017, Brussels [Net Futures 2017]	Experts
6	Results from a large-scale survey on the Next Generation Initiative [Overton 2017]	Public
7	Conclusions from a policy workshop on Generation Internet at the Centre for Science and Policy, Cambridge Computer Laboratory, 1-2 March 2017. [Takahashi 2017]	Experts
8	Opinions expressed by experts at the Digital Innovation Networks Forum concerning how the process of innovation needs to change as a consequence of digitisation and connectivity, 27 June 2017 [DIN Forum 2017 - innovation process]	Experts
9	Conclusions from The Next Generation Internet workshop - Widen the European space of life and work. Workshop Report, 8 June 2017 [PSNC 2017]	Experts

The sources where analysed to identify and relate key concepts from consultation. These concepts are presented as a domain model as shown in Figure 1. This model defines the overall domain model after partial clustering[1], and gives an indication of decomposition into thematic clusters. The key decision factor in determining the theme and membership of each cluster was the strength of the thematic relationships between a core set of entities.

Some concepts were clearly thematically related to each other and this determined the cluster's theme. It was necessary to strike a balance between the specificity and generality of a theme. As an example, the concepts of *privacy* and *citizens' personal data* belong to the same cluster, whose overall theme is *privacy*. Other concepts, for example *citizens* and *regulation*, cut across many themes so they appear in multiple clusters, but if they were chosen as themes in their own right, the clusters would be too complex and too general.

For detailed information on the analysis please refer to the HUB4NGI public deliverable "D2.1 NGI GUIDE V1" [HUB4NGI D2.1].
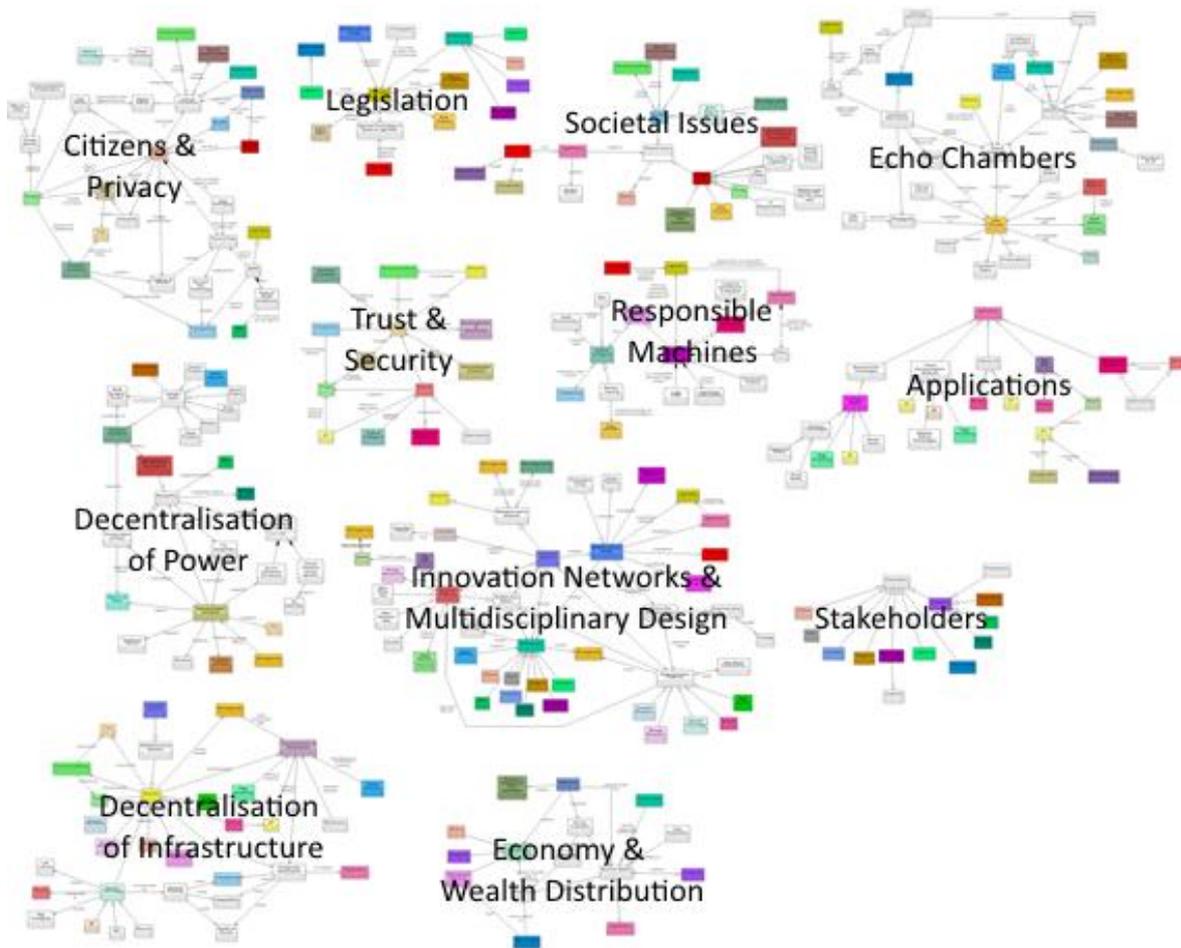

