NEXT GENERATION INTERNET INITIATIVE – CONSULTATION

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FINAL REPORT MARCH 2017, DAVID OVERTON

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Executive Summary:

The open consultation for the Next Generation Initiative (NGI) was held between 10th November 2016 and 9th January 2017. 449 people took part with significant input. Participants were asked to rate and comment upon the importance of value statements and technology areas and encouraged for their views on how to support the NGI.

Values

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. Secondly, participants also felt strongly that the Internet should ensure diversity, pluralism and a right to choose. Thirdly, the concentration of data in a few proprietary platforms is understood as a significant issue today.

Internet should ensure citizens' sovereignty over their own data and protect privacy.

Those rating the importance of this value highest also selected Personal Data Spaces as a very important technology area. Therefore an NGI with a focus on Personal Data Spaces (Technology Area 3) may help in addressing the issues of sovereignty over data.

Similarly important across all participant categories this value would make an attractive vision to pursue to attract participation.

Internet should ensure diversity, pluralism and a right to choose.

Those that considered this value strongest also consider that Personal Data Spaces is very important and Distributed Architectures and decentralised data governance (Technology Area 4) is next biggest.

Internet should avoid the concentration of data in a few proprietary platforms.

There is a close relation between this value and the technology area of Personal Data Spaces (Technology Area 3). There is strong awareness of the impact of the few proprietary platforms upon the protection of personal data in particular. Software defined technologies (Technology Area 5) is the second most important technology area for those that hold this value.

This value is popular among those already engaged in research funded by the European Commission. This can be useful if progression upon existing initiatives is desired.

Other visions

Other visions proposed drew considerably less interest, however some had an appeal to certain niches within the consultation. Younger participants were attracted to values of diversity and pluralism and the notion of a level playing field, where older participants preferred values relating to sustainability, resilience and security and a resistance to concentrating data in proprietary platforms. Respondents from Greece, Belgium and Bulgaria felt strongly about a resilient and secure internet. Those from Sweden, Greece and Ireland responded more strongly to sustainability than other more dominant countries in the consultation (e.g. UK, Italy, Spain).

Beyond the vision statements proposed in the consultation, participants proposed that a trusted, inclusive internet should be seen as a basic human right and the NGI should be mindful of the protection and safety of its users and their data. However, they also recognise the tensions between this and the desire for more unencumbered innovation.

Technology Areas

The top three values above were consistently and strongly held by those supporting the most important of the technology areas.

Technology Area 3 (Personal Data Spaces) and Technology Area 7 (Artificial Intelligence) were the most important areas as recognised by researchers and the bulk of the other groups that took part in the consultation.

Personal data spaces

There is a trade-off between the benefits of innovation possible with the Internet of Things and Big Data and the need to prevent abuse of personal data.
The NGI needs to keep personal data secure and this means educating and enabling citizens regards criminals and big business. Systems that allow assurance, transparency and freedom for citizens to control the data that's held on them should not limit access to innovative services.

Infrastructures are needed to both enable benefits and minimise exploitation of using personal data. This will include enabling privacy aware access control and enforcing accountability for responsible use of personal data.

The values this group related most to were those of sovereignty over data and

diversity, pluralism and the right to choose.

Artificial Intelligence

Despite only a few respondents actually working in this area, many more believed they had a good understanding of the area. Their visions are strongly in line with retaining data sovereignty, diversity and pluralism and not allowing the data to become concentrated in proprietary platforms.

Technical challenges top the list, requiring interdisciplinary approaches and a top-down vision and application of strong use cases (e.g. autonomous vehicles) to shape the needed activities. The impact of greater autonomy and increasing "responsibilities" placed on systems requires work on communication, ethics and the inclusion of human factors within these decision "making" mechanisms. A proper and actionable ethical framework for Artificial Intelligence regarding algorithms becomes essential and deserves long-term project commitments to put some already well documented theory into practice.

Distributed architectures and decentralised data governance

Participants expressed the potential for a financial revolution from these technologies. A number of specific requirements including the continuance of work on blockchain in particular and the need to deal with the power demands for this technology area proposed.

The main challenges identified were in Communicating the business benefits of these digital ledger technologies to existing businesses in a compelling way and collaborating on new decentralised algorithms. Control for citizens over their own data becomes increasingly important yet challenging in a distributed architecture. Investment is needed into a diverse future-proof infrastructure that will enable ever greater autonomy.

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

Other technology areas proposed in the consultation

Discovery and identification tools need to provide assurance that the use and security of personal data is standardised and respected far beyond the initial commercial interest. Non-proprietary, extensible, future-proof, trustworthy standards for the Internet of Things are needed to support end to end connectivity between the Internet and the edge networks connecting all these devices. Semantic repositories are needed.

New forms of interactions and immersive environments face the issues of data privacy, diversity and the concentration of data into proprietary platforms. Intuitive interfaces necessitate work on understanding the psychological & biological effects and the threats and opportunities for industry and citizens of the constant Virtual Reality world. Supporting industry 4.0, embracing immersive distant collaboration and creating market driven products and service are required. An NGI is needed that deals with the packets reliably and with minimal latency. Work is needed in developing the tools for work-flow and process improvements including the advancement of battery technology.

The NGI can be made robust if the agility possible with the ***Software defined technologies*** is embraced and the right methodologies are employed for small and medium-sized enterprises to take a role in this. Co-developments may fulfill requirements for virtualisation and self-adapting algorithms. The protection of such created knowledge will be important. Work on new software specifications is essential as more functionality becomes embedded in soft rather than hardware. Standards need to be future-proofed to accommodate unknown future functionalities that will be required.

Networking solutions beyond IP impact the values of sovereignty of data and pluralism and diversity most strongly. An emphasis on security aspects alongside the palpable need for an improvement over the current IP is justified. The Next Generation Internet may benefit from a non-packet-based approach, but backward compatibility issues must be addressed and an optimal migration path proposed. Higher throughput, low latency and secure communications will place significant challenges upon the NGI infrastructure and architecture. A new high-speed TCP protocol and tools are important areas in need of development. New networking approaches may demand that security is built within the protocol. Maximising security and resilience while assuring good interoperability are key technical challenges.

Other important technology areas

Additional technology areas proposed highlight a focus on security in general and then more specific themed technologies around applying autonomous systems to Smart cities and Smart citizens. The desire is for trusted systems to be developed and language technologies are strongly seen as an important investment to achieve this.

Beyond this, simulation and large experimentation, as well as more hardware orientated projects such as robotics, are proposed as alternative technology areas.

Types of research, who should do it and initiatives to follow

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.

Foresight should direct research and guide the exploitation of evolutionary results into today's technology. Transdisciplinary approaches are needed. Importantly research needs guidance by the social sciences, user needs and awareness of the "known holes" in the current internet.

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.

Relevant initiatives exist within established institutions and are often funded through national and EC programmes. The most popular in the consultation involve Smart initiatives, 5G, Internet of Things and language technologies. Initiatives that address Policy and Societal issues should embrace peer networks, digital learning, e-democracy, e-procurement and e-learning. Finally, the identified on-going work on Public Sector Information (PSI), Big Data and Networking may provide good starting points for prototypes.

"The internet should be a place for citizens to create and contribute to global society, not merely consume and 'like' content. Citizens should have agency, not 'be the product."

