Grant Agreement No.: 732569
Call: H2020-ICT-2016-2017
Topic: ICT-13-2016
Type of action: CSA

HUB4NGI

D2.1 NGI GUIDE V1

Revision: v.1.0

Work package	WP 2
Task	Task 2.1
Due date	30/06/2017
Submission date	08/08/2017
Deliverable lead	IT Innovation
Version	1.0
Authors	Steve Taylor (IT Innovation), Michael Boniface (IT Innovation)
Reviewers	Peter Van Daele (IMEC), Robert Szuman (PSNC) Roman Łapacz (PSNC)

Abstract	The purpose of this deliverable is to determine the key themes pertaining to the next generation of the Internet extracted from recent existing NGI consultation sources, so as to provide a baseline for further consultation in later phases of HUB4NGI. This deliverable provides a synthesis of recent sources of different types, from consultation documents to community events. The result is a knowledge base of major themes across the corpus of sources, and for each theme, recommendations are made.
Keywords	NGI, evidence

DISCLAIMER

COPYRIGHT NOTICE

Project co-funded by the European Commission in the H2020 Programme		
Nature of the deliverable:	**R**	
Dissemination Level		
PU	Public, fully open, e.g. web	✓
CL	Classified, information as referred to in Commission Decision 2001/844/EC	
CO	Confidential to HUB4NGI project and Commission Services	

* R: Document, report (excluding the periodic and final reports)

DEM: Demonstrator, pilot, prototype, plan designs

DEC: Websites, patents filing, press & media actions, videos, etc.

OTHER: Software, technical diagram, etc.

Co-funded by the Horizon 2020 Framework Programme of the European Union

SUMMARY OF KEY RECOMMENDATIONS

This deliverable is the first in the series of Deliverables for HUB4NGI WP2 – the NGI GUIDE. The NGI GUIDE's objective is to analyse the EC's approach to supporting research, development and innovation in the NGI and highlight any additional relevant challenges, aspirations and technologies that are relevant and important in the NGI.

The purpose of this deliverable is to determine the key themes pertaining to the next generation of the Internet extracted from recent existing NGI consultation sources, so as to provide a baseline for further consultation in later phases of HUB4NGI. This deliverable provides a synthesis exercise of recent sources of different types, from consultation documents to community events, and the result is a knowledge base of major themes across the corpus of sources. These key themes are listed below, each with major observations and recommendations for further development and research.

Decentralisation

Decentralisation is a key theme of many sources. The analysis performed for this deliverable has found that decentralisation is in two forms:

- Decentralisation of power. This refers to the current situation where power is deemed to be concentrated in the hands of a few large corporations. The degree of control concentration can range from centralised, where a few powerful entities are able to exert control, to distributed, where many entities can exert local control.
- 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.

Co-funded by the Horizon 2020 Framework Programme of the European Union

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, 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 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, 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

Co-funded by the Horizon 2020 Framework Programme of the European Union

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 part of 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. The recommended mechanism for support of multidisciplinary design is the innovation networks concept discussed in Section 3.4.

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.

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. The question of who or what takes responsibility for an AI system's decisions or actions needs addressing, 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?

Co-funded by the Horizon 2020 Framework Programme of the European Union

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:

Co-funded by the Horizon 2020
Framework Programme of the European Union

- 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 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 the previous discussion 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 impact on security caused by trend towards a heterogeneous network of interconnected devices, resources and people are needed.
- Investigations into how transparency can be incorporated into AI decisions are needed.

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

Co-funded by the Horizon 2020
Framework Programme of the European Union

TABLE OF CONTENTS

Co-funded by the Horizon 2020
Framework Programme of the European Union

LIST OF FIGURES

Co-funded by the Horizon 2020
Framework Programme of the European Union

ABBREVIATIONS

AI	Artificial Intelligence
AR	Augmented Reality
EC	European Commission
FAANG	Facebook, Amazon, Apple, Netflix, Google
GAFA	Google, Amazon, Facebook, Apple
GDPR	General Data Protection Regulation
IoT	Internet of Things
IP	Internet Protocol
NGI	Next Generation Internet
OECD	Organisation for Economic Co-operation and Development
ORD	Open Research Data
SDN	Software Defined Networking
TCP	Transmission Control Protocol
VR	Virtual Reality

Co-funded by the Horizon 2020
Framework Programme of the European Union

1 INTRODUCTION

This deliverable is the first in the series of Deliverables for WP2 – the NGI GUIDE. The NGI GUIDE's objective is to analyse the EC's approach to supporting research, development and innovation in the NGI and highlight any additional relevant challenges, aspirations and technologies that are relevant and important in the NGI.

The purpose of this deliverable is to determine the key themes pertaining to the next generation of the Internet extracted from recent existing NGI consultation sources, so as to provide a baseline for further consultation in later phases of HUB4NGI. This deliverable provides a synthesis exercise of recent sources of different types, from consultation documents to community events, and the result is a knowledge base of themes, to present the current state of the art. For each theme, issues, questions and pointers for further work were determined and these are listed as recommendations.

Because the Internet is intended to be a benefit for society, it is important that we look for societal issues (both benefits and threats or disadvantages) that are caused by, or impacted by, the Internet. Therefore this document addresses societal, economic, design and legislative concerns as well as technology perspectives. The technologies are widely known, but it is the application of technology to address societal issues that raises significant research challenges. Figure 1 shows the key NGI knowledge entities and how they are related.

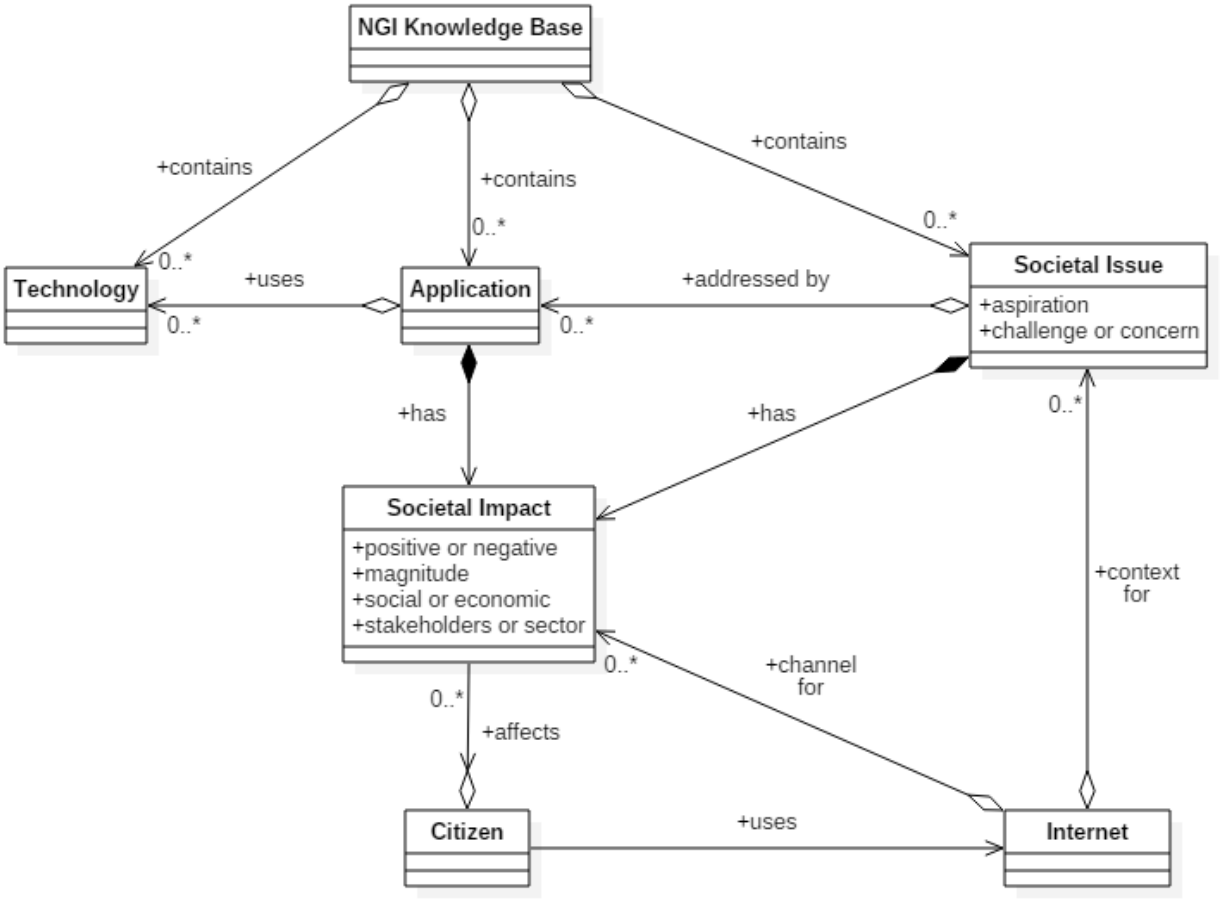


FIGURE 1: NGI KNOWLEDGE ENTITIES

This deliverable is structured as follows.

- Firstly the data sources and the methodology for analysis is described.

Co-funded by the Horizon 2020 Framework Programme of the European Union

- Next, the results of the analysis is provided concerning societal issues, impacts and concepts, as well as technologies and applications.
- Finally, the conclusions of the analysis are summarised, describing the main themes from the results and for each theme, recommendations are made concerning further research and development.

Co-funded by the Horizon 2020
Framework Programme of the European Union

2 SOURCE DATA & ANALYSIS METHODOLOGY

This section describes the source data and analysis process of recent NGI knowledge acquisition efforts and position statements in and around the subject of the Next Generation Internet (NGI). The aim of the analysis is 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.

2.1 SOURCE DATA

The input data for the analysis comprised of the following sources. The sources are a mix of results from large scale consultations, themed workshop outputs, statements by European Commissioners, and opinions expressed at a major NGI-focused conference. The sources were selected to provide a cross-section of established opinion, current discussions and new knowledge available at the current time. All the sources are recent, the oldest being from Q4 2016.

#	Source Description	Type
1	A speech by Vice-President Andrus Ansip at the Next Generation Internet Summit, Brussels, 6-7 June 2017. [Ansip 2017]	EC
2	Conclusions from a Workshop on Personal Data Spaces and Privacy, 9 December 2016. [Burada 2017]	Experts
3	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
4	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
5	Results from a large-scale survey of European citizens. [Lipparini & Romeo 2017]	Public
6	A speech by Carlos Moedas MEP “From the Internet of Things to the Internet of Humans”, Next Generation Internet Summit, Brussels, 6-7 June 2017. [Moedas 2017]	EC
7	Opinions expressed at Net Futures 2017, 28-29 June 2017, Brussels [Net Futures 2017]	Experts
8	Results from a large-scale survey on the Next Generation Initiative [Overton 2017]	Public
9	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
10	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

Co-funded by the Horizon 2020 Framework Programme of the European Union

11	Conclusions from The Next Generation Internet workshop - Widen the European space of life and work. Workshop Report, 8 June 2017 [PSNC 2017]	Experts

TABLE 1: SOURCE DESCRIPTIONS

Table 1 above describes the sources used in this analysis. The "type" column indicates the characteristics of the source. The sources marked "EC" represent the information that is known to the European Commission (EC) already, sources marked "Experts" are the results of consultations with experts, and sources marked "Public" are consultations with the general public.

2.2 METHODOLOGY

The process was to interpret the findings of the "Expert" and "Public" sources using a tabular format as illustrated below. The two "EC" sources served as a "control group" to indicate what is already known by the EC, so are not included in the results.

Source	Concept	Quotation	Source	Keywords	CONCEPT KEYWORDS	Privacy	Collaboration	Artificial Intelligence	Legislation	Internet of Things	Decentralised architectures
	Total					33	24	23	20	18	16
[Burada 2017]	GDPR legislation can hamper SMEs wanting to innovate	There is a misalignment between the interest of users and adopters (SMEs and Start-ups) and the policy/legislation notably the forthcoming General Data Protection Regulation (GDPR) mainly in timescale to comply with the law. There is a tension between innovation and legislation that can be a limiting factor for instance some aspects of GDPR are not clear enough to allow safe investment in R&D&I.	[Burada 2017]	SMEs, regulation, data protection		1			1		
[PSNC 2017]	Privacy is a key theme for Civil society	• The first group of attendees emphasised privacy, transparency and security. People have the right to know where the data collected by service providers are stored and who has control over them. • Legislation must be adapted. Data should be protected the same way in each EU country. • "Privacy is a value!" • People want to feel secure and can even accept limitations of their privacy (within reason) to achieve that.	[PSNC 2017]	privacy, GDPR, legislation, control of personal information, citizens		1			1		
[Burada 2017]	Cost of GDPR compliance may be too high	There is the perception that GDPR will make release of personal data among providers more difficult than today and/or more expensive because of liability and reputation; in addition the barriers created by the legislation will be too high for new (SME/start-ups) entrants while the legislation will not significantly change existing market players' behaviour.	[Burada 2017]	costs, GDPR, privacy, data protection		1			1		
[FIRE STUDY DIN 2017]	Top-priority technology areas include: IoT, 5G; SDN/NFV, Big Data, Edge Computing.	IoT 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).	[FIRE STUDY DIN 2017]	IoT, 5G, trust, security, privacy, big data, edge computing		1				1	

FIGURE 2: KNOWLEDGE ANALYSIS

Each source was examined, and relevant quotations entered into the analysis sheet. Each quotation was summarised in the "Concept" column. Keywords describing the concept were determined by interpretation of the sense of the quotation, and the uses of each concept keyword were counted[1] to give an indication of the amount each concept was discussed, so the "hot" topics could be indicated. A list of the concept keywords is given in the Appendix. Once

[1] The keywords were counted using the columns to the right of Figure 2 – each concept had its own column, and when the concept featured in a quotation, a "1" was added to its column. The list of concept keywords was expanded each time a new relevant keyword came to light. Once all quotations were entered into the analysis sheet, the "1"s were simply summed in each column.

Co-funded by the Horizon 2020 Framework Programme of the European Union

the analysis sheet was complete, it provided an evidence base linking quotations from the sources to concept keywords.

The concepts in the evidence base were organised through the creation of a Domain Model[2], which is a visual representation of the concepts and their relationships, expressed in standard UML class diagram notation[3]. Each concept keyword in the knowledge base was entered into the diagram as an entity and joined with other related entities by connectors labelled describing the type of relationship (e.g. a container-component relationship or the impact of one entity on another, etc.). This enabled a picture of the inter-dependencies between concepts to be easily seen.

The Domain Model quickly became large and complex with many connections, but clear clusters of related concepts emerged and were visible – a potential cluster could be identified by a highly interconnected concept entity, or a small number of thematically related concept entities with many interconnections between them.

As a result of this visual analysis, as well as the concept keyword mention counts in the source texts, the diagram was visually decomposed into thematic clusters centred on concept entities that shared common themes and individual domain models were built from the 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. 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 of clusters, the clusters would be too complex and too general.

To make each cluster self-contained, connections between entities in different clusters were avoided by visual duplication of entities, and therefore the same entity can appear in more than one cluster.

The result of this exercise is shown in Figure 3. This shows the overall Domain Model after partial clustering[4], gives an indication of the complexity of the overall model and the decomposition into thematic clusters.

[2] See e.g. https://en.wikipedia.org/wiki/Domain_model for an explanation.
[3] See e.g. https://en.wikipedia.org/wiki/Class_diagram for a description of the notation.
[4] The 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. The individual clusters are legibly illustrated in later sections.