FIGURE 1: DOMAIN MODEL AFTER PARTIAL CLUSTERING

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[1] The detailed text in this diagram is not intended to be legible – the diagram is merely included to illustrate the decomposition process of the overall Domain Model.

CITIZENS' POSITION IN THE DIGITAL SOCIETY

Just as citizens are members of a civil society, they are also members of a digital society through their use of the Internet. Figure 2 shows the key elements. Citizens' interactions with the Internet have and will continue to evolve over time, and the current trends are towards continuous connection to the Internet, interconnectedness, ease of communication and collaboration. Many of these have beneficial societal implications, but clearly there are also dangers to citizens when they use the Internet.
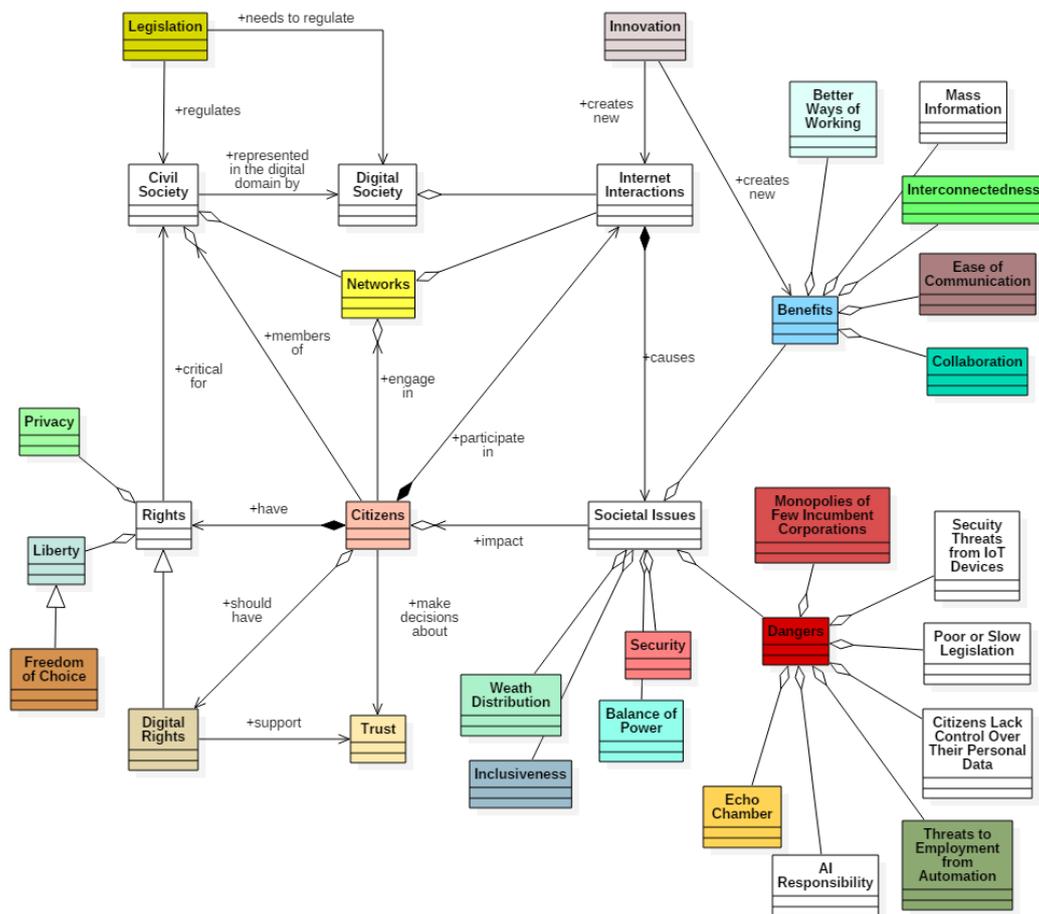