Next Generation Internet Initiative – Consultation

FINAL REPORT MARCH 2017

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1.0 THE CONSULTATION

1.1 What is the NGI Consultation?

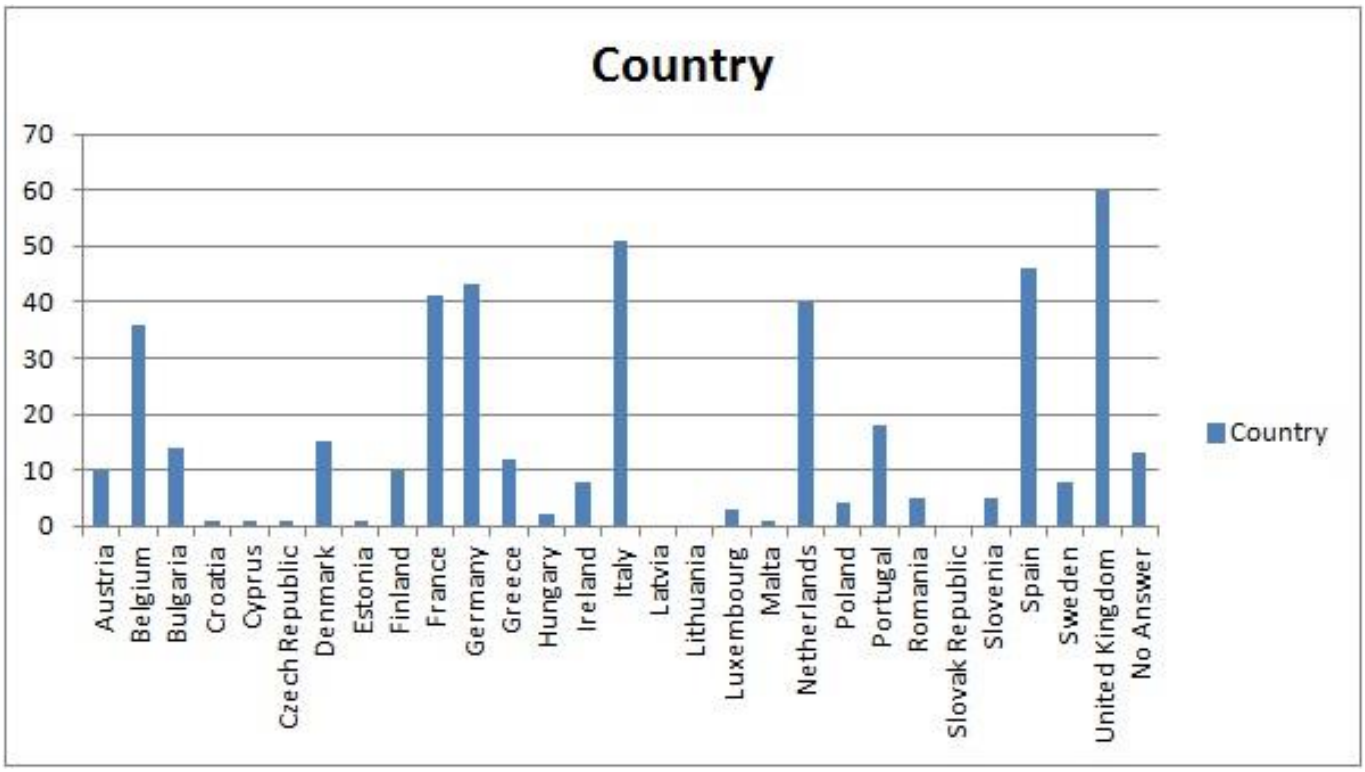
The Next Generation Internet (NGI) consultation took the form of an on-line questionnaire stimulated by various events, blogs and social media activities between 10th November 2016 and 9th January 2017. The consultation falls into two parts, Values and Technology areas, and this report is divided accordingly. Section 2 reports on responses to questions regarding value statements concerning the internet. Section 3 deals with the seven technology areas of the consultation.

1.2 Who took part?

As an open consultation there was a broad range of respondents. 449 respondents took part.

1.21 Country analysis - Where do participants live at the moment?

The consultancy was largely dominated by the Western European countries with little response from Baltic and Eastern European states. The people who are living in the UK provided the most respondents with 60.



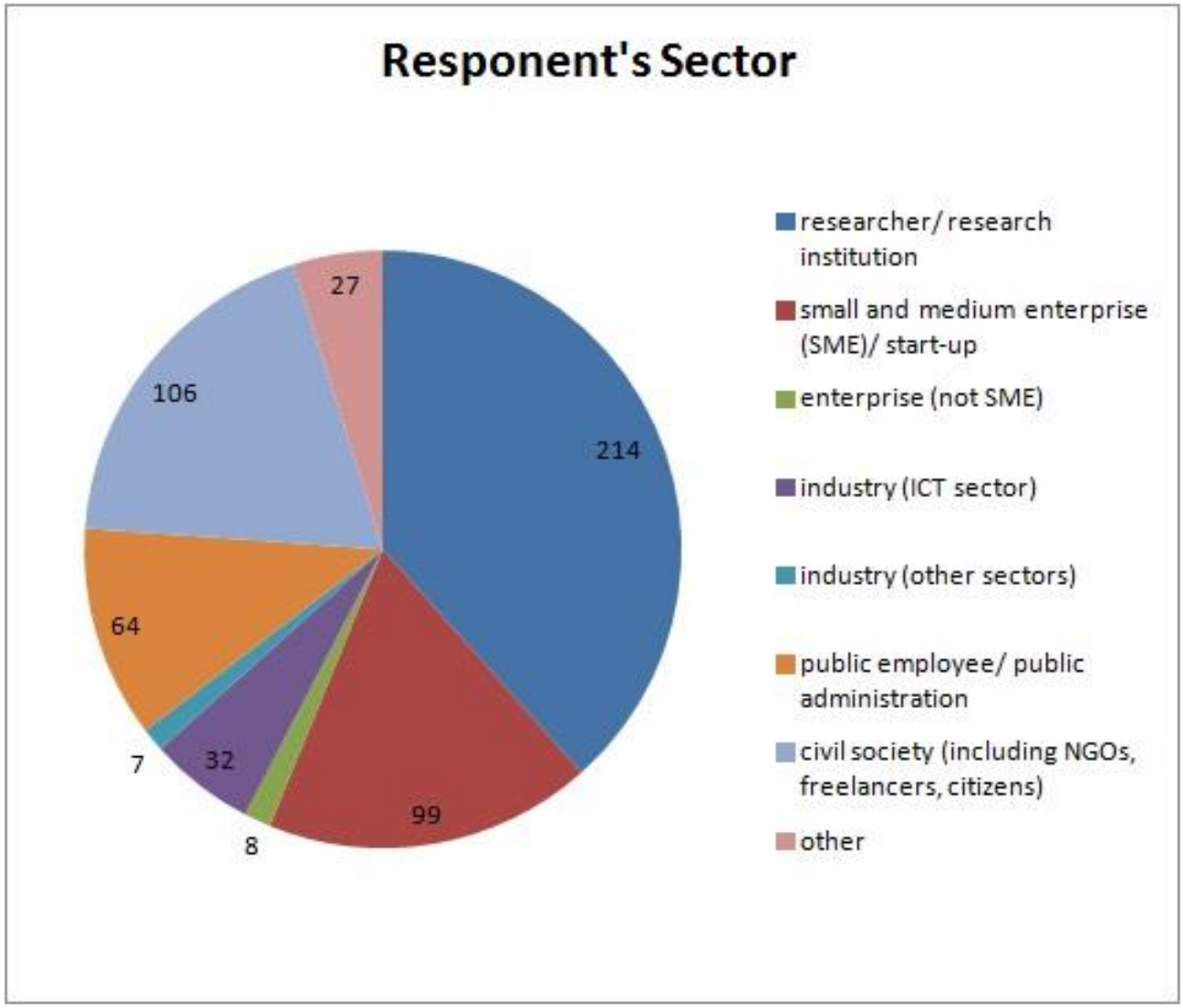
A minority of 36 of the 449 participants are living in countries outside of the EU. Of these Switzerland was the highest with 11. 4 respondents from Norway took part also but all other countries (including USA, Turkey, Brazil, Japan, UAE, Azerbyjan, Israel, Nigeria and Tunisia) fielded 1 response only.

1.22 Demographics

27% of the respondents were female, a figure broadly in-line with the sectors in question. 25% of the respondents are currently below the age of 35. At least 71% of the respondents will still be below the age of 60 in 2027.

1.23 Sector Analysis

38% of the respondents are researchers, 19% from civil society (including NGOs, freelancers & citizens) and 18% are SMEs. 47% had previously applied for or taken part in a Horizon 2020 research and innovation project. Of those that had not, the UK represented the largest group with 39 of their 60 participants never having applied or taken part in H2020 projects.