Co-funded by the Horizon 2020
Framework Programme of the European Union

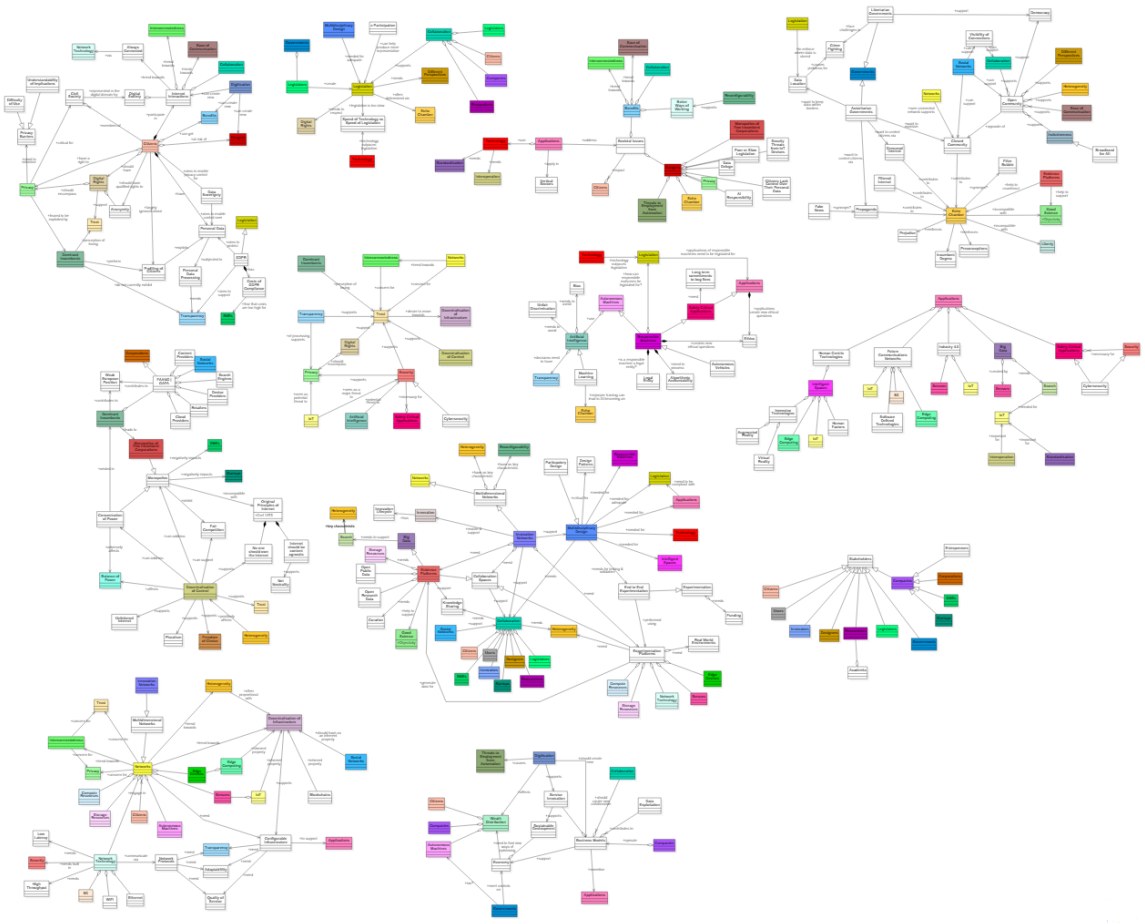


FIGURE 3: DOMAIN MODEL AFTER PARTIAL CLUSTERING

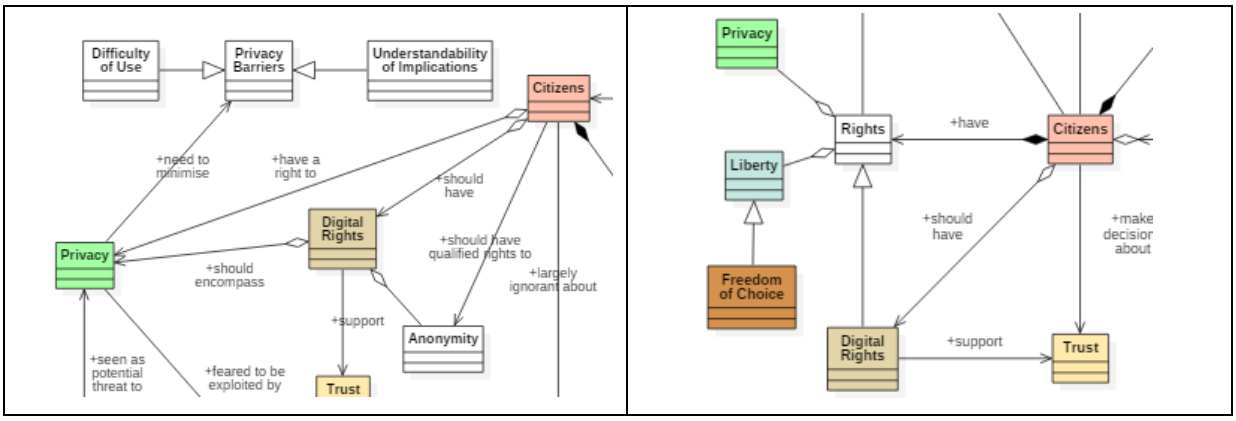
Once a thematic cluster of concepts was decided, a subset of relevant quotations was selected by using the analysis sheet to cross-reference each concept keyword in the cluster to the quotations relevant to it. For each cluster, a discussion was then written, highlighting key points from the cluster's quotations, drawing out points of agreement and disagreement. Where there was clear agreement on a course of action or the course of action was clear, recommendations were made. The results of this analysis are in Section 3, next.

Co-funded by the Horizon 2020
Framework Programme of the European Union

3 RESULTS

This section presents the results of the cluster analysis described above. First, there is an introductory subsection describing the connections between the overall key clusters and this represents the overarching concept of citizens' position in the digital society. Discussion of each of the detailed clusters then follows. Each section contains its own domain model, followed by discussion of the key points emerging from the relevant quotations. From this discussion, recommendations are determined for each section.

Due to the high degree of interconnection between concepts, it is inevitable that the same concept occurs in more than one cluster. Where this happens, the concept is coloured using the same colour in each of the diagrams, so that it may be more easily identified across clusters. This is illustrated in the two following snippets from two separate clusters – for example "citizen" is the same colour in both snippets. Where a concept appears only once in the whole analysis, it is left white.



3.1 CITIZENS' POSITION IN THE DIGITAL SOCIETY

The overall encompassing cluster represents citizens' position in the digital society. Just as citizens are members of a civil society, through their use of the Internet, they are also members of a digital society. Figure 4 shows the key elements.

> *"It was concluded that it may be more meaningful to discuss how the EC could shape "digital society" rather than the "Internet" itself. This language could help emphasise the human-centred nature of NGI, including the need to invest in education and skills." [Takahashi 2017]*

Co-funded by the Horizon 2020 Framework Programme of the European Union

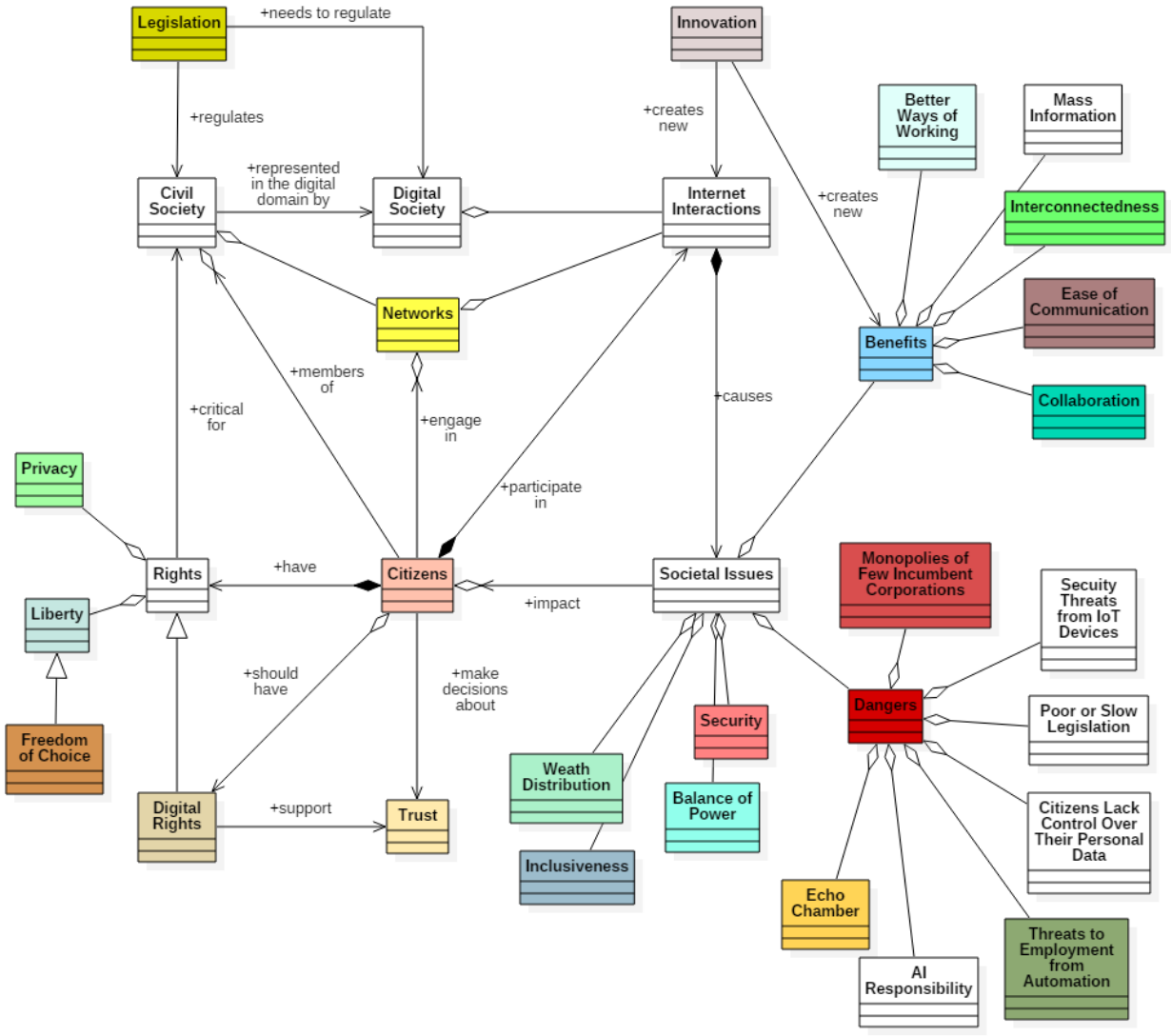


FIGURE 4: CITIZENS' POSITION IN THE DIGITAL SOCIETY

As a result of the citizens' membership of the digital society, they engage in interactions on 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. Most of these have beneficial implications:

"We would benefit from soft experiments in innovation - new ways to connect with each other, collaborate on new innovation pathways" [DIN Forum 2017 - innovation process]

"The minimum ambition should a decentralised general purpose network that keeps open the possibility of global connectivity." [Ditchley 2016]

"The advent of mobile and the spread of Wi-Fi connectivity and 4G networks means that the Internet will soon reach everyone, everywhere, all the time, if allowed to do so." [Ditchley 2016]

"Innovation thrives on brokering ideas amongst people from disparate communities - networks of disparate actors are more likely to create innovation" [DIN Forum 2017 - innovation process]

Co-funded by the Horizon 2020 Framework Programme of the European Union

"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." [FIRE STUDY DIN 2017]

"... simulation models need inputs from multiple domains of knowledge so they already are a kind of multidisciplinary collaboration platform… the act of creating the model gives opportunities for new ideas from the collaborators from different backgrounds]" [DIN Forum 2017 - innovation process]

Whilst interconnectedness is seen as a benefit in general, supporting aspects such as inclusiveness, there are security concerns over the trends towards ever greater interconnectedness:

"Trust, Security & Privacy are of central concern especially when considering highly interconnected networks scenarios." [FIRE STUDY DIN 2017]

There are also dangers to citizens when they use the Internet, and these are illustrated in the figure. Many of these dangers are discussed in detail by the remaining sections below.

"FAANG - Facebook, Apple, Amazon, Netflix and Google - are the dominators of the internet economy. We are moving towards natural monopolies [and] it is very hard to disrupt due to incumbent power and the economies of scale they can access. The combine market value of FAANG stocks is 1.4 trillion US dollars - about 13% of the whole US economy." [Net Futures 2017]

"IOT is seen both as an opportunity but also a major privacy issue for instance through proliferation of hardware of unknown origin." [Burada 2017]

"How to make legislation keep pace with technology?" [Net Futures 2017]

"… the concentration of data in a few proprietary platforms is understood as a significant issue today." [Overton 2017]

"People have the right to know where the data collected by service providers are stored and who has control over them." [PSNC 2017]

"… there should be an understanding of what is the cost of giving away personal data as a negative incentive just like for the CO2 emissions although privacy is a very subjective matter." [Burada 2017]

"Technical innovation often progresses faster than the passage of new legislation …"" [Takahashi 2017]

"There is a risk that the Internet becomes an echo chamber for our own prejudices and preconceptions, rather than a source of objective facts and challenge." [Ditchley 2016]

"… governance models to compensate employment or revenue losses caused by ongoing automatization processes … (72%) agree robots and artificial intelligence steal people's jobs … In line with the findings of the Eurobarometer 460, automation of jobs is a source of great concern ..." [Lipparini & Romeo 2017]

Ditchley argues that citizens should have digital rights, similar to their human rights, that are the same for everyone, and which determine what behaviour is acceptable.

Co-funded by the Horizon 2020 Framework Programme of the European Union

"We should argue for digital rights for individuals, linking this to the long established reference point of the Universal Declaration of Human Rights." [Ditchley 2016]

This concept has not been reinforced by any other of the sources studied, but nevertheless, determination of a gold standard for digital citizens' rights would provide a useful reference context against which to measure behaviour. Ditchley discussed anonymity as a right:

There was debate too over an absolute right to anonymity: the human right to privacy is qualified even in European human rights legislation for example. [Ditchley 2016]

As in the real world, citizens must be accountable for their actions, so therefore the right to absolute anonymity is not automatically given.

Innovation is a key theme in the sources, in particular how the process of innovation can change as a result of the new interconnections made possible by digitisation and the Internet. Innovation can provide new products, services or interactions, but can also change the nature Internet itself and humans' interactions with it.

There should be bridges between basic and applied research in the funding system encouraging creativity, flexibility within short revision cycle. [Burada 2017]

"Innovation needs to be systemic. Innovation should belong to all. Innovation should span the whole economic system. Innovation involves 3 main actors: industry, academia, and government - all aiming to serve the needs of a mass market of consumers (the general public). Citizens should get involved - how should citizens get more involved in the innovation process?" [DIN Forum 2017 - innovation process]

Multi-actor protocol/system design principles and methodologies for cooperating machines and people should be investigated as key to understand the challenges and implications related to the NGI Collective Human Experience (ethics, security, privacy concerns). [FIRE STUDY 2017]

The following sections describe the key societal impacts of the Internet, 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, 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.

Co-funded by the Horizon 2020 Framework Programme of the European Union

- *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 section 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.
- *Applications and Technologies.* This represents the set of technologies and applications that are deemed to have high impact in the NGI.

3.2 DECENTRALISATION

Decentralisation is a key theme, mentioned multiple times in almost all of the sources studied. The analysis for this deliverable has shown that there are two aspects concerning decentralisation:

- Decentralisation of power refers to the current situation where power is deemed to be concentrated in the hands of a few large corporations. The degree of control concentration can range from centralised, where a few powerful entities are able to exert control, to distributed, where many entities can exert local control.
- Decentralisation of infrastructure 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”).

3.2.1 Decentralisation of Control

There are numerous concerned references to the dominance of, and concentration of power vested in, the so-called “dominant incumbents”. These are the large American corporations whose activities form the basis of many citizens’ interactions via the Internet. These incumbents are Google, Facebook, Amazon, Apple, and sometimes Netflix (often referred to by the acronyms “GAFA” or “FAANG”). The key factors are shown in Figure 5.

Co-funded by the Horizon 2020
Framework Programme of the European Union

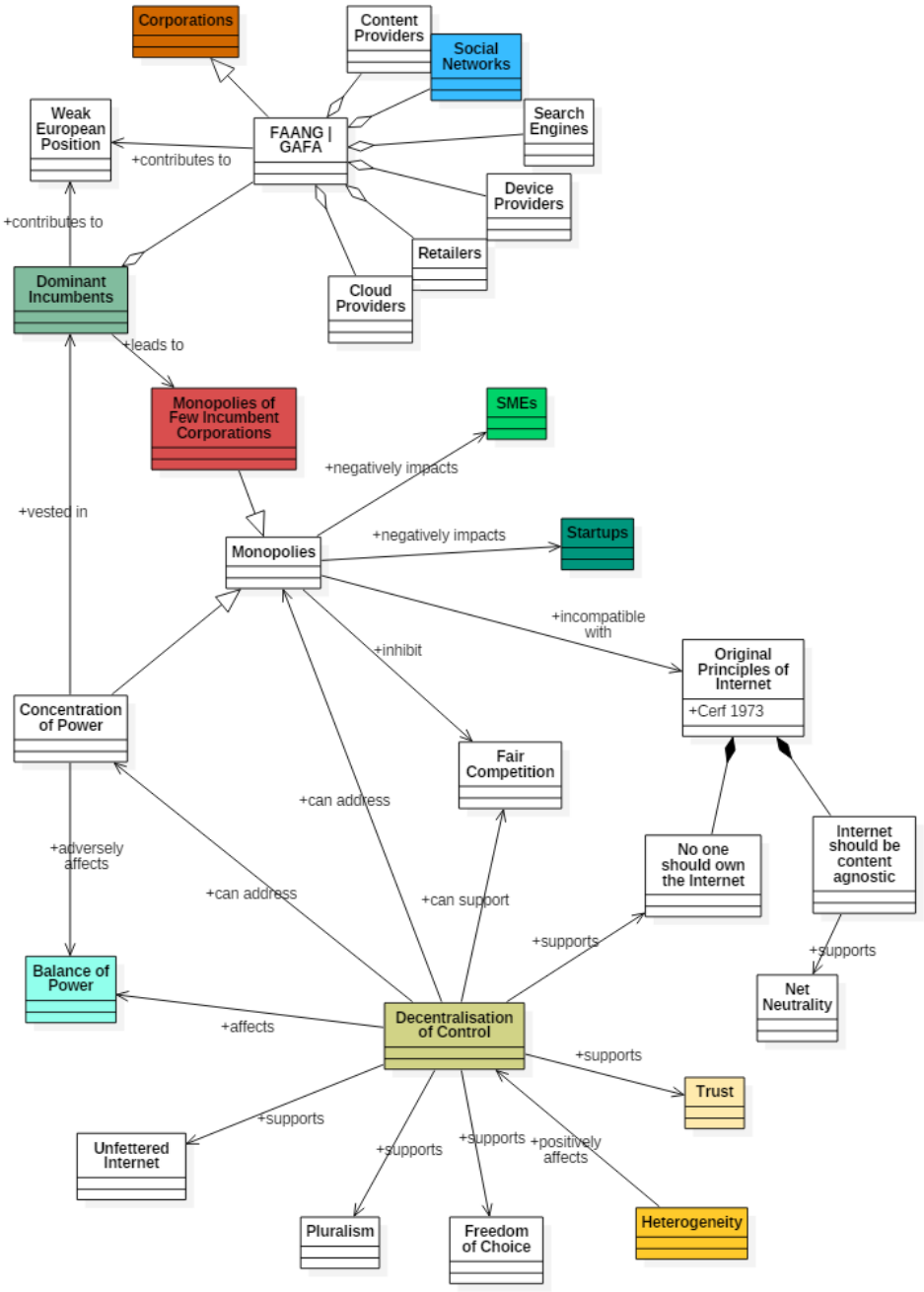


FIGURE 5: MONOPOLIES AND DECENTRALISATION OF CONTROL

The following quote from the DIN Forum illustrates how dominant these incumbents are and sums up the key issues regarding their dominant position, namely that they are forming monopolies that are very hard to break due to their strength.