FIGURE 2: CITIZENS' POSITION IN THE DIGITAL SOCIETY

The following sections describe the key societal impacts of the Internet (benefits and dangers), as described by the sources. The main theme clusters are as follows, and these are described in detail in the following subsections.

➔ **Decentralisation.** This encompasses two subtopics: decentralisation of control, and decentralisation of infrastructure. Decentralisation of control is an aspiration, as it is seen by many of the sources that power is becoming too concentrated in the hands of a few large powerful players. Decentralisation of infrastructure refers to a trend towards distributed architectures such as edge computing or the Internet of Things.

➔ **Privacy.** This is the most often-mentioned concept in the corpus of sources, and protection of citizens' privacy in the context of the Internet is a major concern.

➔ **Innovation Networks.** Digitisation and the Internet have changed the process of how people innovate, both for innovating in future generations of the Internet, and in general.

➔ **Multidisciplinary & End-to-End Design**. It is a strongly advocated principle that innovation in the Internet needs to involve the collaboration of people with varied skills, for example including technical, social and legal, needed to address ever-more heterogeneous applications.

➔ **Legislation.** The pace of legislation is seen to lag the pace of technological development, so the process of legislation needs acceleration.

➔ **Responsible Machines.** These are applications (typically of AI) that have high societal impact, and the issue of responsibility for their actions is becoming of concern.

➔ **Echo Chambers.** Even though the Internet is a vast source of information, there is significant concern that the information available to citizens is filtered through profiling of the citizens or the aspirations of governments.

➔ **Economics & Wealth Distribution.** This covers the digital economy, including business models that can exploit the vast amounts of data available in the Internet. There is fear that the ever-increasing pace of automation will deprive some parts of society, so there is also a need for investigation into how wealth is distributed amongst humans and machines.

➔ **Trust and Security.** These are key underpinning issues that need to be addressed in order to fulfil the potential of the Internet and its positive impact on society. They reflect an ever-growing trend that citizens are becoming less trustful and more aware of the dangers in the Internet.

DECENTRALISATION

Decentralisation is a key theme of many sources, and occurs in two forms:

➔ **Decentralisation of power.** Power can be centralised, where a few powerful entities are able to exert widespread control; or decentralised, where many entities can exert local control. The current situation is that power is deemed to be concentrated in the hands of a few large corporations, and the ambition is towards greater decentralisation.

➔ **Decentralisation of infrastructure.** This refers to the trend towards distributed and edge computing, where resources are not located en-masse in one location, but spread over a wide area. The degree of infrastructure decentralisation ranges from fully centralised to distributed, reflecting the increasing influence of edge computing and IoT devices (the so-called "edgification").

The major unanswered question is how decentralisation of control can actually benefit society. Research is needed in order to determine:

➔ The socioeconomic implications of a few large corporations holding monopolies.

➔ Options to address these implications, possibly learning from previous economic situations where monopolies needed to be controlled.

➔ How disruptive technologies and innovations from small players can be given space, freedom and exposure to demonstrate their potential.

➔ The chances for positive effect of any EC regulation / legislation offset against the cost of pursuing it.

➔ How any regulation can promote diversity, pluralism and freedom of choice without compromising the services the incumbents provide (which are popular with the general public).

Decentralisation of infrastructure is more concerned with the acknowledgement of a trend towards distributed technologies such as edge computing, blockchains and IoT. The key recommendations are:

➔ Blockchains are potentially revolutionary, the key technology driver is IoT, and convergence between 5G, IoT and edge computing is likely. All these technologies need to be supported, but respect must be paid to any implications they have on privacy.

➔ End to end systems design reaching out to edge devices and based on open standards is needed.