2.0 UNDERSTANDING THE VALUES

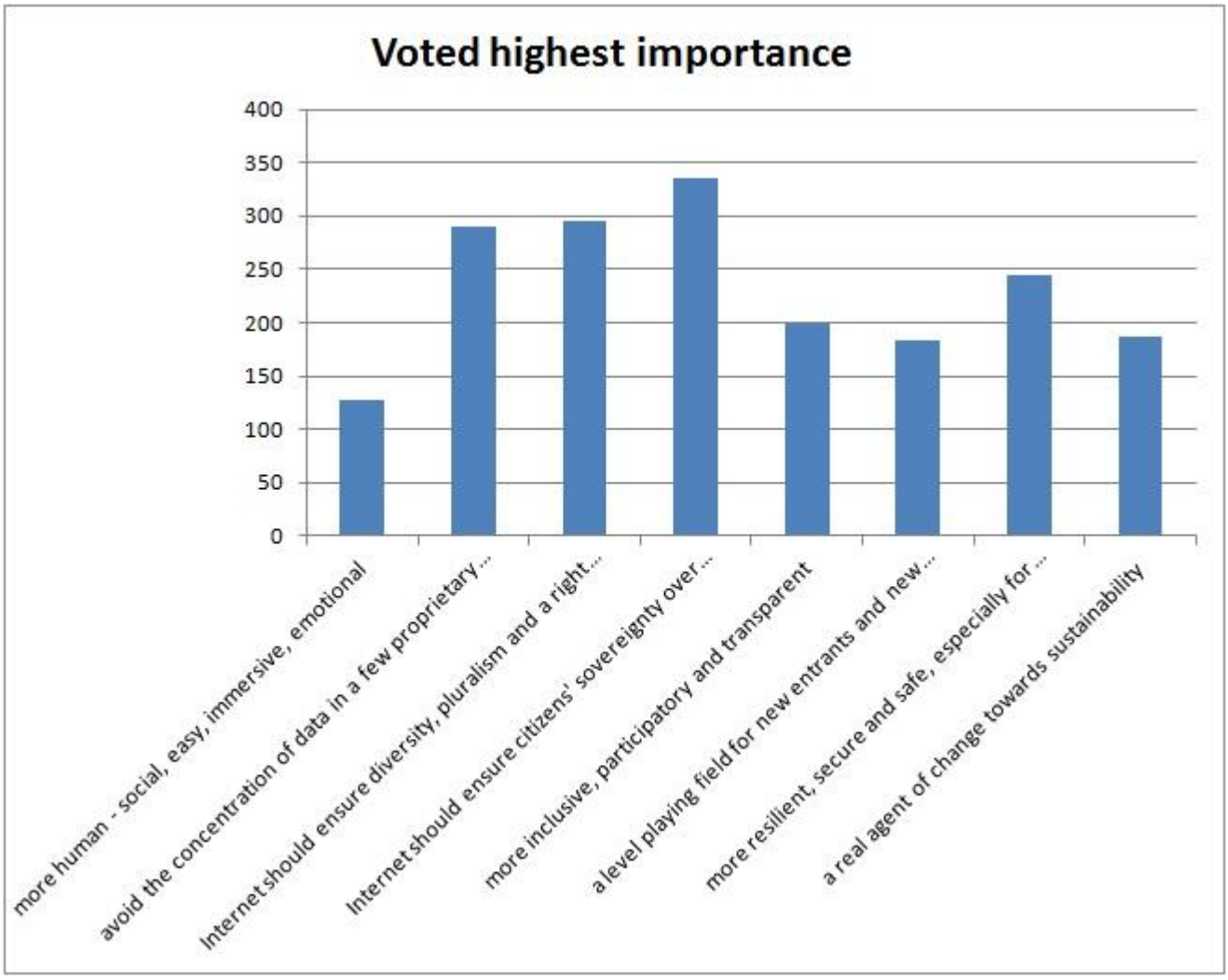
2.1 Overview of the value statements

Eight areas of interest were tested. These took the form of statements to which the participants were asked to respond. These are below and then expanded upon in the subsequent sections of this report.

- Internet should be more human - social, easy, immersive, emotional.
- Internet should avoid the concentration of data in a few proprietary platforms.
- Internet should ensure diversity, pluralism and a right to choose.
- Internet should ensure citizens' sovereignty over their own data and protect privacy.
- Internet should be more inclusive, participatory and transparent.
- Internet should be a level playing field for new entrants and new economic models.
- Internet should be more resilient, secure and safe, especially for children, elderly and people with low digital skills.
- Internet should be a real agent of change towards sustainability.

Participants were asked to provide additional value statements.

Clearly the statements cover some very important areas according to the responses. Each respondent had to rate the importance of each topic area on a scale of 1-5 where 5 was the highest importance.



There was a strong response to the statements posed in the consultation as each of them gained the highest score for importance from at least 25% of the participants (see the spread in the above graph). In order, the highest response was towards the following 3 statements;

1. Internet should ensure citizens' sovereignty over their own data and protect privacy. 336 voted this of highest importance.
2. Internet should ensure diversity, pluralism and a right to choose. 295 voted this of highest importance.
3. Internet should avoid the concentration of data in a few proprietary platforms. 290 voted this of highest importance.

Below are the outcomes of the consultation against each of the statements.

2.2 Internet should be more human - social, easy, immersive, emotional.

2.21 Overview

The value statement that the internet "should be more human - social, easy, immersive, emotional" was considered of highest importance by 128 participants (28.5% of 449 total participants).

2.22 Analysis by respondent's sector

52.3% of the respondents rating this highest for importance were researchers. The SME's in this category represented 24.2% compared with 22.0% overall in the consultation.

2.23 Analysis by country

15 living in Belgium, 7 living in Bulgaria and 5 living in Finland rate this value of highest importance. All other countries applied a lower importance to it.

2.24 Analysis by age

The group rating this of highest importance are in the older age brackets. 31.3% are in group 51-65 (vs 22.9%) and 8.6% over 65 compared (vs 6.0%).

2.25 Analysis by experience of Horizon 2020

51.6% have taken part in Horizon 2020 projects (vs 46.5%).

2.26 Conclusion

This value statement appealed to just 28.5% of respondents to the consultation. The appeal is felt mostly by the older age group research community who have previously had involvement with Horizon 2020. This vision statement therefore is going to appeal more to the researchers in the older age brackets involved with existing projects.

2.3 Internet should avoid the concentration of data in a few proprietary platforms.

2.31 Overview

The value statement that the internet "*should avoid the concentration of data in a few proprietary platforms*" is the third strongest view in the consultation with 65% rating its importance as high (290 participants). It is very close in score to the value on diversity and pluralism (see later) and was the second strongest value for those considering distributed architectures as the most important technology area.

2.32 Analysis by respondent's sector

48.5% of respondents that consider this value of highest importance were researchers. Industry (ICT and other) both rated this highly as 69.2% of their participants considered this value of highest importance.

2.33 Analysis by country

35 each living in Spain, Italy and the UK considered this most important. Of these Spain is proportionately the highest scoring (35 of their 46 participants). A high proportion of the Scandinavian countries also rate this highly (Denmark 12/15, Sweden 5/8, Finland 7/10).

2.34 Analysis by age

The concentration of participants, as with all these analyses, is in the middle age band (35/50) is 45.5% compared with the average for the consultation (46.3%). The younger age group (18/35) is fully 4% below the average at 22% indicating that this value appeals to the older respondent (32.4% compared with 29.3%).

2.35 Analysis by experience of Horizon 2020

This group is more experienced with Horizon 2020 than the average group with 49.0% having been involved with projects previously compared with the average 46.5%.

2.36 Relation to Technology Areas

Technology Area 3, Personal Data Spaces, was the most important technology area for this group with 81.0% voting this area very important. Technology Area 5, Software defined technologies, was the next most important with 61.4%.

Avoiding the 'concentration of data in a few proprietary platforms' is the third most important value overall. However, it appears relatively more important in 'distributed architectures and decentralised data governance' (Technology area 4), where it is the second most important value.

2.37 Conclusion

Overall this is the third most popular value and is clearly an important area.

There is a close relation between this value and the Personal Data Spaces (PDS), Technology Area 3. Comments from many participants reveal a strong concern over the impact of these few proprietary platforms and the protection of personal data. Those that valued this statement highest rated PDS and Software defined technologies the most important TAs.

The higher age profile and the familiarity these participants have with Horizon 2020 means this value is perhaps likely to attract those already engaged in research funded by the EC. This can be useful if progression with existing projects is desired.

2.4 Internet should ensure diversity, pluralism and a right to choose.

2.41 Overview

The value statement that the internet "*should ensure diversity, pluralism and a right to choose*" is the second strongest view in the consultation with 66% rating its importance as high (295 participants).

2.42 Analysis by respondent's sector

48.7% of those who rated this of the highest importance were researchers (consider that 38% of all participants were from research institutions).

2.43 Analysis by country

The top 3 responders live in Italy, UK and Spain. 38 respondents living in Italy rated this as the highest importance, 36 in the UK and 33 in Spain. Of these, proportionately Italy is the most keen on this area with 75% of their respondents. By contrast France's score was just 51% of the respondents.