> *"FAANG - Facebook, Apple, Amazon, Netflix, Google - are the dominators of the Internet economy. We are moving towards natural monopolies, and it is very hard to disrupt due to incumbent power and the economies of scale they can access. The combined market value of FAANG stocks is 1.4 trillion US dollars - about 13% of the whole US economy." [DIN Forum 2017 - innovation process]*

These organisations began life as small startups, providing innovative and disruptive technologies. They have grown into their position of dominance in the last 20 years, but given the current climate, it is difficult to see how their dominant position can be challenged:

Co-funded by the Horizon 2020 Framework Programme of the European Union

"Participants criticised the idea that the Internet is inherently libertarian and disruptive, offering Google and Facebook as examples of industrial consolidation. Repeated references were made to Professor Tim Woo's "The Master Switch", which chronicles how the telephone, radio, cinema and television were hailed as vehicles of social disruption, before falling to corporate monopolisation. Concern was voiced about the concentration of data on a few platforms (e.g. Facebook, Google, etc.), which will place them in pole position to make use of emerging AI technologies and further entrench their market dominance." [Takahashi 2017]

Takahashi continues, citing the original core principles of Internet – that no one should own the network and the network should be agnostic about content, and that these principles do not reflect the current situation of the Internet.

"We were informed that the TCP/IP protocols designed by Cerf in 1973 – 1974 were based on two principles: (i) no one would own the network; (ii) network would be agnostic about content. These principles are understood to have established a "platform for permissive innovation".

The architecture of the Internet may be permissive, but as many sites (e.g. Facebook, Twitter, Instagram, etc.) and laws are not, our experience of the Internet does not embody these values, it was argued.

Participants criticised the idea that the Internet is inherently libertarian and disruptive, offering Google and Facebook as examples of industrial consolidation." [Takahashi 2017]

Burada asserts that Europe is in a weak position.

Business Model drive: any successful alternative model to "GAFA" (Google, Apple, Facebook, and Amazon — the 4 most powerful American technology companies) will have to integrate socioeconomic values as opposed to a plain share of personal data model where Europe cannot compete. [Burada 2017]

Overton concurs with the dominance aspect, also alluding to the processing of citizens' data by the incumbents:

… the concentration of data in a few proprietary platforms is understood as a significant issue today.[Overton 2017]

Lipparini & Romeo 2017 concur with the main points above, and point towards decentralisation and regulation as possible solutions.

"… European citizens are concerned with the increasing power of dominant platforms …

… nearly 80% of respondents to the online consultation stating that it is important to limit the increasing power of dominant platforms aggregating data …

... decentralization to avoid monopolies (74% agreed) ...

Citizens [...] expect the public sector to limit the power of tech-giants.

"Hard regulation" of tech companies is broadly supported ..." [Lipparini & Romeo 2017]

Co-funded by the Horizon 2020 Framework Programme of the European Union

All this evidence points to monopoly / oligopoly situation, which limits user choice and there is little competition against the incumbents. Overton states that diversity, pluralism and availability & freedom of choice are important characteristics of the Internet:

> *… participants also felt strongly that the Internet should ensure diversity, pluralism and a right to choose.[Overton 2017]*

There is clear support for decentralisation of control in the Internet from the sources studied.

> *"We want to decentralise the Internet (not just technology) - create an innovation landscape with alternatives to existing services to compete with and improve on existing ones" [DIN Forum 2017 - innovation process]*

> *"The minimum ambition should a decentralised general purpose network that keeps open the possibility of global connectivity." [Ditchley 2016]*

> *"Europe should be faithful to the decentralised design of the original Internet. Failing to do that will hamper trust in the Internet development." [Burada 2017]*

> *"… the proponents of an unfettered Internet rely on loosely coordinated rhetoric and the power of Internet innovation …" [Ditchley 2016]*

3.2.2 Decentralisation of Infrastructure

All the sources point towards a clear trend towards decentralised infrastructure technologies such as IoT, Blockchains and edge devices / computing. The major elements are shown in Figure 6.

Co-funded by the Horizon 2020 Framework Programme of the European Union

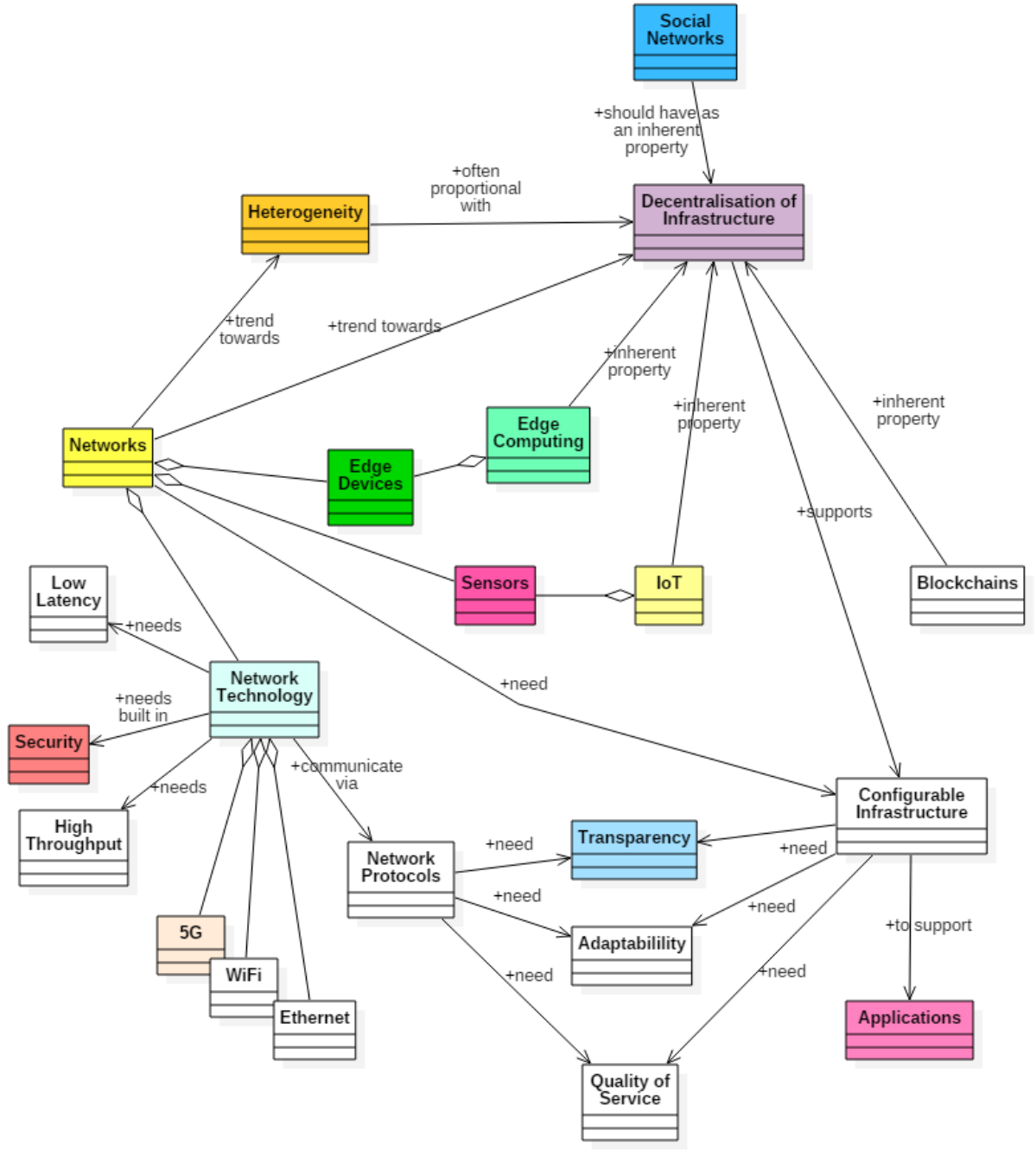


FIGURE 6: DECENTRALISED INFRASTRUCTURE TECHNOLOGIES

Overton asserts that distributed and decentralised architectures (e.g. blockchains) are potentially revolutionary for the financial industry.

> *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. [Overton 2017]*

Overton also asserts that discovery and identification of edge and IoT devices is important, but privacy must be respected, supporting the assertions in Section 3.3.4.

Co-funded by the Horizon 2020 Framework Programme of the European Union

> *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. [Overton 2017]*

The FIRE Study discusses convergence of 5G, IoT and Edge computing:

> *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 [FIRE STUDY DIN 2017]*

> *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 in-depth 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. [FIRE STUDY DIN 2017]*

The FIRE Study also concludes that the key technology driver is IoT:

> *IoT 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). [FIRE STUDY DIN 2017]*

The decentralisation and the push towards edge computing has implications for the design patterns needed. The FIRE Study advocates end to end systems design reaching out to edge devices and based on open standards:

> *Focus should be on end-to-end systems design (with few larger infrastructures including international dimension) based on open global standards and standardised interfaces/APIs, where 5G/6G network is extended towards edge computing and even autonomous connection mechanisms between edges w/o connection to core network. [FIRE STUDY DIN 2017]*

3.2.3 Recommendations

An 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 past economic situations where monopolies needed to be controlled.
- How disruptive technologies and innovations from small players can be given space, and 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 that are so popular with the general public.

Co-funded by the Horizon 2020 Framework Programme of the European Union

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.

3.3 PRIVACY

Protection of citizens' privacy is a major concern across all of the sources studied. Figure 7 shows the major elements.

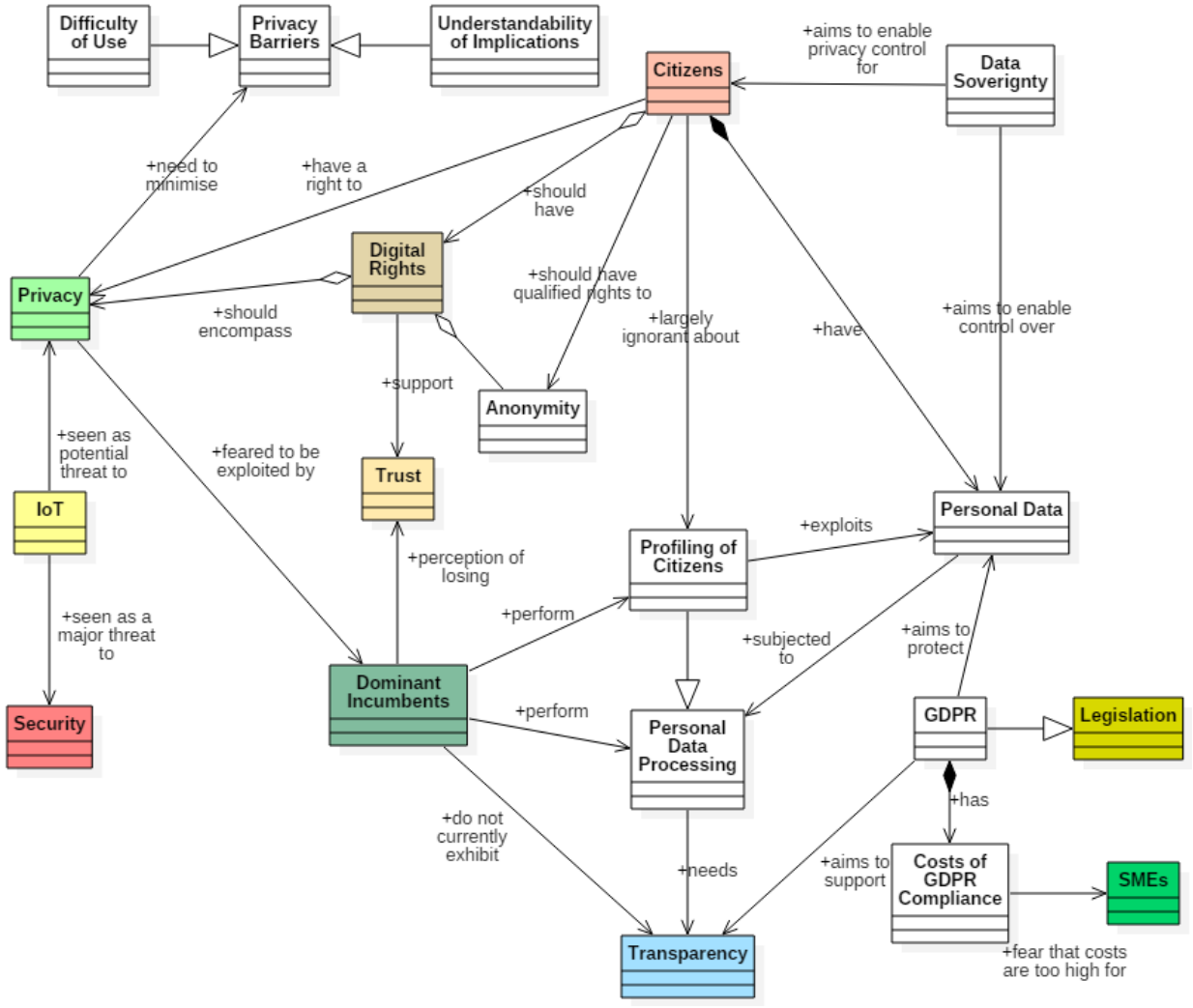


FIGURE 7: PRIVACY

According to Ditchley, the trend is away from privacy:

> *… the trend is decidedly against the privacy and liberty of the individual to exploit the full potential of the Internet with dignity intact. [Ditchley 2016]*

Overton states that sovereignty of their own data is the most important value in the NGI consultation respondents' opinion.

Co-funded by the Horizon 2020 Framework Programme of the European Union

Ensuring citizens' sovereignty over their own data and the protection of their privacy is deemed the most important value proposed in the survey by the participants. [Overton 2017]

Lipparini & Romeo concur that citizens' privacy is of paramount importance.

"... 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.

... 88% of respondents agreed (and 72% strongly agreed) that "protection of privacy is the most important value"

Citizens value very much their right to privacy and data ownerships...

Europeans [...] are hugely concerned by the possibility of being profiled and manipulated via targeted messages."[Lipparini & Romeo 2017]

Privacy is interconnected with many other factors, indicating is central position in the concerns of the respondents:

... 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. [Lipparini & Romeo 2017]

3.3.1 Citizens Lack Control over Their Data

There is a considerable fear that citizens' privacy is being eroded by the exploitation of citizens' personal data by profiling, and citizens have no control over this.

"FAANG - Facebook, Apple, Amazon, Netflix, Google - are the dominators of the Internet economy ... it is concerning that these companies use and sell our personal data" [DIN Forum 2017 - innovation process]

"… any successful alternative model to "GAFA" (Google, Apple, Facebook, and Amazon — the 4 most powerful American technology companies) will have to integrate socioeconomic values as opposed to a plain share of personal data model where Europe cannot compete." [Burada 2017]

Lipparini & Romeo point out that the exploitation of citizen profiling should not compromise the democratic process.

... 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. [Lipparini & Romeo 2017]

This exploitation is related to a fear that citizens do not have control over their personal data. Once a citizen has given over their data to a provider, it is out of the citizen's control forever.

"People have the right to know where the data collected by service providers are stored and who has control over them. Legislation must be adapted. Data should be protected the same way in each EU country. • People want to feel secure and can even accept limitations of their privacy (within reason) to achieve that. [PSNC 2017]

Co-funded by the Horizon 2020 Framework Programme of the European Union

Overton concurs:

> *Ensuring citizens' sovereignty over their own data and the protection of their privacy is deemed the most important value proposed in the survey by the participants. [Overton 2017]*

Exacerbating this problem, there are fears around the difficulties encountered when citizens want to manage their privacy. It is regarded as a barrier by Burada:

> *Ease of use: the barrier for privacy should be minimised in terms of ease of use. [Burada 2017]*

Even if citizens knew where their data was being processed, the current situation is that it is not easy for the citizens to exert any control over how the processing is done, or to prevent processing.

3.3.2 Digital Illiteracy Regarding Implications of Giving Away Personal Data

The majority of citizens do realise the implications of them giving away personal data, and this is seen as an important issue: there is a cost to giving away personal data and most citizens do not appreciate it:

> *"… there should be an understanding of what is the cost of giving away personal data as a negative incentive just like for the CO2 emissions although privacy is a very subjective matter." [Burada 2017]*

> *"Dominance of social networks - should we cut them up? Citizens don't realise what the social networks do with their content - they need to be more clearly informed. Should networks pay for content?" [Net Futures 2017]*

According to Burada, the issue of privacy needs to be understood and addressed by the public:

> *The Internet will be THE digital environment in which we live and will potentially know everything about us. If cost of privacy is perceived as negligible then market interest will prevail. The debate around the evolution of the Internet should be at the political level to find alternative paths for Europe. There is not enough attention to privacy in the public debate today. [Burada 2017]*

Burada also states:

> *Privacy might not be a top priority: users/consumers demonstrate they are keen to give away many personal data through large aggregators in exchange of free services. [Burada 2017]*

Users want the services the large organisations provide, but do not realise the price they pay for those services in terms of personal information. It is asserted that citizens undervalue their personal information due to ignorance regarding what are the implications regarding what is being done with the data and whom it is being sold to or shared with.

This points to a requirement for education of citizens in simple, easy to understand terms, regarding what will happen to the personal data that they submit to an organisation.

Clearly there is a need for transparency regarding the processing of citizens' personal information. In order for citizens to have any control over their personal data in the Internet, they must first know where that data is being processed, and what is being done with it.

> *Companies have an obligation to be clear and transparent about how they are using the data they obtain. [Ditchley 2016]*

Co-funded by the Horizon 2020 Framework Programme of the European Union

Burada proposes that the transparency of processing be indicated by simple certification marks, so that users can easily make informed judgements about the implications of submitting their data to a platform:

> *Transparency: end-users should be aware of the level of privacy they get in accessing a given service for instance: through certification marks easily understandable; open source software checked by trusted parties (such as hackers or NGOs) to form a decentralised trust; this could also be extended to open/certified firmware and hardware design. [Burada 2017]*

3.3.3 Impact of GDPR

The EC's General Data Protection Regulation (GDPR) is due to come into force in 2018. Its intentions are to protect citizens' personal data further than previously, and give citizens more transparency and control over the processing of data. On the face of it, this is good for citizens, but there are concerns that its implementation will unmanageable or too costly for SMEs or startups, stifling their ability to innovate and create wealth.