PRIVACY

Citizens' privacy is the most mentioned subject in the corpus of sources surveyed. Clearly then it is of high importance that privacy is addressed. This is not new knowledge, as the EC has recognised this for a number of years and has responded with the GDPR[2], but even with the prospect of this new regulation, concerns remain. The key recommendations from the sources surveyed are:

➔ Transparency is required to enable citizens to see how their data is being used.

➔ Awareness needs to be raised as to the amount and types of processing that citizens' personal data is subjected to. This needs to be publicised in easy to understand terms.

➔ Research into easy to use mechanisms, protocols and legislation is needed to enable citizens to regain control of their personal data in the Internet.

➔ Evaluation of the GDPR is needed in terms of the practicalities of its implementation and its potential prejudicial impact on smaller organisations.

INNOVATION NETWORKS

Innovation networks are dynamic, heterogeneous interconnections of people and Internet resources, and their aim is to enrich the processes of innovation. A key characteristic of an innovation network is that it supports heterogeneous and multidisciplinary collaboration,

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[2] http://www.eugdpr.org/

whether this is between people and machines, people and people or even machines and machines.

There is a need for physical (e.g. incubators) and virtual places (e.g. Internet forums or virtual communities) where stakeholders concerned with the future of the Internet can interact and share ideas, but this concept should be extended to incorporate platforms such as social networks, evidence platforms and experimentation platforms. It is therefore recommended to investigate integrated collaboration spaces, incorporating experimentation and evidence platforms. If all these concepts are brought together, we will have platforms and spaces for collaboration of people from different disciplines and resources of different types, so that they may create and apply new and existing technologies to real world problems.

For experimentation platforms, the recommendation from the community is clear: continue to support existing experimentation platforms, and extend them to provide technologies such as a European blockchain. It is additionally recommended that, in addition to the current open calls offered to fund experimentation, the experimentation funding mechanisms offer flexible funding to accommodate SMEs that need experimentation in short order, for example:

➜ Responsive mode funding – where applications can be made at any time, and each is judged on its own merits rather than against other applicants.

➜ Fast turnaround of experimentation funding decisions. This can be for smaller experiment grants, and applicants can re-apply for continuation funding.

Evidence platforms should provide easy access to different types of information:

➜ Open Research Data,

➜ Open public data,

➜ Domain-specific solutions to problems, and

➜ Domain-specific models.

Many of these functions exist separately already, so they should be surveyed so as to provide a directory. Investigation into whether the above different platform types need greater integration than is already provided by a Google search, and if so, what extensions are needed.

Finally, it is recommended that innovation support be guided by the approaches taken by national Innovation Agencies, as these have proven track record in generating opportunity that has transferred into viable and sustainable businesses, creating strong bodies of expertise and strengthening their respective national economies.

MULTIDISCIPLINARY DESIGN

Multidisciplinary Design is viewed as important by almost all of the sources surveyed, and involves bringing together the right mix of experts from different disciplines who collaborate to address the problem at hand. In particular, multidisciplinary teams are deemed particularly necessary when deciding on governance or legislation over Internet technology and applications. Multidisciplinary teams are also suited to supporting end-to-end systems design due to its heterogeneous nature, from edge computing, through networks to processing and

application design. Participatory design patterns such as co-design and co-creation involving user communities and citizens are seen as integral to end-to-end systems design. Multidisciplinary collaboration is also well suited for creating simulation models, and the act of creating the model is a collaboration in itself.

Multidisciplinary design for NGI is clearly important, so it needs to be supported, by identifying links that are needed, facilitating introductions and communication between previously unconnected communities and involving close engagement with user communities where necessary.

Interoperability of technology, supported by open standards, is seen as important. Interoperability supports end to end systems design reaching out to edge devices and enabling multi-technology interconnected networks, and therefore should be encouraged and supported.

LEGISLATION

Legislation and the legislative process are recurring themes in the sources. Different sources concur that legislative speed cannot keep up with technical development, resulting in ineffective and out of date legislation. Often, citizens and business are ahead of governments in understanding the implications of Internet, and the overall conclusion is that the legislative process must reform to adapt to the speed that technology evolves at. The key recommendations are as follows.

➔ Smart consultation techniques can be used to engage more citizens quickly. New mechanisms and methods for e-participation and citizen consultation should be investigated.

➔ Multidisciplinary teams should work together to determine appropriate legislation for safety critical applications of technology, so that both the technical, application, ethical and legal perspectives are considered.