2.44 Analysis by age

26.4% of respondents finding this value of highest importance were between the ages of 18 and 35, 43.4% were 35-50 years and 30.2% were over 50. This indicates that the value attracted a slightly younger group of participants.

2.45 Analysis by experience of Horizon 2020

45% of these respondents had experience of Horizon 2020 projects.

2.46 Relation to the Technology Areas

81.0% of this group stated Technology Area 3, 'Personal Data Spaces' was very important. Next highest was Technology area 4, 'Distributed Architecture and decentralised data governance', with 57.6%.

2.47 Conclusion

As the second most popular of the value statements this is clearly an important value.

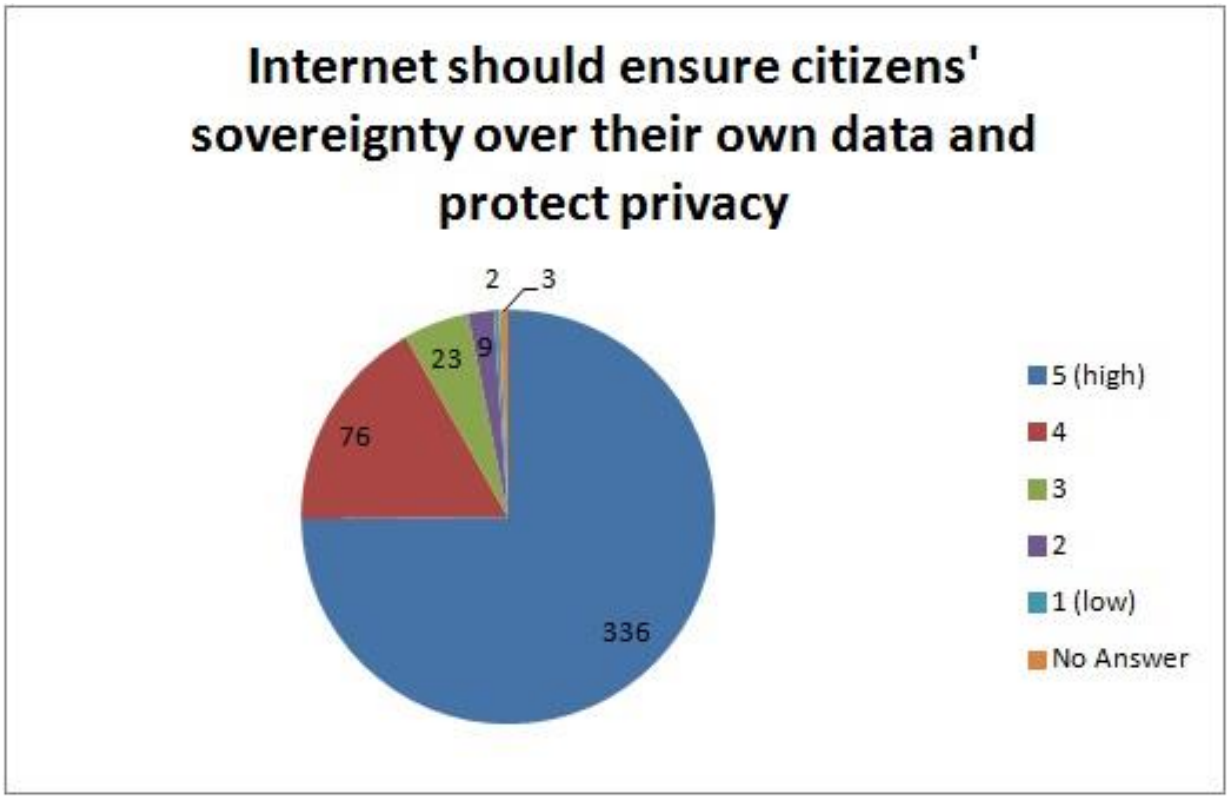
Those that considered this value strongest also consider that Technology Area 3, Personal Data Spaces, is very important and Technology area 4, Distributed Architectures and decentralised data governance is next biggest.

It is also noteworthy that the value appeals to a younger demographic. The dominant sector for the respondents is research and academia.

2.5 Internet should ensure citizens' sovereignty over their own data and protect privacy.

2.51 Overview

The value statement that the internet "*should ensure citizens' sovereignty over their own data and protect privacy*" is the strongest view in the consultation with 75% rating its importance as high (336 participants).



2.52 Analysis of the respondent's sectors

Of those that scored this as the most important statement 49% were researchers (vs. 38% taking part), so there is a clear academic interest in working on this area.

2.53 Analysis by country

Of those that scored this as the most important statement 41 currently live in the UK (68% of all UK respondents) and 37 in both Italy (51 total) and France (41). So proportionately France responded the strongest amongst the largest responding nations.

2.54 Analysis by age

To analyse the differences in attitudes toward the value statements I have taken the two younger age groups (together 18-35) and the two older age groups (51 to over 65).

With the younger group there was a strong agreement with the leading two statements. 85 of the 111 participants in this age group rated sovereignty over data as the highest importance and 78 of them rated diversity and pluralism at the highest importance. This is in-line with the overall survey results.

In the older group there was strong agreement on the sovereignty of data (102 of 130 respondents), but the second most important area was seen to be that the internet should avoid concentration in proprietary platforms (93).

The evidence for these most popular value statements is that there is consistency across the age groups on these value statements.

2.55 Analysis based on experience of Horizon 2020

For those who had NOT previously taken part in H2020 projects (potentially a new audience) I analysed the top values statements. Again Sovereignty over data was the highest importance (181 of 240 respondents) with Diversity and Pluralism second (162).

2.56 Relation to Technology Areas

86% of those rating this value highest also considered Technology area 3 'Personal Data Spaces' as a very important area for research. Technology areas 4 (Distributed architecture and decentralised data governance) and 7 (Artificial Intelligence) are joint second in terms of importance, each with 55.1% the group stating these technology areas very important.

2.57 Conclusion

It's clearly demonstrated that this value statement is deemed the most important of the survey according to participants.

Those rating the importance of this value highest also selected Personal Data Spaces as a very important technology area. The strong correlation suggests that providing a focus on personal data spaces may address the issues of sovereignty over data.

Analysis by age, sector, country or experience demonstrates this is a consistent view. Analysis of those that have not taken part in H2020 projects also indicates this would be an attractive vision to pursue to attract new participants.

2.6 Internet should be more inclusive, participatory and transparent.

2.61 Overview

199 (44.3%) respondents considered this at the highest level of importance.

2.62 Analysis by respondent's sector

53.7% of the respondents placing the highest score in the importance of this value statement were in the research profession. Industry (other sectors) (4 out of 7), public employee (33/64) and civil society (51/106) participants all represented higher percentages than their average across the consultation. All other sectors (SME's, ICT sector and other) are correspondingly lower scoring in this area.

2.63 Analysis by country

Those that live in the UK (27/60), Spain (25/46) and Italy (27/51) rate this value highest, so Italy and the UK are equal by proportion of their participants. All others scored this value low with only the following above 50%; 58.0% of those that live in Belgium, 62.5% of Ireland (5/8).

2.64 Analysis by age

There is a slight older bias beyond 50 years old in this group (30.1%) particularly in the age bracket 51-65.

2.65 Analysis by experience with Horizon 2020

46.2% of the respondents that rated this value statement at the highest importance have been engaged with the Horizon 2020 which is only just under the average in the full consultation.

2.66 Conclusion

There was a strong bias toward the research professions for the value statement. But it also appears that industry (others), public employees and (to an extent) civil society have a relatively positive response to this value statement.

2.7 Internet should be a level playing field for new entrants and new economic models.

2.71 Overview

183 (40.8%) respondents considered this at the highest level of importance.

2.72 Analysis by respondent's sector

46.5% of the respondents placing the highest score in the importance of this value statement were in the research profession (vs 47.66% on average). Through each of the sectors there was a similarly low level of interest in this value statement with no one sector attracting more than 50% scoring this area at the highest importance.

2.73 Analysis by country

Those that live in Greece appreciated this value the most with 8 of their 12 participants scoring the value of a level playing field at the highest importance level. Those living in the UK and Italy provided the greatest number of participants that rated this value as most important.

2.74 Analysis by age

This value appealed to an interesting spread across the age groups. In the 18-25 year group 10 out of the total of 16 respondents to the consultation scored this value as highest importance. In the 50-65 year group 55 of the 106 respondents scored the same.

2.75 Analysis by experience with Horizon 2020

46.9% of those scoring this at the highest importance have had previous involvement with Horizon 2020.