> *There is the perception that GDPR will make release of personal data among providers more difficult than today and/or more expensive because of liability and reputation; in addition the barriers created by the legislation will be too high for new (SME/start-ups) entrants while the legislation will not significantly change existing market players' behaviour. [Burada 2017]*

> *"There is a misalignment between the interest of users and adopters (SMEs and Start-ups) and the policy/legislation notably the forthcoming General Data Protection Regulation (GDPR) mainly in timescale to comply with the law. There is a tension between innovation and legislation that can be a limiting factor for instance some aspects of GDPR are not clear enough to allow safe investment in R&D&I." [Burada 2017]*

In the first of the two above quotations, Burada goes further, stating that the GDPR will not change existing processors' behaviour. This could be interpreted as reinforcing the position of the "dominant incumbents".

There is clearly a need to evaluate the GDPR in terms of its implementability and its potential prejudicial impact on smaller organisations.

3.3.4 Impact of Technologies on Privacy

The Internet of Things encompasses many devices of different types, and risks have been highlighted regarding risks to privacy and security, mainly through their multiplicity, heterogeneity and immaturity.

> *IOT and Big Data create new and unknown power balance between providers and users that needs to be framed by European values e.g. privacy protection, decentralisation, collaboration, and transparency. [Burada 2017]*

> *IOT is seen both as an opportunity but also a major privacy issue for instance through proliferation of hardware of unknown origin. [Burada 2017]*

In addition to the above, the trend towards the ubiquity of "smart devices" in the home is causing concern regarding security integrity and privacy violations[5].

[5] http://www.telegraph.co.uk/technology/2017/03/08/smart-tv-perfect-way-spy/

Co-funded by the Horizon 2020 Framework Programme of the European Union

The new, heterogeneous networks of people, devices and machines requires thought to determine and address the security and privacy issues arising from complex interactions between entities of different types.

> *Decentralised and distributed social networks, wikis, sensors, blockchain value networks where a heterogeneous mix of humans, autonomous, manual and remotely operated machines will co-exist and interact must be investigated. This very much relates to understanding also a number of trust, security and privacy issues we are going to increasingly have to deal with within Next Generation Internet scenarios. [FIRE STUDY DIN 2017]*

Cloud computing is important but can pose threats to privacy and security:

> *Cloud solutions are seen as a great opportunity for both Education (for which competences and skills on cloud systems are highlighted as important all over the conversations) and Business. But they are also seen as a potential major threat for Privacy, Security and Surveillance. This means that interventions could be designed to support new business and social domains explicitly offering the best of Cloud and Security/Privacy ... [Lipparini & Romeo 2017]*

3.3.5 Recommendations

- 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.

3.4 INNOVATION NETWORKS

Innovation networks are a concept derived from work in the FIRE Study, there known as "Digital Innovation Networks", which has investigated the way in which the new communication advantages and access to vast quantities of information brought about by digitisation and the Internet are changing the way we innovate.

The network structure of innovation has changed as a result of digitisation:

> *"Network structure of innovation has changed as a result of digitisation - who connects to whom. Changes in network structure reflect how ideas are mulled over (i.e. who is talking to who) before being put into practice and evidence flowing back from practice to the next generation" [DIN Forum 2017 - innovation process]*

Digitisation also creates new interaction patterns in innovation networks:

> *"… researchers don't have to be in the same place or even in the same time to benefit from each other's work as long as data is persisted and records are kept" [DIN Forum 2017 - innovation process]*

The work is not complete: there is a need to continue experiments in human collaboration and network interactions:

Co-funded by the Horizon 2020 Framework Programme of the European Union

"We would benefit from soft experiments in innovation - new ways to connect with each other, collaborate on new innovation pathways" [DIN Forum 2017 - innovation process]

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

"… A key point is that innovation networks consist of nodes of many different types, e.g. people, technology, data, processes, AI etc. These are resources that are used and connected as necessary." [DIN Forum 2017 - innovation process]

"Many different infrastructure types are needed working together to make a platform to facilitate innovation collaboration" [DIN Forum 2017 - innovation process]

Innovation networks' main elements are shown in Figure 8. An innovation network is itself a multidimensional form of network, and includes concepts such as *collaboration spaces*, *experimentation platforms* and *evidence platforms* (all discussed later). Any or all of these concepts can be utilised at any time, depending on the needs of the task at hand. Innovation networks are explicitly intended to support the concept of multidisciplinary design (covered later in Section 6.5).

Co-funded by the Horizon 2020 Framework Programme of the European Union

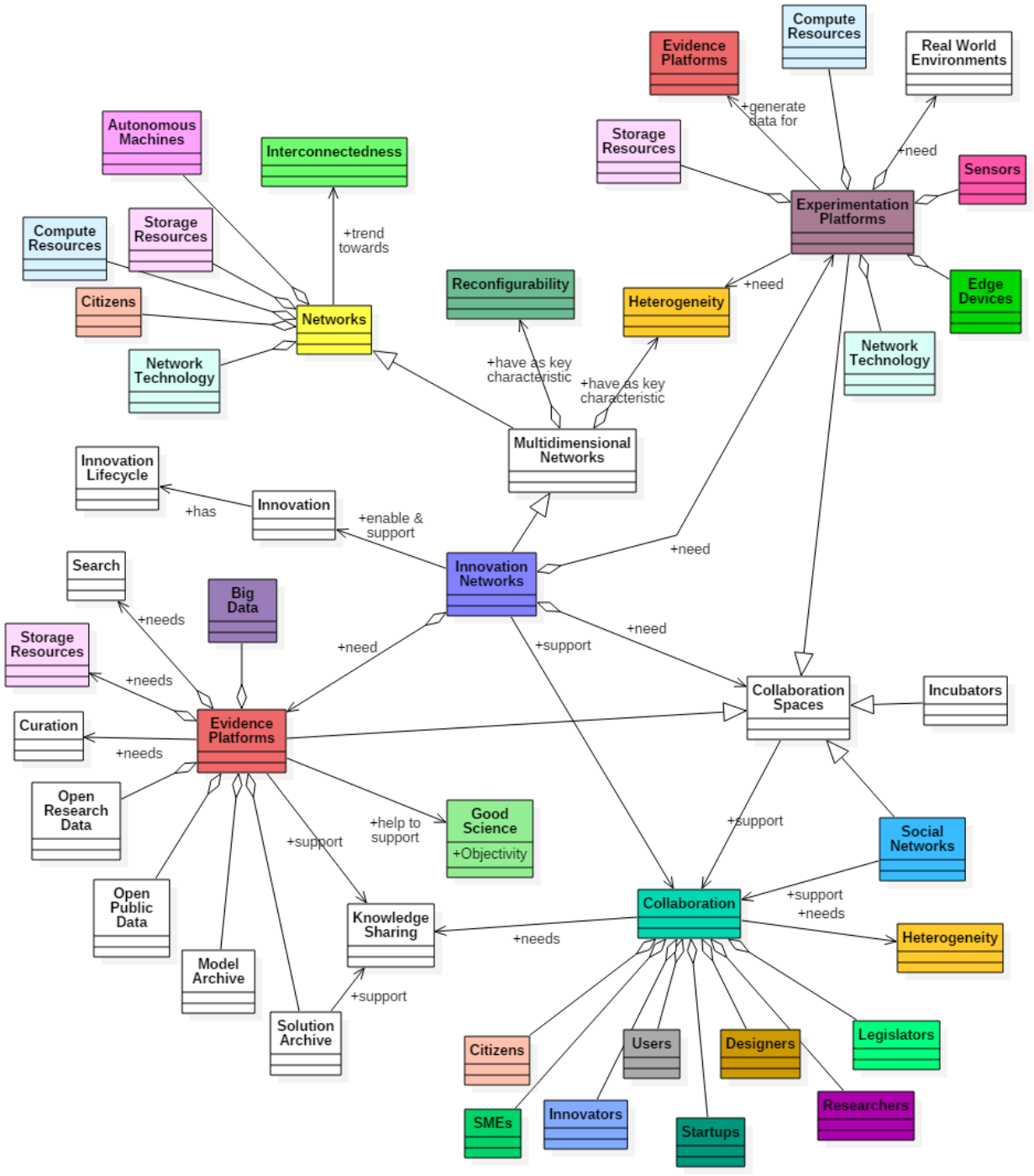


FIGURE 8: INNOVATION NETWORKS

Innovation networks can be utilised whenever innovation and collaborative working is needed. They may be used for any innovation but can also be applied to evolve the NGI itself.

3.4.1 Collaboration Spaces

Lipparini & Romeo advocate that:

> *More efforts are needed at European, national, and local levels to create spaces and places where citizens, stakeholders, and policy makers could exchange on the future of NGI related issues [Lipparini & Romeo 2017]*

Co-funded by the Horizon 2020 Framework Programme of the European Union

Clearly there is a need for physical (e.g. incubators) and virtual places (e.g. Internet forums) where stakeholders concerned with the future of the Internet can interact and share ideas. This can serve as a starting point for our definition of collaboration spaces to support innovation, but it is asserted that the definition of "collaboration spaces" should be wider than simply places where people can interact – collaboration spaces should also incorporate platforms such as social networks, evidence platforms and experimentation platforms, as advocated by participants in the DIN Forum 2017:

> *"… new platforms show who is collaborating, who is working in what field, can provide open scientific data" [DIN Forum 2017 - innovation process]*

> *"Many different infrastructure types are needed working together to make a platform to facilitate innovation collaboration" [DIN Forum 2017 - innovation process]*

Nurse [Nurse 2015] supports the notion of collaboration and ecosystems where collaboration is facilitated:

> *The research community is highly interconnected and the overall ecosystem is complex. Collaboration often leads to the whole being greater than the sum of the parts. […] Barriers are to be avoided in research systems – the most effective research systems are characterised by freedom of movement and action. [Nurse 2015]*

3.4.2 Experimentation Platforms

Heterogeneous Experimentation Platforms[6] are already in existence (e.g. Fed4FIRE[7]), and are strongly advocated as an important component of NGI innovation. The FIRE Study reinforces the need for a platform of integrated heterogeneous experimentation resources, emphasising the point that real-world experimentation environments are important, and goes further recommend that new resources including a pan European blockchain should be provided:

> *End-to-end network and protocol validation and interoperability tests should include real life experimental environments in an early phase of development, and include activities to provide fast feedback and to improve the quality of models and simulations. [FIRE STUDY DIN 2017]*

> *New research and experimentation areas should include a pan European blockchain, including robotic devices, and the establishment of mixed experimentation environments with large numbers of heterogeneous devices with IoT programmability, and Large Scale Streams. [FIRE STUDY DIN 2017]*

The PSNC workshop on NGI concurs on both points made by the FIRE Study, adding that startups need access to experimentation infrastructure and resources provided as a service.

> *Blockchain – we have to adapt and understand this technology (so trainings for better skills are important). It can be a concept of future Internet (especially mobile). Very important will be better compression algorithms (some companies in USA already work on this). [PSNC 2017]*

> *Startups need easy and affordable access to technology hardware (advanced infrastructure), software and clouds. [PSNC 2017]*

[6] The term "Experimentation Platform" is preferred over the more common "Experimental Platform", because the platform enables experimentation, and the platform is not in itself experimental.
[7] https://www.fed4fire.eu/

Co-funded by the Horizon 2020 Framework Programme of the European Union

FIRE/NGI experimentation - sometimes checking if something works OK in practice can be very expensive, so the possibility for startups to inexpensively simulate this on computers should be easy available. [PSNC 2017]

The existing pattern of open calls and experimentation funding are supported by the FIRE STUDY:

In order to attract more experimenters to test new networks/protocols, and enable prototyping for rapid innovations, Open Calls should continue with and w/o funding mechanisms to create interest for innovative SMEs, Startups and business verticals (e.g. eHealth, Automotive, Media, etc.). In this way, academic and industrial players would work closer already in the beginning of new technology development life-cycles, the academia view would be part of future standards, and business aspects and business models would be better taken into account. [FIRE STUDY DIN 2017]

It would be useful to see more flexibility in the open call models, however. The current cycles of open calls can be fixed regarding subject types and often have long lead times (in the order of 3-6 months) between application and decision or commencement of experiments. SMEs very often need to be much more agile than these timescales permit: they need a decision in the order of days, rather than months, so they can perform e.g. a validation experiment within the week.

3.4.3 Evidence Platforms

Participants in the DIN Forum asserts that evidence bases are a platform for innovation:

"…for researchers an important aspect is the ability to share data and models

... Evidence base is a platform for innovation

… sharing data and models helps people to collaborate, identify new ideas and test existing ideas

… new interactions help us to build, curate and exploit the evidence bases

" [DIN Forum 2017 - innovation process]

From this, we can define evidence platforms as places where data and models are stored and may be searched, and solutions to problems are archived and can be made available. At the current time, a single integrated platform containing all these functions cannot be found, but the individual functions are already available, and are discussed below.

There are clear similarities to the push towards Open Research Data (ORD), which supports open science. Both the EC and the OECD have investigated mechanisms to reinforce the principles of open science. The EC has consulted widely to determine its position, a major result being the Results of the Public Consultation on Science 2.0 [EC Science 2.0 2014], which investigated how science needed to change given new technologies and changes in attitudes, especially how the new technologies can enable and reinforce science's core principles of openness, transparency and reproducibility. The name "Science 2.0" has now been replaced by "open science", better illustrating the core principle of the initiative. The OECD has determined policy to clarify and support open science [OECD 2015a]. The slide set "Open Science: The Policy Challenges" [OECD 2015b] asserts that science should be a global public good, accessible by and for the benefit of all humankind. The OECD defines open science by what elements it should include:

Co-funded by the Horizon 2020 Framework Programme of the European Union

Open access to scientific publications

Open and "intelligent" access to research data (and materials)

Open access to digital applications and source code

Open access for scientists, the public and commercial companies

[OECD 2015b]

Responding to the Public Consultation on Science 2.0 [EC Science 2.0 2014], the Royal Society concurs with the principles of open science, backed up with open research data:

"Science has benefited from open practices throughout history."

"Open science offers public and civic, economic and international benefits. Making data open can improve public engagement, enabling the public to engage more easily in the process and results of science."

"Openness should be the default for research unless precluded by fundamental ethical and legal requirements (such as privacy, security, safety and confidentiality)."

"Data-intensive science is also becoming a driver for economic growth and development."

[Royal Society Science 2.0 2014]

There is clear will from the scientific community to support ORD, and repositories exist, such as Zenodo [Zenodo], to hold and curate ORD, and make it available and findable. Fed4FIRE+ has investigated ORD from the point of view of an experimentation platform, and a full discussion is available in the public Fed4FIRE+ D2.1 deliverable [Taylor 2017].

The ORD repositories are mainly concerned with the results of scientific experiments (e.g. data), but participants at the DIN Forum specified that sharing knowledge on problems solving would have additional benefits to support the innovation community. It is advocated that both data and solutions to problems should be persisted and easy to find:

"Persistence & cost of search: Data and results should be kept, curated and made findable, so future researchers do not have to reinvent the wheel. Often the cost of looking for solutions to problems is so great or the search intractable, that we resort to making our own solution instead of finding other peoples'" [DIN Forum 2017 - innovation process]

There are existing domain-specific platforms hosting solutions to problems, e.g. Stack Overflow for programmers[8]. Its popularity on Google searches is testament to the success of its format. It is an open question as to what other solution sharing platforms exist. A survey should be conducted to determine where solutions in other domains are collated are made available for searching.

In addition to Open Research Data and solutions to problems, open public data is important from the perspective of startups:

Open public data – discoverable and easy to process linked to other data sources (private/personal). For example: we have already all data on our mobile device (like: weather forecasts, public transport data, city bikes, etc.) but they have different data formats and we have to manually check

[8] https://stackoverflow.com/questions

Co-funded by the Horizon 2020 Framework Programme of the European Union

everything one by one, so there is a need for some automation which could link all this data together as some "open link". Open data is important to link them between and with other data sources. [PSNC 2017]

At the current time, it is not clear whether any tighter integration than is available currently – e.g. using a Google search to find the answers to questions, or searches of open data repositories. Another related question is whether all of the information should be stored in one place. It is asserted that this is very unlikely, since repositories and platforms addressing individual parts already exist. The key question then is how to provide a single place that provides all these resources in one place, and how it can improve on what Google searches already offer.

3.4.4 Innovation Support

Paraphrasing and interpreting [Nurse 2015], the innovation lifecycle from pure (discovery) research to product or service development is shown in Figure 9.