RESPONSIBLE MACHINES

The so-called "responsible machines" are typically autonomous applications of AI whose actions need to be regulated because they are either safety critical or impact the lives of citizens in significant ways, such that regulation is needed. Autonomous vehicles are an exemplary case.

There is a pressing need for research and discussion involving multidisciplinary teams from the legal, sociological and technical domains to provide answers to ethical and legal questions surrounding responsible machines. Key questions include the following, and research is needed to address them.

The issue of legal and moral responsibility for AI systems is a critical unresolved question. Who *or what* takes responsibility for an AI system's decisions or actions, especially if an AI system causes harm? Could it ever be the case that an AI system be a legal entity and bear responsibility for its actions in its own right?

There is currently a debate regarding the application of ethics to responsible machines. Some advocate that ethics should be designed into AI technology, while others argue that it

is the application of the AI technology that needs ethical governance. Investigation into the pros and cons of each argument is needed. Related to this issue is the question of how AI should be regulated. Should there be design regulations for "ethical AI", or should the applications of AI be regulated?

Transparency of AI decision making is a key aspect of the so-called "algorithmic accountability". There are fears amongst experts that AI decisions may deliberately or inadvertently include bias or discrimination. Investigation is needed into how the algorithms can explain their decisions, and how bias or discrimination can be avoided.

Responsible machines often operate in safety critical modes, where their actions or inactions can cause harm to humans. Safety critical software needs commitments from developers to provide updates to fix bugs and security flaws, and there is an open question on how commitments can be acquired from creators of AI technology to issue patches for safety critical flaws over the long term, including what will happen should a safety critical AI developer go out of business.

ECHO CHAMBERS

Many sources agreed that there is a risk that the Internet becomes an "echo chamber", where profiling of citizens; and citizens' preferences and social groups limit the information they can see to sympathetic views, reinforcing the citizens' entrenched views.

Multidisciplinary research is needed in order to answer questions relating to the promotion of diversity and truth in the Internet. Many of these questions relate to the causes of limited or biased information and how the information can be made less biased or more complete. Examples of causes include unbalanced search results from Internet search providers that tune the results to users' previous searches or preferences; restrictions on Internet search results through interventions by authoritarian governments; the current high-profile of "fake news" (is the news really fake or is someone merely accusing it of being fake?); and social groups that pursue a particular agenda by reinforcing certain arguments, ignoring other opinions.

These questions raise other questions of jurisdiction, state control and liberty, and a question overarching them all is: *what levels of intervention are acceptable before liberty is compromised?*

ECONOMICS & WEALTH DISTRIBUTION

Digitisation and the Internet are increasingly becoming major influencers on economies and wealth distribution. A widely-held fear is the threat to human employment from AI & automation. We need to find new ways of distributing wealth as the machines take over certain tasks in the economy. Research and innovation is needed in order to investigate the following topics.

➜ Wealth distribution models that accommodate humans and machines, so that the needs of both types are addressed.

➜ How to support SMEs in the new Internet economy.

➜ Alternative business models to challenge the incumbents.

➔ Business models to exploit sustainable Internet resources, such as data.

TRUST AND SECURITY

Trust and security are significant concerns, expressed in many contexts within the sources. The sources highlight some specific threats, and there is consensus amongst them regarding these threats.

Security:

➔ The trend towards interconnectedness poses threats, and that the ease of connectivity is a threat to countries' national security.

➔ A major security concern is the Internet of Things. This encompasses a proliferation of devices, whose security provenance and resilience may not be verified. Many IoT devices are created by manufacturers whose expertise lies in areas other than Internet security, and devices may be infrequently or never patched to address security concerns.

Trust:

➔ Transparency is seen as an important enabler for privacy and trust in systems, AI systems especially, and this is clearly related to discussions concerning algorithmic accountability and transparency.

➔ The concern over concentration of power also affects trust that citizens place in the dominant incumbents.

The key recommendations are therefore as follows.

➔ Research is required into the impact of IoT devices on security.

➔ Studies into the impacts on security caused by trend towards a heterogeneous network of interconnected devices, resources and people are needed.

➔ Investigations are needed into how transparency can be incorporated into AI decision-making.

➔ Investigation is needed into the trust implications of the power vested in the large dominant corporations.

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