2.76 Conclusion

Researchers again dominate those with the highest scores for importance on this value statement. The response by country indicates that this value was thinly supported across the geographies with only Greece appearing to support it more strongly than others.

It's an interesting result for this value. Despite the evident low interest it still may be useful as it appeared to resonate more with the younger age group than any of the others. Though this young group was rather small (total of 16 in the consultation) it may be an indication of what might appeal to elicit greater engagement in the future.

2.8 Internet should be more resilient, secure and safe, especially for children, elderly and people with low digital skills.

2.81 Overview

245 (54.6%) respondents considered this at the highest level of importance.

2.82 Analysis by respondent's sector

48.2% of the respondents placing the highest score in the importance of this value statement were in the research profession (vs 47.7% on average). All other sectors show only a small variance from the average across the consultation.

2.83 Analysis by country

Those that live in Belgium (20 out of a total of 36 participants), Bulgaria (12/14) and Greece (9/12) rated the importance of this area highest.

2.84 Analysis by age

The age profile is skewed toward the middle of the age brackets with 47.4% of those that placed highest importance on this value vs 46.3% for the whole consultation. The over 65s were also higher (7.4% vs 6.1%) Naturally this older group makes sense given the subject matter.

2.85 Analysis by experience with Horizon 2020

42.9% of those scoring this at the highest importance have had previous involvement with Horizon 2020 vs 46.5%.

2.86 Conclusion

This value statement attracted a lot of interest relative to most others. The older age groups may be attracted by the subject matter as they may identify more with some of the issues stated in this vision statement. Its attraction to those that have not taken part in the H2020 programme and its appeal to the specific countries may be a useful insight.

2.9 Internet should be a real agent of change towards sustainability.

2.91 Overview

The value statement that the internet "*should be a real agent of change towards sustainability*" attracted 187 participants to rate it at the highest importance level (42% of the 449 consultation participants).

2.92 Analysis by respondent's sector

49.8% of respondents that consider this value of highest importance were researchers compared with 47.7% in the overall consultation. All other areas had only minor variances from the overall consultancy scores.

2.93 Analysis by country

The following countries of residence had the greatest interest in proportion to the number of participants from each country; Greece (8 out of 12) and Ireland (6/8) and Sweden (7/8)

2.94 Analysis by age

There is a slight skew toward the older age group from this value statement. Age group 51-65 is 24% vs 22.9% overall. 65+ is 7.5% vs 6.0% overall.

2.95 Analysis by experience of Horizon 2020

46.0% of this group is experienced with Horizon 2020 compared with the average 46.5%.

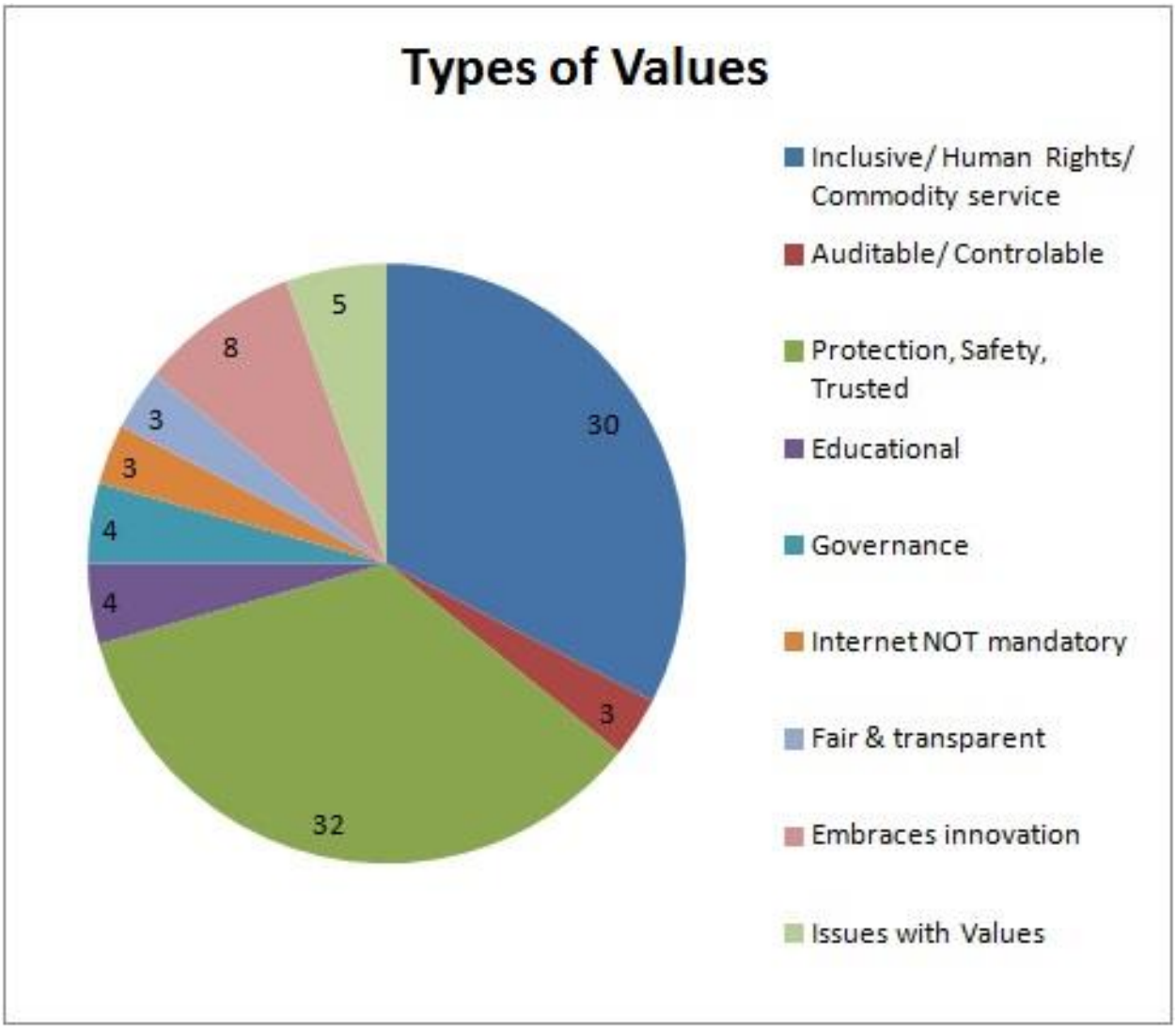
2.96 Conclusion

This value statement was not broadly seen as very important by the responders, but for participants living in Greece, Ireland and Sweden it clearly has some resonance (Note: one must consider the low number of respondents from each of those countries and decide if these are statistically representative).

There is an appeal to the older groups in the consultation.

2.10 Additional Statements

The Participants were asked if there were any additional statements they would propose for the NGI. This resulted in 115 statements that fell into the categories seen in the chart below.



In the main these were dominated by visions of an inclusive internet that's seen as a basic human right and that can be trusted in terms of content and the protection and safety of its users and their data.

"The internet should be a place for citizens to create and contribute to global society, not merely consume and 'like' content. Citizens should have agency, not 'be the product'. "

-

"The unfettered free flow of our personal data to just a few siren servers is a distortion. We need a new equilibrium where e-citizens benefit from disclosing personal data to service providers."

There were also those with a vision for greater freedoms to innovate on the internet.

> ***"Internet should allow people to develop innovation in any sectors but also should protect personal data and provide a mean to anyone to withdraw information exhaustively."***
>
> ***-***
>
> ***"Internet should be used for public services more widely. Internet should become a critical infrastructure for businesses."***

There were clear tensions between these two visions with some asking for less regulation and some asking for less intervention.

> ***"The European policy must ensure sovereignty of citizens, enterprises, on their data and digital services to enforce the benefit of all stakeholders in the switching towards the digital society."***
>
> ***vs***
>
> ***"Internet should be out of the hands of governments and their agencies."***

Greater auditing and controlling tools for the internet were desired by a minority as were educational opportunities, fairness and transparency and the notion that the internet should not be mandatory (there were oppositions to this last perspective too).

Within this request for additional value statements, 5 objections to the proposed value statements were made. These put forward the opinion that the values proposed were too service orientated and did not consider the network requirements and that too many concepts were wrapped up in a single value statement.

2.11 Conclusion on understanding values

2.111 The principle concerns emerging from the consultation

Ensure 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.

The second and third most popular of the statements (those that scored the highest in terms of importance) were "*Internet should avoid the concentration of data in a few proprietary platforms*." and "*Internet should ensure diversity, pluralism and a right to choose*." These were also popular among those supporting the most important Technology areas in the consultation (see section 3).