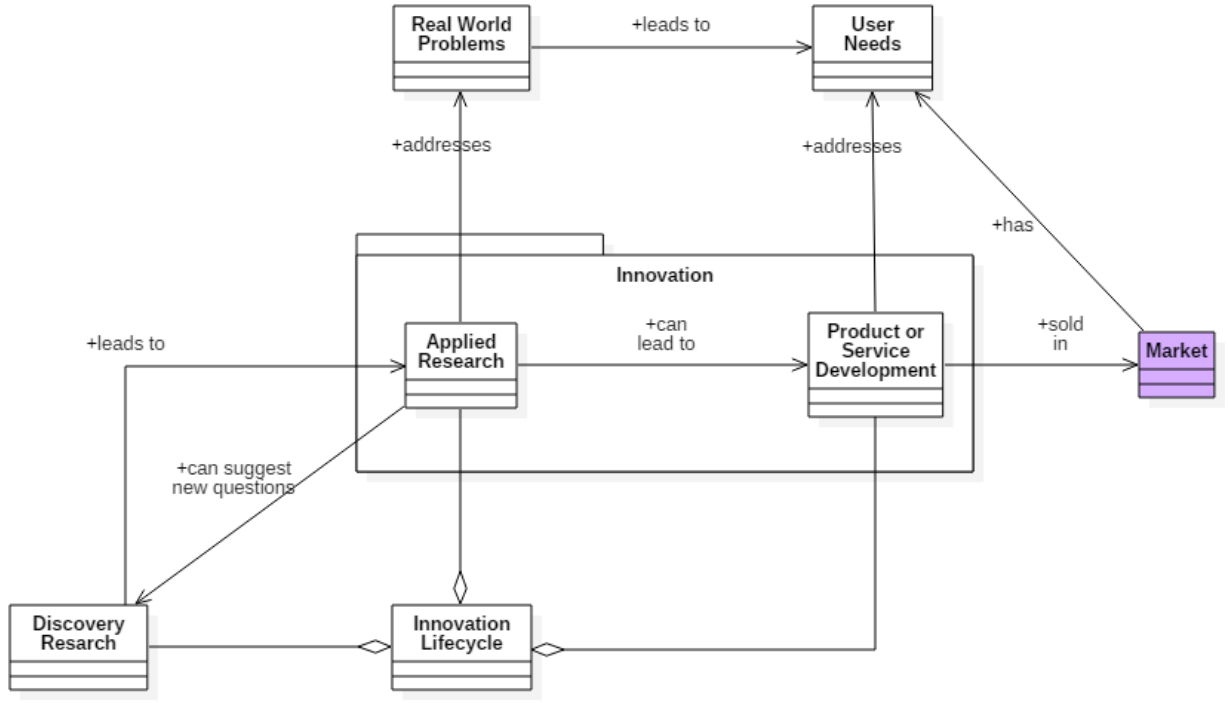


FIGURE 9: INNOVATION LIFECYCLE

Research is funded by governments, commercial institutions, and charities. Government funded research is usually performed within universities or government departments. In universities, it has the objective of increasing a publicly-accessible body of knowledge and training students to discover and use that knowledge. In government departments, it is usually to support public policy. Research funded by commercial institutions is usually to create a competitive advantage for the company, and accompanied by innovation to exploit the research into the market place. Commercial innovation can also be supported by governments via grants and accelerators. Charitable research is usually to support philanthropic interests.

Pure (or Discovery) research produces knowledge about the world. It is often characterised by understanding of the chosen field, formation and testing of hypotheses including experimentation, data gathering, analysis, conclusion and possible re-formulation of hypothesis.

"… all research methods share common features: theories built on previous research; empirical testing through the gathering of evidence; impartial and accurate observation; careful collection of relevant data and its rigorous

Co-funded by the Horizon 2020 Framework Programme of the European Union

analysis; openness to challenge from other experts; transparency of the whole process." [Nurse 2015]

Applied research is "aimed at achieving specific outcomes" [Nurse 2015]. This is directed research aimed at addressing real world problems, so requires understanding of the needs of the target user community together with a sufficiently well-developed knowledge base of the subject area.

Research does not follow a linear direction from pure (discovery) to applied and finish there. Knowledge can be acquired from applied research and give clues to further discovery research, so the process can be iterative or bi-directional.

Applied research often proves concepts or demonstrates the utility of a technology for a particular application. In order to transition from results of applied research to a marketable product or service, development is required, where the outcomes of the applied research are refined and tested in real world conditions. The actual innovation occurs in the transition between the applied research and the product or service development, and may incorporate elements of both.

There is often a gap between applied research outputs and product and service development, and this is due to the traditional ways the two activities are funded. Applied research is often funded by public money (e.g. EC or national grants), and product and service development is often funded by private money (e.g. venture capital for entrepreneurs). This gap is addressed by so-called "Innovation Agencies".

Glennie & Bound [2016] describe a survey plus analysis of 10 national Innovation Agencies, e.g. Innovate UK, DARPA (USA) and Tekes (Finland). They describe four major types of innovation agency:

- Market and System Fixer – aims to fix failings in the market that mean innovations are not getting through. A typical case is the gap between research funding (often provided by public funds) and late stage commercialisation funding (often provided by private e.g. VC type funding.
- Industry Builders – focused on developing and nurturing a particular industry sector, usually guided by national government objectives.
- Mission Drivers – aims to create innovation to solve recognised problems.
- System Optimiser – mixing the three above strategy types.

It is recommended that innovation support be guided by the approaches taken by national Innovation Agencies. There are many stories of successful business created that were started or accelerated by the Innovation Agencies surveyed by Glennie & Bound.

3.4.5 Recommendations

Collaboration spaces are clearly important, and the recommendation is to investigate mechanisms to provide 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

Co-funded by the Horizon 2020 Framework Programme of the European Union

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.

3.5 MULTIDISCIPLINARY & END-TO-END 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. The key elements of multidisciplinary design are shown in Figure 10.

Co-funded by the Horizon 2020
Framework Programme of the European Union

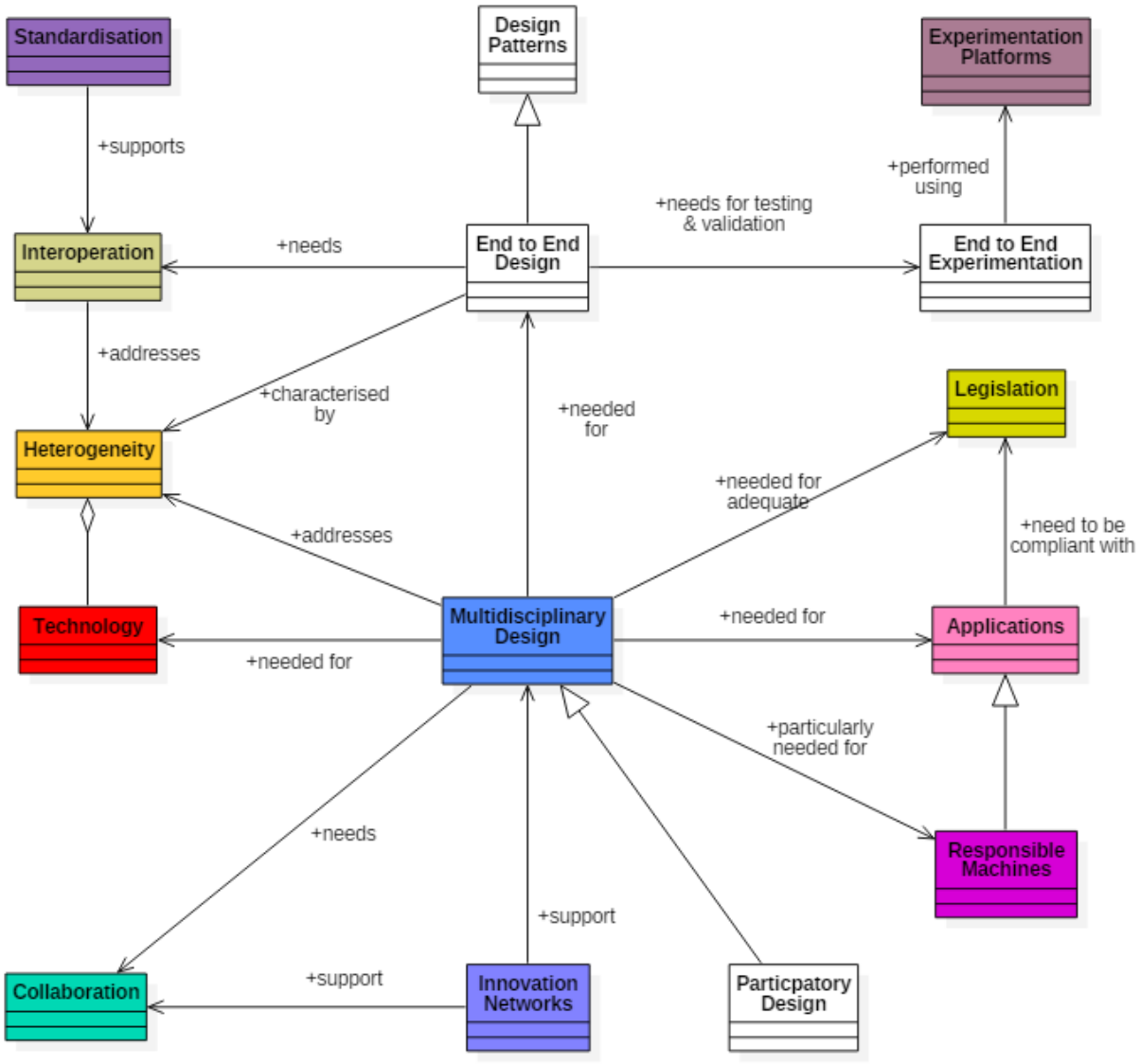


FIGURE 10: MULTIDISCIPLINARY DESIGN

In the sources, multidisciplinary design collaborations for Internet innovation are seen as important in general:

> *An analysis on the type of research, actors and initiatives reveals an appetite for collaboration among interdisciplinary groups engaged in a mixture of long term and applied research projects. [Overton 2017]*

> *"[there is a] need for multidisciplinary, interdisciplinary and trans-disciplinary research - different disciplines working together to understand innovation for sustainable development" [DIN Forum 2017 - innovation process]*

> *Over 50% of survey participants selected the Multidisciplinatory approach as the main policy recommendation for the NGI experimentation: The interconnectivity of Next Generation Internet Experimentation systems will require a multidisciplinary approach to a number of challenges to be faced when realizing the all-and-always connected vision. Bringing together people, data, devices in a variety of deployment scenarios will require end-to-end experimentation to be driven by combining expertise from different technology domains (e.g. wireless networks, optical networks, cloud*

Co-funded by the Horizon 2020 Framework Programme of the European Union

computing, IoT, data science) in relation to specific vertical sector needs (healthcare, creative media, smart transport, marine industry, etc.) and horizontal disciplines push factors (e.g. psychology, law, sociology, arts, economics). [FIRE STUDY DIN 2017]

In particular, multidisciplinary teams are deemed particularly necessary when deciding on governance or legislation over Internet technology and applications:

Multi-actor protocol/system design principles and methodologies for cooperating machines and people should be investigated as key to understand the challenges and implications related to the NGI Collective Human Experience (ethics, security, privacy concerns). [FIRE STUDY DIN 2017]

It was agreed that investing in hybrid teams of lawyers and technical experts will help ensure that legislation is relevant and implemented effectively. [Takahashi 2017]

For all this technology investment is needed to support effective governance that balances rights and supports legislation. A multi-disciplinary approach is essential. [Overton 2017]

Multidisciplinary teams are particularly 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 part of end-to-end systems design. In turn, end-to-end design is supported by interoperability and open standards.

Specifically relevant to experimentation, but not only, engagement of large numbers of users and communities of users for co-creation, awareness and design constraints should be enforced so as to ensure innovative services, applications and technologies to be more easily understood, accepted and adopted. [FIRE STUDY DIN 2017]

End-to-end experimentation integrating radio – network – application/services through codesign in early phases should foster multidisciplinary research, development and innovation. [FIRE STUDY DIN 2017]

Focus should be on end-to-end systems design (with few larger infrastructures including international dimension) based on open global standards and standardised interfaces/APIs, where 5G/6G network is extended towards edge computing and even autonomous connection mechanisms between edges w/o connection to core network. [FIRE STUDY DIN 2017]

Interoperability and Open standards is clearly the most relevant factor for the respondents selected by almost the 80% of participants to the survey.[FIRE STUDY DIN 2017]

Impact factors that should be accounted for include interoperability, open standards…. [FIRE STUDY DIN 2017]

The "citizens" involvement as "actors" in the research is crucial. This may include representative bodies, policy makers and regulators but these need to encompass women, students and activists. [Overton 2017]

Co-funded by the Horizon 2020 Framework Programme of the European Union

Multidisciplinary collaboration is also well suited for creating simulation models, and the act of creating the model is a collaboration in itself.

> *"... simulation models need inputs from multiple domains of knowledge so they already are a kind of multidisciplinary collaboration platform. The act of creating the model gives opportunities for new ideas from the collaborators from different backgrounds." [DIN Forum 2017 - innovation process]*

3.5.1 Recommendations

Multidisciplinary design for NGI is clearly important, as it enables end-to-end system design incorporating multiple aspects of the overall system from technical to social to legal. Therefore multidisciplinary and end-to-end system design need to be supported, involving close engagement with user communities where necessary. Interoperability and open standards are clearly important to enabling end-to-end system design, and therefore should be encouraged and supported.

The recommended mechanism for support of multidisciplinary design is the innovation networks concept discussed in Section 3.4.

3.6 LEGISLATION

Legislation and the legislative process are recurring themes in the sources. The key elements are shown in Figure 11.

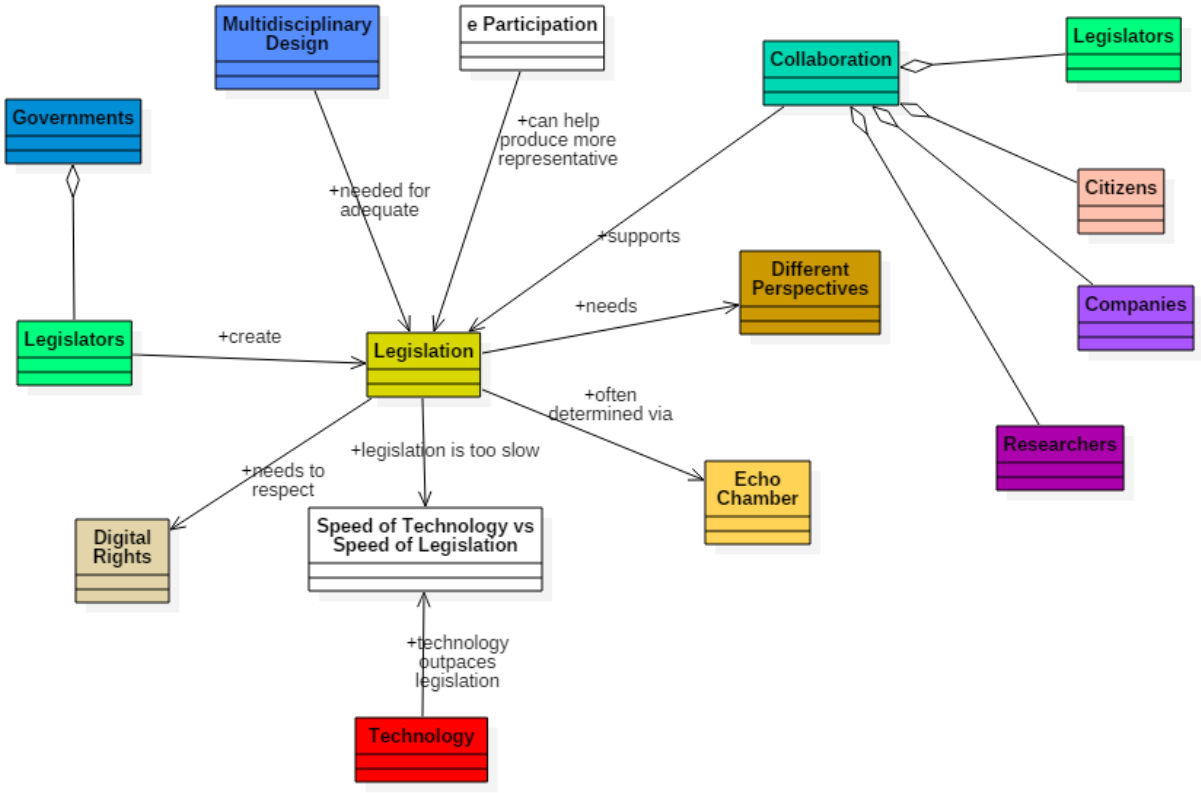


FIGURE 11: LEGISLATION

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.

Co-funded by the Horizon 2020 Framework Programme of the European Union

"Technical innovation often progresses faster than the passage of new legislation, we heard." [Takahashi 2017]

In most cases, citizens and businesses are ahead of their governments in understanding the implications of the Internet. [Ditchley 2016]

Changes are rapid so legislation must adapt. [PSNC 2017]

Fast legislation is needed to keep pace with technology. [Net Futures 2017]

How to make legislation keep pace with technology? [Legal, ethical and social issues in a software defined world] [Net Futures 2017]

Different solutions are proposed. Takahashi suggests that AI could provide automation to speed up the legislative process, whilst it is already understood from Section 3.5 that multidisciplinary approaches can be effective, especially when legislating for safety critical and applications with high societal impact.

"Using AI to automate some of the legislative process could be one way of helping the law to match the rate of technological change." [Takahashi 2017]

It was agreed that investing in hybrid teams of lawyers and technical experts will help ensure that legislation is relevant and implemented effectively. [Takahashi 2017]

"An interdisciplinary approach needed to determine legislation for new technology [Legal, ethical and social issues in a software defined world]"[Net Futures 2017]

New ways of legislating are advocated:

"E-participation & smart consultation for legislation. Consult as many people as possible at all levels of policy, not just the big things like referendums but also the small things like local issues" [Net Futures 2017]

These will require easy and fast methods for engagement with citizens, but will need to be mindful of the demographics of the citizens that use the Internet, meaning that any online consultations are not likely to be representative of the population.

3.6.1 Recommendations

- Legislation speed is too slow to keep pace with technological developments.
- 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.

3.7 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. The key elements are shown in Figure 12.