The research community dominated many of the opinions in the consultation, but their views were proportionately strongest in the values concerning a "*more human - social, easy, immersive, emotional*" internet and a more inclusive, participatory and transparent one.

The conclusions against each value statement identify key interests that can be used to target audiences.

2.112 The relation to Technology Areas in the consultation

Ensure citizens' sovereignty over their own data and the protection of their privacy is seen consistently as important as it was the highest scored value statement by those scoring each individual technology area as "very important". The value appealed to the main-stream of the consultation (in terms of age profile, previous experience with Horizon 2020 and country).

Of the top 3 value statements, the vast majority (81-86%) considered Personal Data Spaces (Technology area 3) to be a very important area. There was a big leap down the next most important technology area. Software Defined Technologies was favoured by 61.4% of those valuing the avoidance of data concentrated in a few proprietary platforms, whereas those sharing the view about 'diversity and pluralism' and 'data sovereignty' values preferred (Technology area 4) distributed architectures and decentralised data governance (55.1 and 57.6%).

2.113 Main Findings 1

Adapting the value statements and adopting some of the new proposed statements may target the specific technology areas more accurately. For example, assuring that the protection, safety and inclusivity elements are included in each technical area and providing a new vision statement may help with this.

2.114 Main Findings 2

The seemingly less popular value statement (just 40.8% respondents saw as highest importance) concerning the "...level playing field for new entrants and new economic models..." demonstrates that the younger generation, SME's and non-research profile participants could be more attracted to such sentiments.

2.115 A proposed value statement

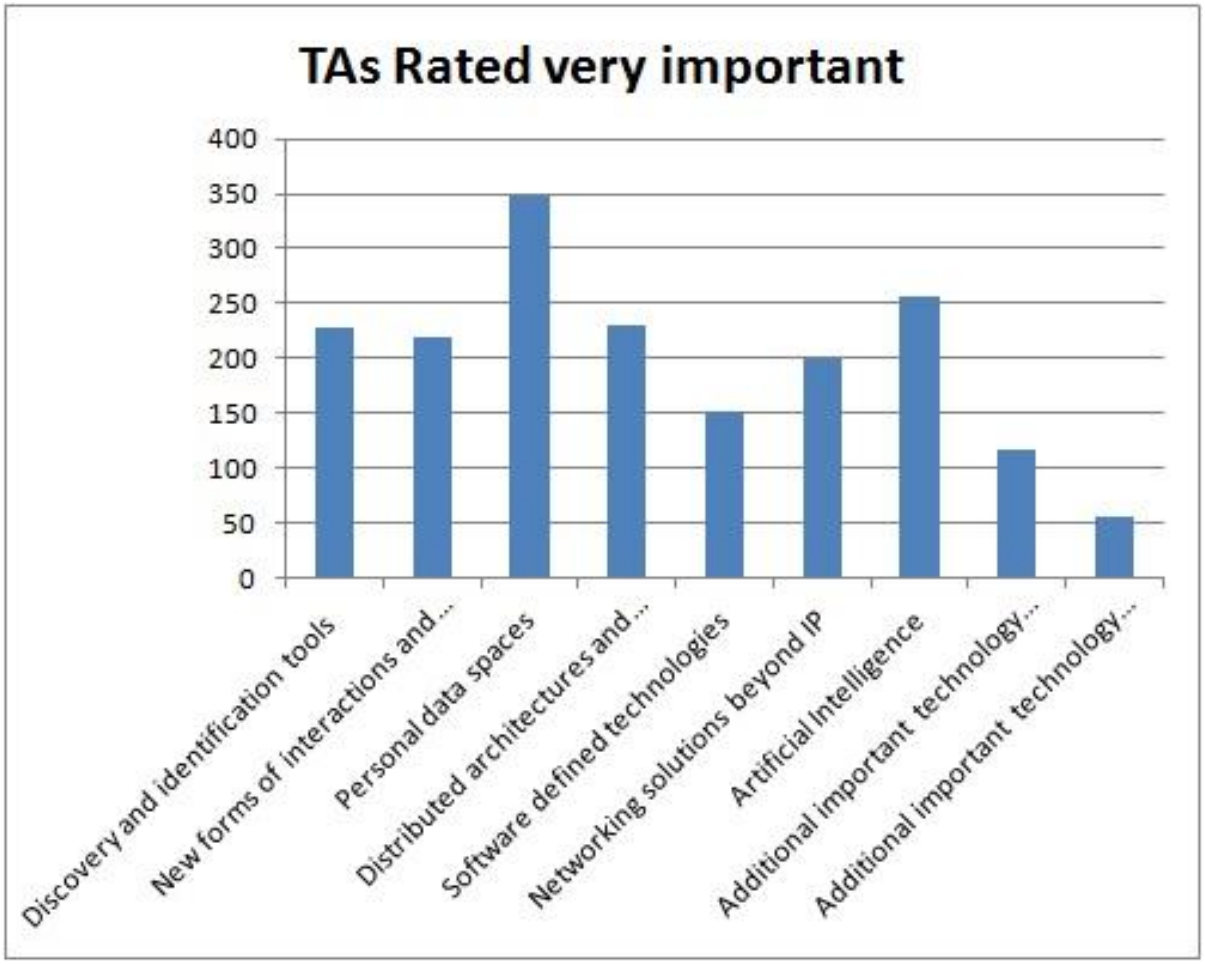
Reflecting the highest importance areas as judged by the participants in the consultancy I can propose the below vision statement for NGI.

"The Next Generation Internet should ensure citizen's sovereignty over their own data and protect their privacy as a priority. It should ensure diversity, pluralism and a right to choose and should avoid the concentration of data on a few proprietary platforms."

3.0 UNDERSTANDING THE TECHNOLOGY AREAS

3.1 Overview of the technology areas

In the consultation 7 technology areas (TAs) were proposed and respondents were encouraged to include two additional areas. The relative importance of each was sought.



Personal Data Spaces and Artificial Intelligence were the areas rated very important by the greatest number of participants.

In each area I have analysed the results from those that rated each technology area as "very important". Proposed critical challenges in each area are categorised and discussed in the below sections and the raw data is available in Annex 2. Annex 1 contains the tables of relevant initiatives by technology area.

3.2 TA 1 Discovery and identification tools -

3.21 Background

The discovery and identification tools technology area is described in the consultation as;

"One of the premises of the Internet of Things is that devices around us will be partly physical and partly digital, with a vast majority of those devices being "headless", lacking buttons, screens and other means by which the user interacts with the device. This premise forces us to figure out ways to discover, identify, and interact with the objects, devices and services in our lives in a seamless way, as well as ways to be made aware of the connected devices that surround us at any given moment."

3.22 Who selected this as very important

227 people considered this area very important. 51.1% of the respondents rating this very important were researchers. The age distribution was biased toward an older profile of respondent; 42.3% on the middle bracket of 35-50 year olds 19.4% were younger and 36.2% older.

3.23 Which sector and level of expertise

37.0% of those who rated this area very important actually work in the area and another 39.7% have a good understanding. This suggests the opinions are backed up with very strong experience.

What is your expertise in this technology area?

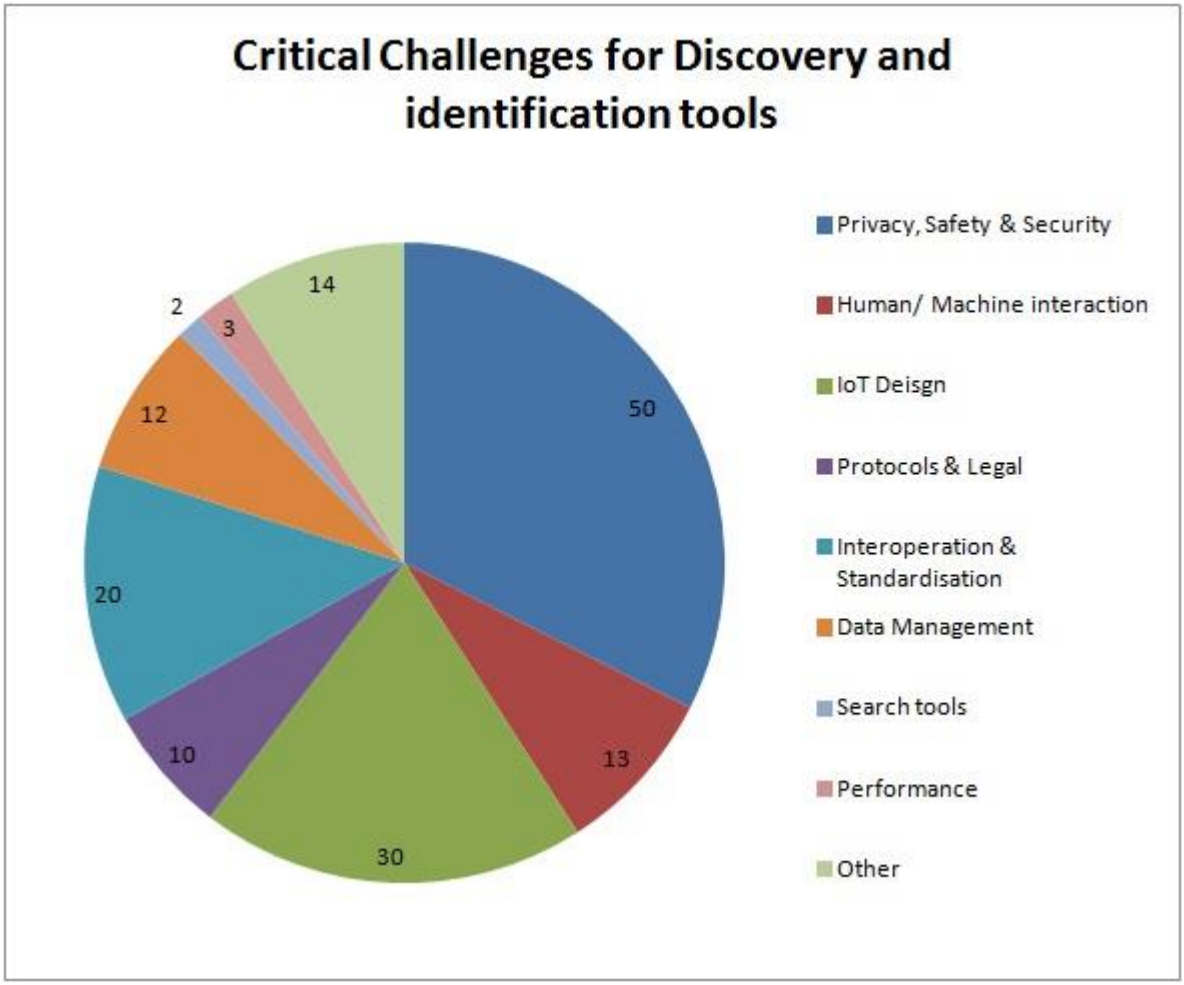
		Answers	Ratio
I work in this area		84	37.00 %
I have a good understanding of the area		90	39.65 %
I have just general knowledge		52	22.91 %
No Answer		1	0.44 %

3.24 Research and Innovation Challenges for Discovery and identification tools

Participants were asked which are the greatest challenges in the technology area. Their responses were free-form but I've made a broad categorisation:

- Privacy, Safety & Security- Challenges that relate to maintaining safety and security of data through increasingly interconnected devices and services.
- Human/ Machine interaction- Developments that assist humans in controlling their data use and navigate the internet.
- IoT Design- Challenges in the design of IoT and their connecting services
- Protocols & Legal - Development of legal controls and service protocols to support ethical use.

- Interoperation & Standardisation - Interoperation between devices and services and the needed standardisation to make these work
- Data Management- Challenges in handling and protecting large volumes of data in a distributed system
- Search Tools- Challenges in creating new unbiased and accurate tools for discovery independent of the major commercial platforms
- Performance- Challenges in improving the performance (speed and accuracy) of discovery on the internet.



The bulk of responses were in the Privacy, Safety and Security and the IoT Design categories. Sector specific responses related health and the connected house.

Privacy, Safety and Security - example answers from the consultation

- "Security of the Home devices"
- "Security of personal data. Security of "Things""
- "Ensuring adequate security of connected IoT devices, for example through minimum security standards, e.g. not shipping devices with default admin passwords."
- "Keeping boxes secure and ensuring owners can keep them secure, even when the company that made them, don't care."

IoT Design- example answers from the consultation

- "Ability to interrogate headless devices and their backend systems to understand what they are actually doing, not just what they say they are doing."
- "Technology (including Internet of Things) should always serve people and not the other way around."
- "There should be a good balance between easy accessibility to the devices and services around users and security issues."
- "Low cost and low price of IoT devices and accommodation of their functionality in the current available spectra will be a major issue."
- "We need to figure out ways to link devices into meaningful semantic units and link them to events we are interested in. A problem is that most relevant events are rare making such linkage difficult."

Interoperation and Standardisation - Examples from the Consultation

- "Extensible, future-proof, trustworthy standards, APIs and protocols that support the complete life-cycles of potentially highly complex resources - hardware and software."
- "End to end connectivity between the Internet and the edge networks connecting the devices"
- "It is important and it should be more a "proximity" and context-aware Internet to filter content by location. The emerging Physical Web is a good example about this opportunity."
- "Standardisation, interoperability, device discovery, privacy"
- "Semantic Repository - Context Awareness and Machine Learning"

3.25 Initiatives

Overall 117 participants responded with suggested relevant initiatives. The most popular were FIWARE, AIOTI (Alliance for the Internet of Things) and The Things Network. It's a long list with very few repetitions indicating that this is a very active area well services with existing initiatives. A full list is found in Annex 1.

3.26 Relation to Values statements

Those that considered this technology area very important prioritised the value statement on *data sovereignty*, with *diversity and pluralism* second.

76.7% of those rating TA1 very important scored sovereignty at the highest level of importance. This conforms to the overall survey results. These participants rated "*The internet should avoid the concentration of data in a few proprietary platforms*" as the third most important value.

3.27 Conclusion

This technology area attracts a predominantly academic/ research respondent in the older age bracket. Respondents were well qualified in this area. Perhaps consequently the number of initiatives identified by the participants is very high suggesting this is already a well-supported technology area.

This group recognises the balance needed between security over data and creation of desirable services that improve lives. The critical challenges fell into 3 clear areas (representing 100 of the 154 challenges put forward).

- The main challenges for Discovery and identification tools are in:
    - Privacy, Safety and Security; Assurance is needed by a fearful public over the use of their personal data and security of the services and devices they use. This should be provided by adoption of security standards in manufactured IoT products and their services that are assured beyond the vendors' initial period of (commercial) interest.
    - IoT design; A balance between simple accessibility of services and security is needed that allows IoT to best serve humans. A challenge is to make devices at lower cost and exploit the available spectra whilst still enabling the interrogation of those devices (for security reasons) and making them a sensible part of linking a users profile with the events they are interested in.
    - Interoperation and Standardisation; Non-proprietary, extensible, future-proof, trustworthy standards are needed for the IoT to support end to end connectivity between the Internet and the edge networks connecting these devices. Semantic repositories are needed in a more context aware internet composed of more highly complex resources.
- An interesting quote proposed "*It is essential to devise and drive the adoption of non-proprietary (open) standards for IoT, and to ensure that these maintain privacy and security, and prevent the domination of supranational giants like Google*."

Beyond the importance this group held to the values of data sovereignty and diversity there was a strong bias toward the value of avoiding the concentration of data within a few proprietary platforms.

In dealing with Discovery and identification tools we're dealing with the trade-off between security over data and creation of desirable services that improve lives. The challenge is to assure security over personal data whilst developing performant devices and services that interoperate to provide quality in discovery independent of the proprietary platforms.

3.3 TA 2 New forms of interactions and immersive environments

3.31 Background

The consultation describes this technology area thus;

"Increased computing, transmission power and next generation of devices (enabled by micro-nano-bio technology) allows conceptualizing new forms of interactions with machines and immersive environments that will have an impact in our professional and private life. New challenges are raising related to augmented and virtual reality, behaviour, human-computer interactions, haptics, human-human interactions through computers, machine-to-machine, spatial recognition and geographic information systems."

3.32 Who selected this as very important

104 (23%) of the respondents saw this technology area as very important. The age profile is slightly skewed toward the older participants with 23% below the modal age group (35-50yrs = 40.6%) and 36% over that age.