Co-funded by the Horizon 2020 Framework Programme of the European Union

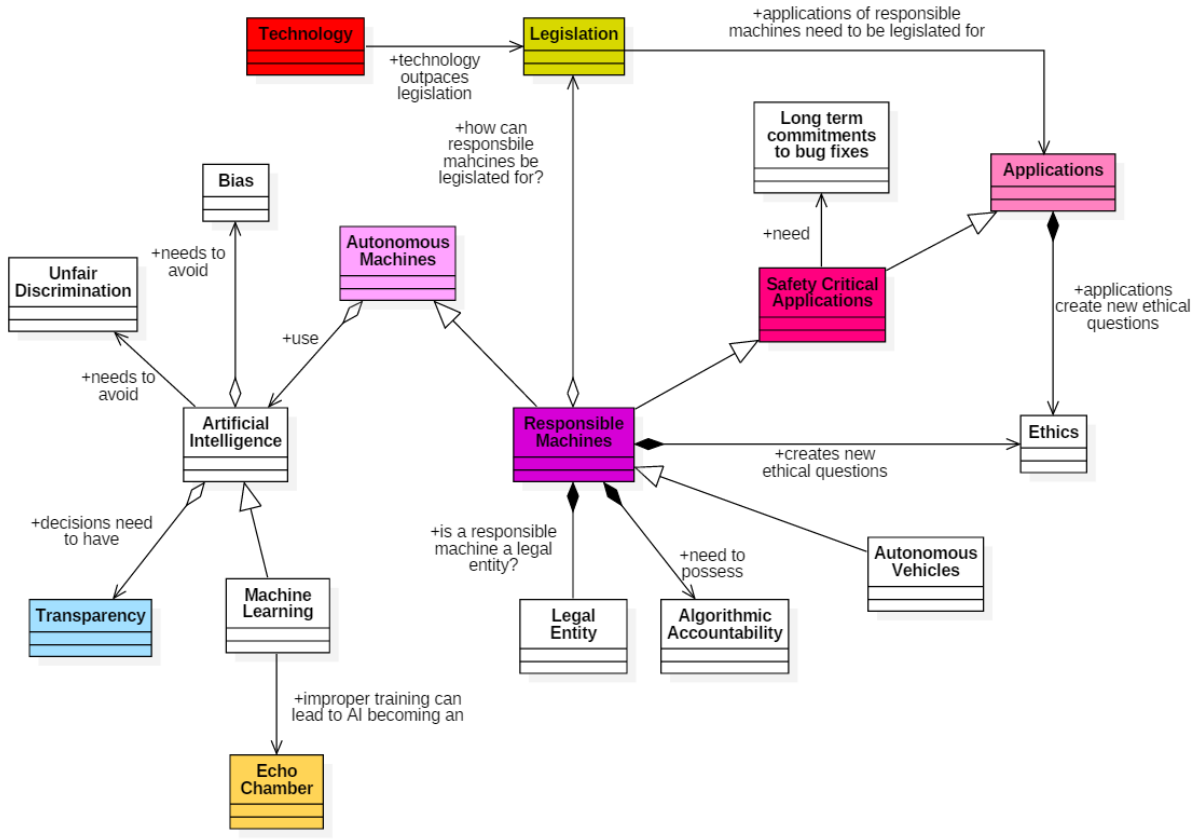


FIGURE 12: RESPONSIBLE MACHINES

A well-known and understood exemplary use case is autonomous vehicles. These are under the control of AI algorithms and safety critical, but the current legislation lags the technical developments. Currently the default position is that there needs to be a human being in control of the vehicle, and it is they that take responsibility, but future usage situations may make this impractical at scale, and will hamper the benefits of the autonomous vehicles.

We need to protect from AI systems failures and unpredictable behaviour, and be in control of AI systems:

> *... 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 ... [Lipparini & Romeo 2017]*

AI is likely to result in machines that need to be responsible for their actions. Ethics of responsible machines needs to be investigated, for example to determine how they can be regulated and legislated for. Takahashi:

> *"As machine learning advances, AI will play an increased role in daily life (e.g. self-driving cars, semi-automated justice systems).*
>
> *The prominence of AI will pose new ethical questions, as well as creating a new and urgent demand to answer old ones. For example, self-driving cars will face the classic "trolley problem", which involves choosing a course of action where every option leads to harm." [Takahashi 2017]*

Overton concurs, additionally citing that work needs to be done on the transparency of the algorithms:

Co-funded by the Horizon 2020 Framework Programme of the European Union

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. [Overton 2017]

New technologies, particularly AI pose new legal and ethical challenges, and it is an open question whether the current laws and law making process can address these challenges – this is a critical use case supporting the arguments for reforms of the legislative process discussed in Section 3.6.

"[There are] legal & ethical implications of emerging technologies" [Legal, ethical and social issues in a software defined world] [Net Futures 2017]

Are laws up to challenge of digitisation? [Legal, ethical and social issues in a software defined world] [Net Futures 2017]

AI also poses risks to society in the hands of people or organisations that wish to do harm:

"The proliferation of AI and the Internet of things has the capacity to deliver enormous benefits to society, but will also create new risks.

Cyberphysical attacks and AI terrorism will be among the new threats that the state has to manage." [Takahashi 2017]

Responsible machines often operate in safety critical modes, where their actions or inactions can cause harm to humans. Safety critical software needs commitments from its developers to provide updates to fix bugs and security flaws:

Continuation of service in safety critical applications? [Legal, ethical and social issues in a software defined world] [Net Futures 2017]

Making companies responsible for providing security updates over the long term could mitigate some of these risks. The example of a self-driving car, produced and purchased in a developed nation, before being sold second-hand to a developing nation was raised. It was argued that NGI could aim to ensure that security updates are provided for the entirety of the car's use, not just its use by the initial purchaser [Takahashi 2017]

An open question remains concerning what will happen should the AI developer go out of business.

3.7.1 Algorithmic Accountability

The responsibility issue for AI raises a significant issues about whether and how can an AI algorithm be accountable for its actions:

"Algorithmic accountability: How to trust a black box algorithm? How to opt out of algorithm use? To what extent do algorithms violate privacy? Accountable & ethical data management & analytics: Decision explanation, transparency, decision responsibility, how can I trust machine learning prediction? Robustness to bias / diversion / corruption" [Net Futures 2017]

Algorithmic accountability is supported in the Net Futures debate "Legal, ethical and social issues in a software defined world":

"Accountability, transparency, responsibility is needed for new technology"

"… there is a responsibility gap for AI systems" [Net Futures 2017]

Co-funded by the Horizon 2020 Framework Programme of the European Union

A critical point regarding who (or what) is liable for AI decisions. If an AI algorithm causes harm, who or what is responsible?

> *"… who is liable for AI decisions?" [Net Futures 2017]*

The related question of whether AI could ever become a legal entity, with its own rights and responsibilities, has been posed:

> *Participants provocatively proposed the idea of rights for AI; arguing that if AI were to be taxed, as Bill Gates had suggested, they could be afforded civil protections under the principle of "no taxation without representation". " [Takahashi 2017]*

Legal and ethical compliance for AI was discussed at Net Futures as a possible solution to managing the accountability for AI actions:

> *"… there is a need to make sure software is used as intended for legal and ethical compliance" [Net Futures 2017]*

However, it is difficult to see how the uses the algorithms are put to can be monitored and enforced. Once an algorithm is made available, it can be put to any use it functions for.

Transparency is a key aspect of algorithmic accountability, in that it is widely agreed in the Net Futures debate that the algorithms need to be able to explain their decisions.

> *"… there is a lack of understanding in what data & algorithms actually do" [Legal, ethical and social issues in a software defined world] [Net Futures 2017]*

> *"Transparency is needed - how did a decision come about? [Legal, ethical and social issues in a software defined world] [Net Futures 2017]*

> *"AI disrupts the legal system - it blurs rules on liability. AI has application unpredictability and appears as black boxes that are difficult to explain - AI is new tools that are hard to scrutinise and need to be more transparent." [Legal, ethical and social issues in a software defined world] [Net Futures 2017]*

> *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. [Overton 2017]*

Takahashi concurs:

> *"We heard that there is a need for AI to be transparent, so that citizens can understand how their personal data is being used. But the complexity of systems where multiple AI interact will make it difficult to achieve meaningful transparency." [Takahashi 2017]*

The question of avoiding bias or discrimination has been raised by multiple parties. An exemplary case was given in the Net Futures debate, illustrating the need for transparency in decision making. This was concerned with gender discrimination when AI algorithms filter Curriculum Vitae in recruitment situations. The case was summed up thus:

> *"AI should be fair and testable. There is the possibility of discrimination from algorithms." [Legal, ethical and social issues in a software defined world] [Net Futures 2017]*

Bias can be built into AI - it is only as good as its inputs or training:

Co-funded by the Horizon 2020 Framework Programme of the European Union

"AI is only as good as its inputs or training. It can be prejudiced or biased. Citizens need to trust so needs to be transparent in decisions and transparently unbiased" [Net Futures 2017]

“AI is like a child - you need to train it with ethical values” [Legal, ethical and social issues in a software defined world] [Net Futures 2017]

Machine learning risks becoming an echo chamber for the user's preconceptions and biases:

Machine learning will also become deeply embedded in how we absorb the Internet. There is a risk that the Internet becomes an echo chamber for our own prejudices and preconceptions, rather than a source of objective facts and challenge. [Ditchley 2016]

3.7.2 Ethical Frameworks for Autonomous Machines

Ethical frameworks for AI and autonomous machines are advocated by Overton:

A proper and actionable ethical framework for Artificial Intelligence regarding algorithms becomes essential … [Overton 2017]

There was controversy in the Net Futures debate regarding the ethical considerations of AI, and where they should be placed. Some participants advocated that AI should have ethics designed in:

"Legal standards must be built into system design. This poses questions over what happens with learning algorithms? How can you design these with ethics in mind?” [Legal, ethical and social issues in a software defined world] [Net Futures 2017]

The counter argument is that the application of technology should be the subject of legality and ethics, rather than the technology per se:

"… it is the use that the tech is put to that is the subject of the legal and ethical question, rather than the tech itself. Tech is ethics agnostic. if you try to put ethics in tech you constrain it or can cause harm - it is the application of tech that is subject to ethics. How is application use and tech design combined and what are the ethical questions?" [Legal, ethical and social issues in a software defined world] [Net Futures 2017]

It is not clear how ethics can be designed into AI technology, and investigation needs to take place into where the ethical and legal questions lie. The ethics of AI are not a new subject, and lessons can be learned from the societal impacts of robotics, a well-cited example being Isaac Asmiov’s “Three Laws of Robotics[9]” [Asimov 1942]. The concept of robotics as tools is discussed in Parry [Parry 2010], supporting the notion that it is the application that the tool is put to that needs ethical consideration and legislation governing what is permissible.

3.7.3 Recommendations

Research and discussion involving multidisciplinary teams from the legal, sociological and technical domains is needed to provide answers to ethical and legal questions surrounding Artificial Intelligence.

[9] Isaac Asimov’s “Three Laws of Robotics”:
1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.
2. A robot must obey orders given it by human beings except where such orders would conflict with the First Law.
3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

[

Co-funded by the Horizon 2020 Framework Programme of the European Union

- Who or what takes responsibility for an AI system's decisions or actions? Who or what should be prosecuted if an AI system causes harm?
- How should legislation be brought to effect on AI systems?
    - What are the most appropriate regulations?
- Are AI systems ever likely to be legal entities?
    - How can an AI system be incentivised to be compliant with the law? It does not understand the notions of penalties for non-compliance.
- Should ethics be designed into AI technology, or should ethics apply to the applications of AI technology?
- Transparency: how can AI systems explain their decisions?
- How can bias be eliminated from AI systems?
- How can commitments be acquired from creators of AI technology to issue patches for safety critical flaws over the long term?

3.8 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. Ditchley:

> *There is a risk that the Internet becomes an echo chamber for our own prejudices and preconceptions, rather than a source of objective facts and challenge. We are already seeing this in the rapid spread of false news. [Ditchley 2016]*

Many sources quoted filtration and censorship of the Internet, often without the knowledge of the consuming citizens, as problematic:

> *Increasingly consumers are being presented with a selected slice of the Internet, controlled, filtered and sanitised. [Ditchley 2016]*

The phrase “filter bubble” was coined by Eli Pariser [Pariser 2011], and refers to the isolation of citizens in “bubbles” of information filtered to suit their opinions. This filtration can be attributed to profiling of citizens by search engines so that the citizens get results they like, but can also be due to social aspects such as social networks:

> *(Technologies such as social media) lets you go off with like-minded people, so you're not mixing and sharing and understanding other points of view ... It's super important. It's turned out to be more of a problem than I, or many others, would have expected. [Gates 2017]*

The phenomena of over-connected innovation networks can produce similar effects, mentioned in the DIN Forum:

> *"… sometimes people are over-connected in one group.”*
>
> *"Densification of network – it is paralysed because it is too heavily connected, especially in areas of innovation" [DIN Forum 2017 - innovation process]*

The major elements concerning echo chambers and some identified possibilities to counteract them, are shown in Figure 13.

Co-funded by the Horizon 2020 Framework Programme of the European Union

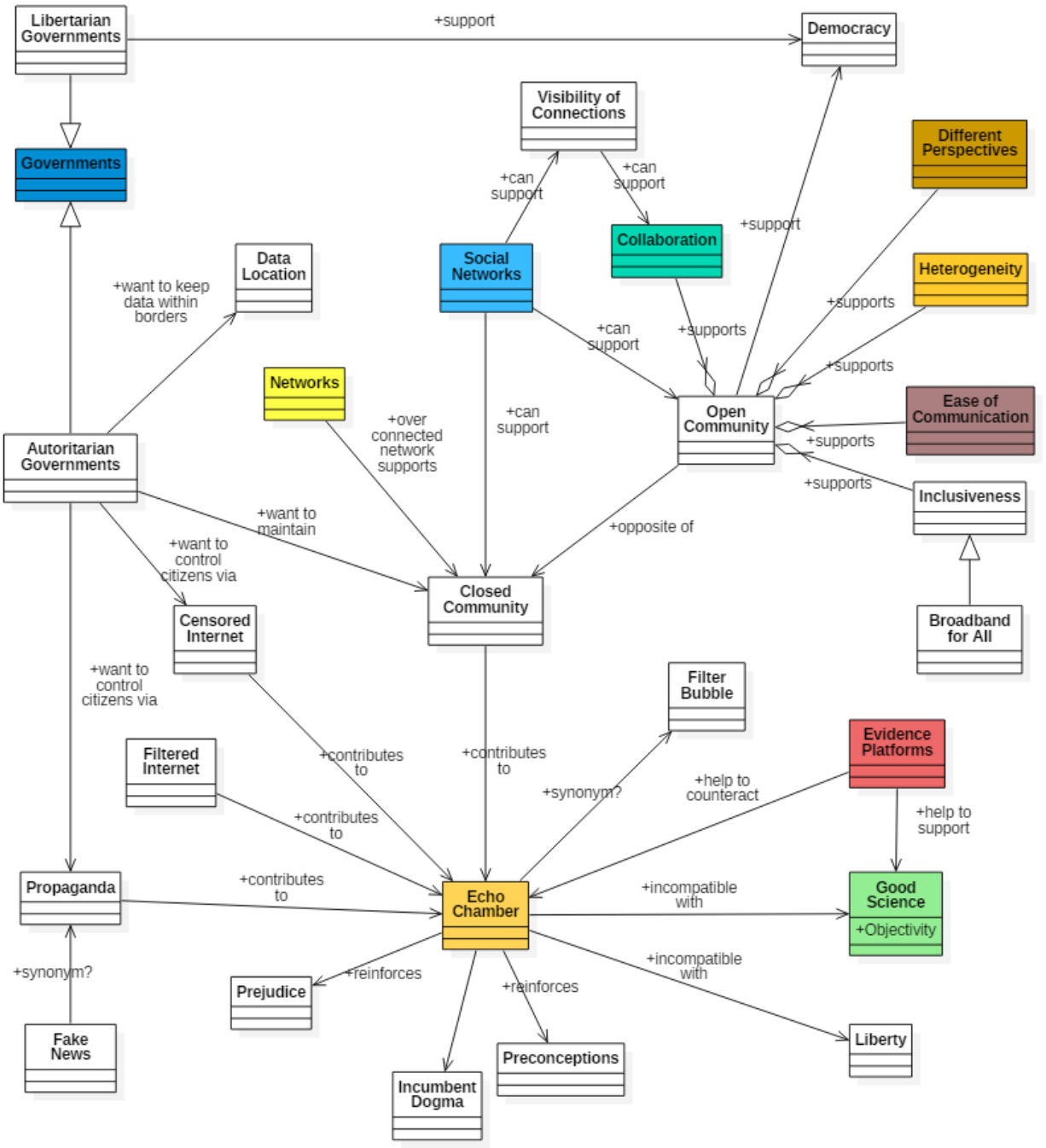


FIGURE 13: ECHO CHAMBERS

Ditchley asserts that the Internet should enable people to connect and find any information, not just the information that some authority has decided is appropriate.

> *We should work to keep alive the dream of any individual on the planet being able to contact another and to find the information they need ... [Ditchley 2016]*

3.8.1 Limitations to Democracy & Liberty

There is widespread concern over the abuse of Internet technologies causing threats or limitations to democracy and liberty. This could be through the actions of governments wishing to use the capabilities of the Internet to exert controls over citizens:

Co-funded by the Horizon 2020 Framework Programme of the European Union

Authoritarian governments increasingly want to bring the Internet under control and keep data at home in order to ensure access. [Ditchley 2016]

"... the Internet is heavily regulated and subject to state influence (e.g. the NSA's PRISM program, the Great Firewall of China, etc.). Governments will continue to have an important role in regulating the Internet and ensuring prosperity. States are creating geographies of data through data localisation laws, which require companies to store customers' and employees' personal data locally." [Takahashi 2017]

In the Lipparini & Romeo study, democracy is seen to be under threat: it is suspected that the electorate can be manipulated via the power of the Internet as a source of big data, and as a broadcast medium. There is also the recently publicised issue of "fake news":

... 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 ... [Lipparini & Romeo 2017]

... 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.[Lipparini & Romeo 2017]

"Over 70% of respondents strongly agree that action is needed to tackle filter-bubbles, ec[h]o-chambers and fake news … Fact-checking solutions through scientific research would also be warmly welcome …" [Lipparini & Romeo 2017]

There is a trade-off between privacy protection and regulation towards social control, and governance needs to balance rights and support legislation:

For all this technology investment is needed to support effective governance that balances rights and supports legislation. A multi-disciplinary approach is essential. [Overton 2017]

… 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. [Lipparini & Romeo 2017]

3.8.2 Issues

Options need to be investigated to address echo chambers. Some possible options are described below. There are, however, many challenges.

Regulation of search engines, so that they produce more balanced results, is possible. Users may not want this, however – they may prefer to get results that agree with their opinions and see alternatives as "irrelevant" results. The original purpose of the search engines' tuning results based on users' preferences was to give users the most "relevant" results[10]. If more "objective" results are returned, the users' perspective may be that their search experience is worse than before.

[10] Other factors may influence the search results

Co-funded by the Horizon 2020 Framework Programme of the European Union

Citizens' social groups should not be interfered with, unless there are genuine reasons (such as illegal activity). Many citizens want to interact with like-minded people, and clearly in a liberal society, this should not be prevented.

Promoting inclusiveness (e.g. broadband for all) and diversity (e.g. heterogeneity and multidisciplinary discourse) is a possible partial solution, but citizens cannot be forced into diversity.

> *"All EU citizens (including persons with disabilities, seniors, etc.) have the right to benefit from modern ICT services. The services should be designed in a way to be simple to use by all." [PSNC 2017]*

> *"… ubiquitous access to the Internet is/should be the right of each EU citizen (just like access to clean water or energy infrastructure)." [PSNC 2017]*

> *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 … [Lipparini & Romeo 2017]*

> *"Innovation thrives on brokering ideas amongst people from disparate communities - networks of disparate actors are more likely to create innovation." [DIN Forum 2017 - innovation process]*

3.8.3 Recommendations

Multidisciplinary research is needed in order to answer questions relating to the promotion of diversity and truth in the Internet. Some of these questions raise other questions of jurisdiction, state control and liberty, and a question overarching all of the questions below is: What degrees of intervention are acceptable before liberty is compromised?

- How can filter bubbles caused by unbalanced search results be addressed?
    - How can the vested interests of the large incumbent corporations providing search services be influenced to provide "balanced" results?
- How can filter bubbles caused by social groups be addressed (if at all)?
- How can echo chambers caused by state censorship be addressed?
- How can we balance utility for the public with accuracy of information?
- How can we address the question of fake news – how can be facts be verified?

3.9 ECONOMICS & WEALTH DISTRIBUTION

Digitisation and the Internet are increasingly becoming major influencers on economies and wealth distribution. According to Ditchley:

> *The digital economy is increasingly simply the economy. [Ditchley 2016]*

The Internet has changed market dynamics:

> *"Dynamics of market networks have changed [as a result of the Internet]. They are now customer centric, they are platform based and new platforms are emerging. Companies doing service innovation are changing and new initiatives may become popular." [DIN Forum 2017 - innovation process]*

The major elements are shown in Figure 14.

Co-funded by the Horizon 2020 Framework Programme of the European Union

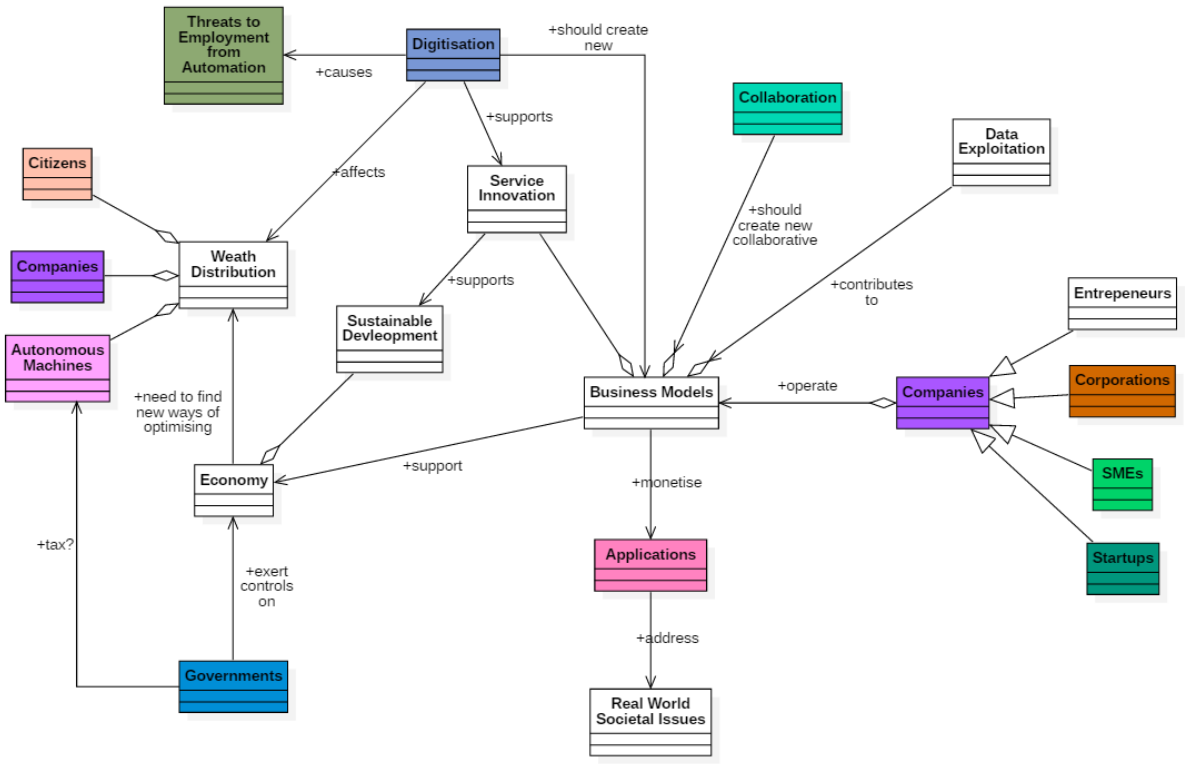


FIGURE 14: ECONOMICS AND WEALTH DISTRIBUTION

3.9.1 Support for SMEs

SMEs are seen to be at a disadvantage compared to other business types, and need help to take advantage of NGI:

> *"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. The potential to foster financial inclusion, increase SMEs and social enterprises' competitiveness, or encourage civic engagement and social solidarity are all underestimated across Europe." [Lipparini & Romeo 2017]*

> *International collaboration and SMEs competitiveness follow as very relevant impact factors for more than 50% of the respondents. [FIRE STUDY DIN 2017]*

3.9.2 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. How can humans and machines coexist in the economy? What roles are humans ideally suited for, and what roles are machines best at? How can humans' livelihoods be sustained, and how can the machines be paid for?

> *"… governance models to compensate employment or revenue losses caused by ongoing automatization processes … (72%) agree robots and artificial intelligence steal people's jobs … In line with the findings of the*

Co-funded by the Horizon 2020 Framework Programme of the European Union

Eurobarometer 460, automation of jobs is a source of great concern ..." [Lipparini & Romeo 2017]

"Employment & wealth distribution. New ways of distributing wealth aiming towards a society where people and machines contribute and have value. Dividing up work between what machines and AI can do and what people can do. Overcoming fear of robots taking our livelihood. Should we tax robots and AI? This leads on to question about responsible machines, how you legislate for them? Altruism - volunteering or working for the common good, and payment for this to encourage it" [Net Futures 2017]

3.9.3 New Business Models

There is a feeling that new and alternative business models are needed to challenge the current dominance of the incumbents, and that collaboration-based business models integrating people and resources from varying disciplines and sectors offer significant possibilities:

"NGI should be value driven and human centric - we want to promote alternative business models and alternative infrastructures to promote alternative solutions" [DIN Forum 2017 - innovation process]

"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." [FIRE STUDY DIN 2017]

Over 50% of survey participants selected the Multidisciplinatory approach as the main policy recommendation for the NGI experimentation: The interconnectivity of Next Generation Internet Experimentation systems will require a multidisciplinary approach to a number of challenges to be faced when realizing the all-and-always connected vision. Bringing together people, data, devices in a variety of deployment scenarios will require end-to-end experimentation to be driven by combining expertise from different technology domains (e.g. wireless networks, optical networks, cloud computing, IoT, data science) in relation to specific vertical sector needs (healthcare, creative media, smart transport, marine industry, etc.) and horizontal disciplines push factors (e.g. psychology, law, sociology, arts, economics). [FIRE STUDY DIN 2017]

"What are the most probable business models?
• Fair trade
• Standards
• Support from the government
• Federated model
• Data as currency (exchange of data)
• Bartering (exchange of resources)
• Open innovations (big companies with external resources)
• Knowledge as a service
• Competence centres
• PPP, B2B, B2C, B2B2X
• crowd funding
• A2C (AdministrationToCitizens) "[PSNC 2017]

Co-funded by the Horizon 2020 Framework Programme of the European Union

3.9.4 Sustainable Development

The NGI needs to support sustainable development, which is defined as “meeting the needs of the present without compromising the ability of future generations to meet their own needs[11]”. Internet resources are particularly suited for sustainable development, mainly because, due to digitisation, their use does not necessarily imply that they are depleted. An often-quoted phrase of modern times is that “data is the new oil”. This is true to a certain extent, in that it is regarded as a tradeable resource, but the critical difference between data and oil is that data does not disappear once it is used. Services based on sustainable resources such as data are therefore encouraged:

> *Digitisation enables service innovation, service innovation promotes sustainable development" [DIN Forum 2017 - innovation process]*

3.9.5 Recommendations

Research and innovation is needed in order to investigate:

- Wealth distribution models that accommodate humans and machines, so that the needs of both types are addressed:
  - How can humans and machines coexist in the economy?
  - What roles are humans ideally suited for, and what roles are machines best at?
  - How can humans’ livelihoods be sustained, and how can the machines be paid for?.
- 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.

3.10 TRUST & SECURITY

Trust and security are significant concerns, expressed in many contexts within the sources. The FIRE STUDY concludes that:

> *Trust, Security & Privacy are of central concern especially when considering highly interconnected networks scenarios. [FIRE STUDY DIN 2017]*

> *"IoT 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). [FIRE STUDY DIN 2017]*

The major elements are shown in Figure 15.

[11] http://www.un.org/en/ga/president/65/issues/sustdev.shtml

Co-funded by the Horizon 2020 Framework Programme of the European Union

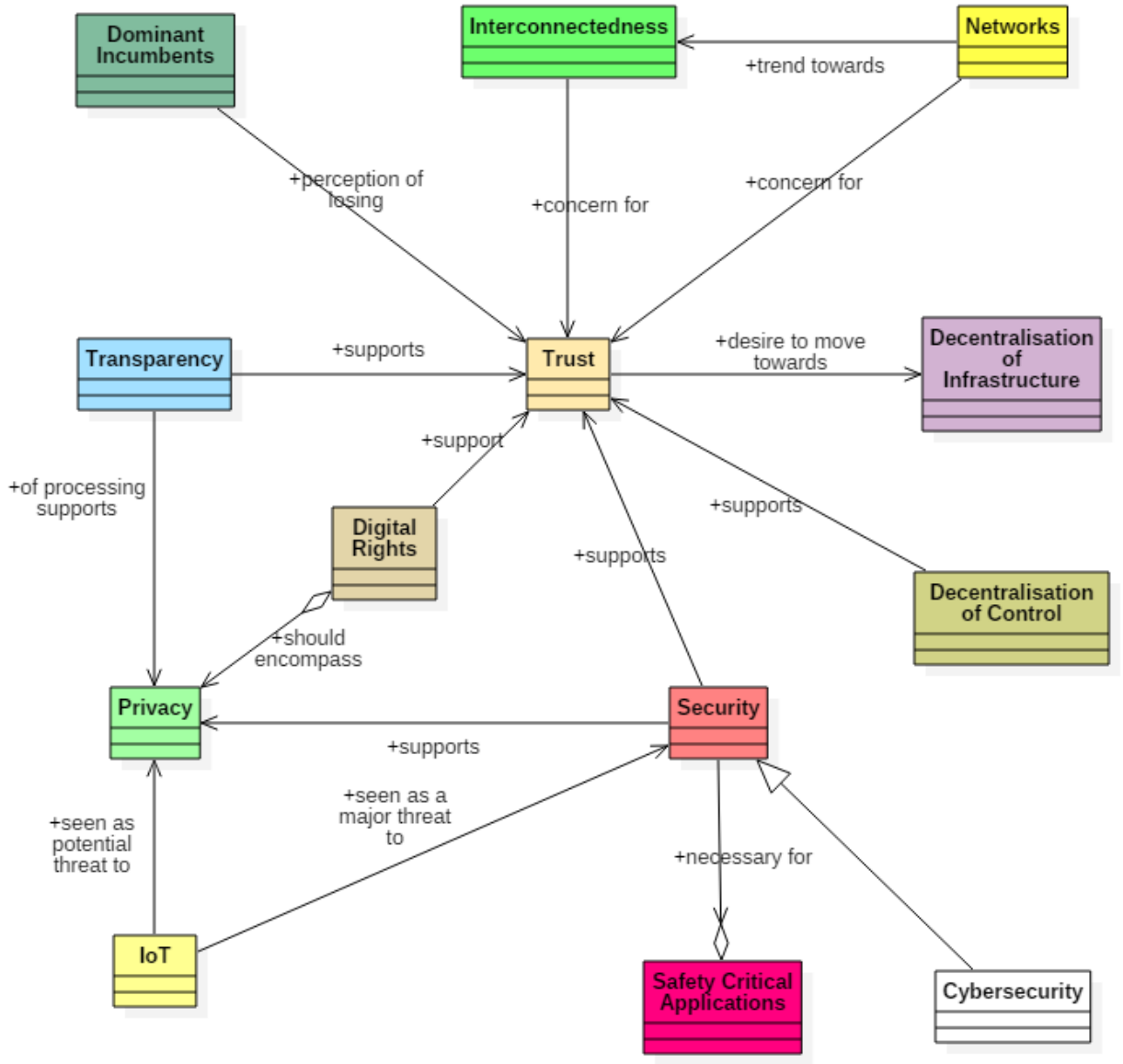


FIGURE 15: TRUST AND SECURITY

The trend towards interconnectedness poses threats. The FIRE STUDY asserts:

> *Trust, Security & Privacy are of central concern especially when considering highly interconnected networks scenarios. [FIRE STUDY DIN 2017]*

> *Decentralised and distributed social networks, wikis, sensors, blockchain value networks where a heterogeneous mix of humans, autonomous, manual and remotely operated machines will co-exist and interact must be investigated. This very much relates to understanding also a number of trust, security and privacy issues we are going to increasingly have to deal with within Next Generation Internet scenarios. [FIRE STUDY DIN 2017]*

Ditchley concurs, adding that the ease of connectivity is a threat to countries' national security:

> *Even for liberal governments, the ease of connectivity and communication on the Internet poses an inherent threat to national security. [Ditchley 2016]*

Co-funded by the Horizon 2020 Framework Programme of the European Union

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 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. Ditchley:

> *… we are now building the industrial Internet and the Internet of Things, which will make cyber security impossible to secure … [Ditchley 2016]*

> *These issues will become ever more urgent as the Internet deepens its penetration into our lives, society and environment through the industrial Internet and Internet of Things. Cyber security will become a synonym for safety. Much more and urgent work is required on this.[Ditchley 2016]*

Takahashi concurs, adding that AI terrorism also poses threats:

> *"The proliferation of AI and the Internet of things has the capacity to deliver enormous benefits to society, but will also create new risks. Cyberphysical attacks and AI terrorism will be among the new threats that the state has to manage." [Takahashi 2017]*

Research is clearly needed to address IoT + cyber security

> *These issues will become ever more urgent as the Internet deepens its penetration into our lives, society and environment through the industrial Internet and Internet of Things. Cyber security will become a synonym for safety. Much more and urgent work is required on this. [Ditchley 2016]*

Transparency is seen as an important enabler for privacy and trust in systems, AI systems especially:

> *Transparency: end-users should be aware of the level of privacy they get in accessing a given service for instance: through certification marks easily understandable; open source software checked by trusted parties (such as hackers or NGOs) to form a decentralised trust; this could also be extended to open/certified firmware and hardware design. [Burada 2017]*

> *"AI is only as good as its inputs or training. It can be prejudiced or biased. Citizens need to trust so needs to be transparent in decisions and transparently unbiased" [Net Futures 2017]*

> *There needs to be much more work on algorithmic transparency. [Ditchley 2016]*

This is clearly related to the previous discussion concerning algorithmic accountability:

> *"Algorithmic accountability: How to trust a black box algorithm? How to opt out of algorithm use? To what extent to algorithms violate privacy?*

> *Accountable & ethical data management & analytics: Decision explanation, transparency, decision responsibility, how can I trust machine learning prediction? Robustness to bias / diversion / corruption" [Net Futures 2017]*

The concern over concentration of power also affects trust that citizens place in the dominant incumbents. Decentralisation of power and trust is intimated:

> *Dominance of social networks - should we cut them up? Citizens don't realise what the social networks do with their content - they need to be more clearly informed. Should networks pay for content? [Net Futures 2017]*

Co-funded by the Horizon 2020 Framework Programme of the European Union

The challenge is how to move towards redistribution and decentralisation of trust. [Burada 2017]

"We want to decentralise the Internet (not just tech) - create an innovation landscape with alternatives to existing services to compete with and improve on existing ones" [DIN Forum 2017 - innovation process]

"… decentralization to avoid monopolies (74% agreed) ... Citizens [...] expect the public sector to limit the power of tech-giants. "Hard regulation" of tech companies is broadly supported ..." [Lipparini & Romeo 2017]

3.10.1 Recommendations

- Research is required into the impact of IoT devices on security.
- Studies into the impact on security caused by trend towards a heterogeneous network of interconnected devices, resources and people are needed.
- Investigations into how transparency can be incorporated into AI decisions are needed.
- Investigation is needed into the trust implications of the power vested in the large dominant corporations.

3.11 APPLICATION AREAS & TECHNOLOGIES

This section differs from the previous sections, in that it merely identifies the technologies and application areas mentioned by the sources as important and gathers the citations for each application and technology. No recommendations are made in this section, as the technology and applications have already been identified as important.

3.11.1 Technologies

3.11.1.1 Internet of Things (IoT)

In a number of the sources, IoT is marked out as the top technology driver:

… the broad majority of readers agree that IoT, BigData and machine learning are the most promising Internet technologies in terms of their impact on both the labour market and people's personal lives. [Lipparini & Romeo 2017]

IoT 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). [FIRE STUDY DIN 2017]

3.11.1.2 Network Technology

Key networking technologies (5G, SDN, new network protocols) and convergence between them are important:

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. [FIRE STUDY DIN 2017]

Co-funded by the Horizon 2020 Framework Programme of the European Union

IoT 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)… [FIRE STUDY DIN 2017]

5G connectivity and accessibility – access to already existing technologies is also very important for startups. For example: in some places like small villages there can be a problem to use High Quality Video Conference. [PSNC 2017]

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. [Overton 2017]

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. [Overton 2017]

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 in-depth 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. [FIRE STUDY DIN 2017]

Networking protocols robust to and adaptable to variations of outcomes and with transparent constraints – for more than 50% respondents. [FIRE STUDY DIN 2017]

3.11.1.3 Blockchains & Distributed Ledgers

Blockchains and distributed ledgers are widely seen as revolutionary technologies:

Emerging technologies such as the blockchain and distributed ledgers – which are still not familiar to most people - should be supported ... [Lipparini & Romeo 2017]

Blockchain – we have to adapt and understand this technology (so trainings for better skills are important). It can be a concept of future Internet (especially mobile). Very important will be better compression algorithms (some companies in USA already work on this). [PSNC 2017]

Distributed architectures and decentralised data governance [:] Participants expressed the potential for a financial revolution from these technologies. A

Co-funded by the Horizon 2020 Framework Programme of the European Union

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. [Overton 2017]

Heterogeneous testbeds and a pan European blockchain should be provided

New research and experimentation areas should include a pan European blockchain, including robotic devices, and the establishment of mixed experimentation environments with large numbers of heterogeneous devices with IoT programmability, and Large Scale Streams. [FIRE STUDY DIN 2017]

3.11.1.4 Big Data

Big data is also seen as amongst the most promising technologies:

… the broad majority of readers agree that IoT, BigData and machine learning are the most promising Internet technologies in terms of their impact on both the labour market and people's personal lives. [Lipparini & Romeo 2017]

3.11.1.5 Edge Computing

Top-priority technology areas include: IoT, 5G; SDN, Big Data and Edge Computing:

IoT 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). [FIRE STUDY DIN 2017]

3.11.1.6 AI and Autonomous Machines

AI and autonomous machines are seen as having a major Impact on society:

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. [FIRE STUDY DIN 2017]

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 [FIRE STUDY DIN 2017]

As machine learning advances, AI will play an increased role in daily life (e.g. self-driving cars, semi-automated justice systems). [Takahashi 2017]

… the broad majority of readers agree that IoT, BigData and machine learning are the most promising Internet technologies in terms of their impact on both the labour market and people's personal lives. [Lipparini & Romeo 2017]

3.11.1.7 Open Data

Open public data is important from the perspective of startups:

Co-funded by the Horizon 2020 Framework Programme of the European Union

Open public data – discoverable and easy to process linked to other data sources (private/personal). For example: we have already all data on our mobile device (like: weather forecasts, public transport data, city bikes, etc.) but they have different data formats and we have to manually check everything one by one, so there is a need for some automation which could link all this data together as some "open link". Open data is important to link them between and with other data sources [PSNC 2017]

3.11.1.8 Cloud Computing

Cloud computing is important but can pose threats to privacy and security:

Cloud solutions are seen as a great opportunity for both Education (for which competences and skills on cloud systems are highlighted as important all over the conversations) and Business. But they are also seen as a potential major threat for Privacy, Security and Surveillance. This means that interventions could be designed to support new business and social domains explicitly offering the best of Cloud and Security/Privacy ... [Lipparini & Romeo 2017]

3.11.2 Applications

3.11.2.1 Industry 4.0

Industry 4.0 is a key application area:

"Industry 4.0 is a big change – next phase in the digitization of the manufacturing sector. Industry 4.0 relies heavily on Internet services. Latest robotic research is getting to the point where knowledge is shared across the network. Exploitation of the knowledge available in the Internet for faster and better robotic learning." [PSNC 2017]

3.11.2.2 Immersive Environments

New forms of interactions and immersive environments are important:

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. [Overton 2017]

The potential of AI, Virtual Reality (VR) and Augmented Reality (AR) in the customer management and marketing field should also be leveraged. [Lipparini & Romeo 2017]

3.11.2.3 Collective User Experience

Collective user experience – decentralised, heterogeneous and distributed architectures and social networks are important:

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. [FIRE STUDY DIN 2017]

Co-funded by the Horizon 2020 Framework Programme of the European Union

... 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). [FIRE STUDY DIN 2017]

Intelligent Spaces: [to] 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 ... [FIRE STUDY DIN 2017]

3.11.2.4 Lifelong Learning

ICT lifelong learning is seen as important:

It is important to raise people's awareness of the significance of acquiring ICT skills throughout their lives … [Lipparini & Romeo 2017]

3.11.2.5 Inclusiveness

Inclusiveness and ubiquitous connection are key themes for Civil society:

"All EU citizens (including persons with disabilities, seniors, etc.) have the right to benefit from modern ICT services. The services should be designed in a way to be simple to use by all."

"… ubiquitous access to the Internet is/should be the right of each EU citizen (just like access to clean water or energy infrastructure). " [PSNC 2017]

Bridging digital divides, addressing digital literacy challenges, and crucially enabling citizens to innovate for themselves to address these issues are all seen as important:

"… the concept of the digital divide is evolving as the use of the Internet changes….providing populations with the digital literacy to solve problems and engage in innovative ways of solving them is important. Creating appropriately structured and regulated choice spaces for everyone that encourage human responses in a system of increased functional machine agency will be a challenge." [FIRE Study - DIN]

"There is potential of increased 'isolation' of those behind general levels of connectivity though this does not mean that those with faster networks are symmetrically ahead of the pack. The asymmetry and potential for growing 'divides' are important risk factors as they may slow development, or increase the strain on other policies and instrumentalities called upon to rectify them." [FIRE Study - DIN]

3.11.2.6 Protection from the Dangers of the Internet

Protecting people from the dangers of the Internet is important:

Protecting individuals (human protection) – people are not aware how deep they are in the Internet. Not only data protection problem but also people protection (device level & data use protection). [PSNC 2017]

"The redistribution and reallocation of information, computing power, knowledge, costs and benefits may not lead to a situation that places risks (e.g. innovation and security risks) on those best able to bear them, or which

Co-funded by the Horizon 2020 Framework Programme of the European Union

offers the best chances of useful negotiability of these roles and responsibilities." [FIRE Study – DIN]

Co-funded by the Horizon 2020
Framework Programme of the European Union

4 CONCLUSIONS

This deliverable has surveyed a number of recent sources and has attempted to elicit common themes from them, pointing to directions for further areas of research and development. The key themes of the analysis conducted for this deliverable are listed below.

- *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, 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 section 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.
- *Applications and Technologies.* This represents the set of technologies and applications that are deemed to have high impact in the NGI.

The key recommendations are summarised in the Executive Summary, so are not repeated here.

The next steps in the NGI GUIDE will be to determine a course of action for consultations to acquire additional knowledge, and to implement it by running consultations.

Co-funded by the Horizon 2020
Framework Programme of the European Union

5 REFERENCES

[Ansip 2017] Speech by Vice-President Andrus Ansip, Next Generation Internet Summit, Brussels - 6-7 June 2017 https://ec.europa.eu/commission/commissioners/2014-2019/ansip/announcements/speech-vice-president-ansip-next-generation-Internet-summit_en

[Asimov 1942] Isaac Asimov, "Runaround", Astounding Science Fiction. March 1942.

[Boniface 2016] Study into the Future of Digital Innovation Networks, FIRESTUDY working paper

[Boniface, Calisti & Serrano 2016] Michael Boniface, Monique Calisti, Martin Serrano: Drivers Transforming Next Generation Internet Research and Experimentation, https://ec.europa.eu/futurium/en/content/next-generation-Internet-experimentation

[Boniface et al 2017] Michael Boniface (IT Innovation), Timo Lahnalampi and Monique Calisti (Martel Innovate), Fire STUDY deliverable D5.1, Policy Recommendations v1, 2017

[Burada 2017] Irina Burada, Jean-Luc Dorel, Conclusions Workshop on Personal Data Spaces and Privacy, 9 December 2016. https://ec.europa.eu/futurium/en/content/workshop-personal-data-spaces-and-privacy-0

[Ditchley 2016] Will we still have a single global Internet in 2025? - The Ditchley Foundation http://www.ditchley.co.uk/conferences/past-programme/2010-2019/2016/global-Internet 2016

[DIN Forum 2017 - innovation process] Notes taken at the DIN Forum 2017, to appear at: https://www.ict-fire.eu/event/digital-innovation-networks-forum/?instance_id=70

[EC Science 2.0 2014] European Commission, Validating the results of the Public Consultation on Science 2.0: Science in Transition, 2014, https://ec.europa.eu/research/consultations/science-2.0/science_2_0_final_report.pdf

[FIRE STUDY 2017] The FIRE STUDY Next Generation Internet (NGI) White Paper Survey Results. https://www.ict-fire.eu/the-fire-study-next-generation-Internet-ngi-white-paper-survey-results/ Retrieved 2017-06-19.

[Friends of Europe 2017] Policy choices for a digital age - taking a whole economy, whole society approach. http://www.friendsofeurope.org/smarter-europe/policy-choices-for-a-digital-age/ Retrieved 2017-06-30

[Gates 2017] Filter bubbles are a serious problem with news, says Bill Gates. https://qz.com/913114/bill-gates-says-filter-bubbles-are-a-serious-problem-with-news/

[Glennie & Bound 2016] HOW INNOVATION AGENCIES WORK: International lessons to inspire and inform national strategies, NESTA - Alex Glennie and Kirsten Bound, May 2016. Retrieved from http://www.nesta.org.uk/sites/default/files/how_innovation_agencies_work.pdf, 14 Feb 2017.

[Lipparini & Romeo 2017] Fiorenza Lipparini, Project manager, REIsearch, Guido Romeo, Science Editor in Chief, REIsearch-NGI. CITIZEN ENGAGEMENT AND MEDIA CAMPAIGN ON THE NEXT GENERATION INTERNET - Analysis and results of the launch of REIsearch 2.0. Available at: https://reisearch.eu/pdf/REIsearch-SecondInitiative-Report.pdf. Retrieved 2017-06-30.

[Moedas 2017] Moedas, Carlos. From the Internet of Things to the Internet of Humans, Next Generation Internet Summit, Brussels - 6-7 June 2017. https://ec.europa.eu/commission/commissioners/2014-2019/moedas/announcements/welcome-address-next-generation-Internet-summit_en Retrieved 2017-06-19.

[Net Futures 2017] Notes taken by Steve Taylor from sessions at Net Futures 2017, 28-29 June 2017, Brussels

Co-funded by the Horizon 2020 Framework Programme of the European Union

[Nurse 2015] Nurse, Paul. "Ensuring a successful UK research endeavour." A Review of the UK Research Councils, Department for Business, Innovation & Skills, UK Government (2015).

[OECD 2015a], "Making Open Science a Reality", OECD Science, Technology and Industry Policy Papers, No. 25, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/5jrs2f963zs1-en

[OECD 2015b] Carthage Smith and Giulia Ajmone Marsan, Directorate for Science, Technology and Innovation, OECD Open Science – the Policy Challenges, https://jipsti.jst.go.jp/rda/common/data/pdf/lecture/Smith_Symposium.pdf

[Overton 2017] DAVID OVERTON, NEXT GENERATION INTERNET INITIATIVE – CONSULTATION - FINAL REPORT MARCH 2017 https://ec.europa.eu/futurium/en/content/final-report-next-generation-Internet-consultation

[Pariser 2011] Eli Pariser. The Filter Bubble: What the Internet Is Hiding from You. 2011.

[Parry 2010] Principles of robotics - Regulating robots in the real world. The joint EPSRC and AHRC Robotics Retreat, September 2010. https://www.epsrc.ac.uk/research/ourportfolio/themes/engineering/activities/principlesofrobotics/

[PSNC 2017] Poznan Supercomputing and Networking Centre, The Next Generation Internet workshop - Widen the European space of life and work. Workshop Report, 8 June 2017

[Royal Society Science 2.0 2014] Royal Society - Consultation response: Science 2.0, https://royalsociety.org/topics-policy/publications/2014/consultation-response-science-2-0/

[Takahashi 2017] Takahashi, Makoto. Policy Workshop Report Next Generation Internet - Centre for Science and Policy Cambridge Computer Laboratory. Centre for Science and Policy (CSaP) in collaboration with the Cambridge Computer Laboratory. 1-2 March 2017. https://ec.europa.eu/futurium/en/system/files/ged/report_of_the_csap_policy_workshop_on_next_generation_Internet.docx and https://ec.europa.eu/futurium/en/content/policy-workshop-report-next-generation-Internet-centre-science-and-policy-cambridge-computer 2017. Retrieved 2017-06-19.

[Taylor 2017] Taylor, S. Fed4FIRE+ D2.01 Initial Guidelines on Data Management. In preparation. 2017.

[Zenodo] The Zenodo open research data repository, https://www.zenodo.org/, retrieved 2017-02-08.

Co-funded by the Horizon 2020 Framework Programme of the European Union

APPENDIX – CONCEPT KEYWORDS

The following table shows the concept keywords for the knowledge base described in Section 2. These keywords were drawn by inspection from the source data, and are ordered in the table by the number of times they were mentioned in the sources.

Concept Keyword	Count
Privacy	33
Collaboration	24
Artificial Intelligence	23
Legislation	20
Internet of Things	18
Decentralised architectures	16
Citizens' personal data	15
Trust	15
Regulation	14
Transparency	14
Security	13
Multi-disciplinary design	12
Innovation networks	11
Power - balance of	11
Citizens	10
Distributed architectures	10
Control of personal information	9
Ethics	9
GAFA / FAANG	9
Human-centric technologies	9
Human factors	8
Speed of technology	8
Startups	8
Companies	7
Concentration of power	7
Edge computing / devices	7
Government	7
Immersive environments	7
Interconnectedness	7
Machine learning	7

Co-funded by the Horizon 2020 Framework Programme of the European Union

Concept Keyword	Count
Participatory design	7
Responsible machines	7
Speed of legislation	7
Technology	7
Algorithmic accountability	6
Fake news	6
Filtered Internet / filter bubble	6
Monopolies	6
Pluralism	6
Authoritarian governments	5
Big data	5
Data Sovereignty	5
Experimentation infrastructures	5
GDPR	5
Heterogeneity	5
Innovation	5
Profiling of citizens	5
Regulation of internet	5
Bias	4
Business models	4
Crime fighting	4
Data protection	4
Data location	4
Digital rights	4
Economy	4
Governance	4
Net neutrality	4
Network technology	4
SMEs	4
Standards	4
5G	3
Agency	3
Always connected	3
Application of technology	3
Autonomous machines	3

Co-funded by the Horizon 2020
Framework Programme of the European Union

Concept Keyword	Count
Blockchains	3
Cloud	3
Competition	3
Digital ledgers	3
Echo chamber	3
Economic incentives	3
Employment	3
Interoperability	3
Robotics	3
Search	3
Social impact of internet	3
Software defined technologies	3
State control	3
Unfettered Internet	3
Agility	2
Anonymity	2
Augmented reality	2
Broadband access for all	2
Certification	2
Costs	2
Democracy	2
Discrimination	2
E-government	2
E-participation	2
End to end systms design	2
Ethics designed into tech	2
Global connectivity	2
Liberty	2
Platforms	2
Protection from internet dangers	2
Research	2
Safety-critical software	2
Sensors	2
Service economy	2
Social networks	2

Co-funded by the Horizon 2020
Framework Programme of the European Union

Concept Keyword	Count
Storage	2
Throughput	2
Virtual reality	2
Academia	1
Age issues	1
AI human control	1
AI malfunction	1
Applied research	1
Backward compatibility	1
Basic research	1
Collaboration spaces	1
Computing	1
Content agnostic	1
Controversy	1
Crowd	1
Cyberphysical attacks	1
Decision support tools	1
Digital disappointment	1
Digital economy	1
Digital society	1
Disruptors become incumbents	1
Diversity	1
Ease of use	1
Editability	1
Employment for humans and machines	1
Evidence bases	1
Experimentation funding	1
Fintech	1
Filtering inappropriate content	1
Freedom of choice	1
Gender issues	1
H2020	1
Human rights	1
Identification of devices	1
Identity Management	1

Co-funded by the Horizon 2020
Framework Programme of the European Union

Concept Keyword	Count
Infrastructures	1
Inclusiveness	1
Industry 4.0	1
Innovation Support	1
International data exchange	1
Internet impact on work	1
Latency	1
Lifelong learning	1
Market dynamics	1
Metadata	1
Multi-actor protocols	1
Multiple access devices	1
National security	1
No one should own the Internet	1
Open calls	1
Open data	1
Persistence	1
Plain language	1
Quality of service	1
Reconfiguration	1
Reliance on digital tools	1
Single sign on	1
Softwareisation	1
Sustainable development	1
Validation	1
Visibility	1
Wealth distribution	1

Co-funded by the Horizon 2020
Framework Programme of the European Union