3.33 Which sector and level of expertise

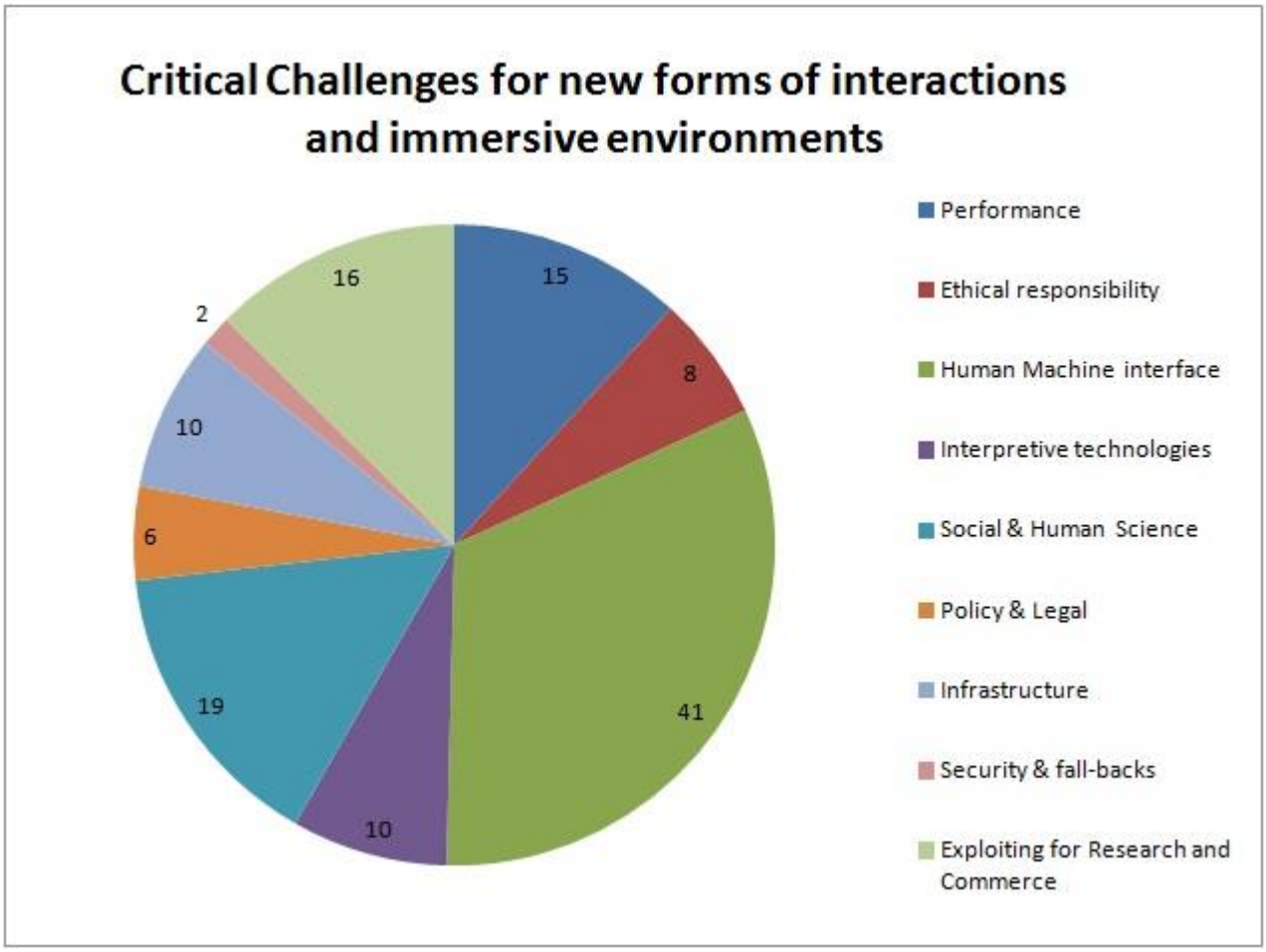
47.9% of this group were researchers showing slight bias compared with the 38% of researchers that took part in the consultation. 34.3% of the participants voting this technology area very important work in the area and another 32.3% claim to have a good understanding of the area. This is a relatively well qualified group.

3.34 Research and Innovation Challenges for New forms of interactions and immersive environments

Participants were asked which are the greatest challenges in the technology area. Their responses were free-form but I've made a broad categorisation:

- Performance- Challenges that relate to speed, latency, high bandwidth, battery capacity, quality of service, device capability and general improvement of processes involved.
- Ethical Responsibility - Needed responses to addiction, laws on robotics and balancing smart with wise technologies.
- Machine-Human interface - Design and design approaches considering new forms of interface
- Interpretive technologies - Challenges in creating and deploying technologies that need to infer relations from an increasing array of data and sensor inputs
- Social and Human Science - Understanding the behavioural impacts of the new environments
- Policy & Legal- Challenges in policy making for combined human and machine shared choices (as seen in automated vehicles)
- Infrastructure- Platforms, interoperability standards and communication protocols and frameworks to ease the creation of services for the new environments.
- Security and Fall-backs - Recognising the overdependence upon new interactions and creating fall-backs in case of failure.

- Exploiting for Research and Commerce - Challenges in exploiting specific market and research opportunities in the new environments.



Of the 127 challenges 32% related to the Human Machine interface, 15% to Social and Human Science, 13% to Exploiting for research and commerce and 12% to Performance.

Human-Machine Interface - example answers from the consultation

- "Designing for VR and AR so that they are intuitive and easy to use."
- "Integration of the various motor and sensory capacities of the user, including BCI (Brain Computer Interface), natural displacements (locomotion), generalized haptic feedback, touch simulation and spatialized sound"
- "Human-machine interactions incorporating emotions and sentiments; human-human interactions mediated by devices; speech to speech translation"
- "... there is a need to develop a more physical interaction between the machine and human. The machine has to understand and react not only to the human voice but also react to emotions, gestures, expressions and the overall human behaviour in order to really offer an immersive experience."

- "Interactive systems that can interpret and react to spoken language in a robust and precise way, providing high quality responses, is a key research area that Europe needs to concentrate on."

Social and Human Science - example answers from the consultation

- "Researchers from Social and Human Sciences should play a key role in this area of research. No more money to tech guys (and I'm a tech guy)!"
- "Psychological & biological effects of constant VR world."
- "...put some more focus on new and innovative ways of reaching the citizens by the new forms of interactions"... addressing the ..."possibilities related to e-governments and the axis of government-citizens and government-companies."

Exploiting for Research and Commerce - example answers from the consultation

- "Novel production concepts and models and their implementation ("industry 4.0")"
- "Motion enhancement and animation blending technologies also have applications in training, engineering and sports."
- "...online virtual reality business solutions and products that can be interacted with and shared over the network"
- "...immersive distant collaboration"

Performance - example answers from the consultation

- "Being able to deliver not just sufficient capacity but tight statistical bounds on packet loss and delay in order to ensure smooth and consistent experiences."
- "Methodologies and tools for process & workflow improvement "
- "...technical development of Life-long batteries or other energy sources, minimization of the devices"

3.35 Initiatives

79 responses were given regards to related initiatives which is a fairly low response rate. The two main initiatives are EuroVR Association and NEM (New European Media). The full list is in the Annex 1.

3.36 Relation to Values statements

Those that rated this technology area very important supported values on *data sovereignty* (166), *diversity and pluralism* (147) and *the avoidance of concentrating data into proprietary platforms* (136).

3.37 Conclusion

The group that regarded new forms of interactions and immersive environments are well qualified to comment on this area, though their age profile is slightly older than the average.

They have concerns for the issues of data privacy, diversity and the concentration of data into proprietary platforms.

- The critical challenges fall mainly into the areas of:

- Human-Machine Interface; Striving for intuitive interfaces by embracing various motor and sensory inputs, exploiting human voice, emotions, gestures, expressions and overall human behaviour in order to really offer an immersive experience.
- Social and Human Science; To understand and assure respect for the Psychological & biological effects of the constant VR world. Understanding the opportunities and threats to industry and citizens and those that related to e-governments and the axis of government-citizens and government-companies.
- Exploiting for Research and Commerce; Exploiting research and innovation in support of industry 4.0, embracing immersive distant collaboration and creating products and services in the area such as motion enhancement and animation blending technologies and applying these to market driven opportunities.
- Performance; Engaging with miniaturization of devices, the capacity of the NGI to deal with the packets and the reliability and latency issues associated with it. Developing the tools for processes and work-flows improvements and developing battery technology.

New forms of interactions and immersive environments will interact with all human senses and abilities to input and make requests. This needs a human science approach to understanding the impacts on society in balance with the many opportunities it presents to the European research and industry base. Key investments are also needed in technology that will improve performance and make this technology area ever more pervasive.

3.4 TA 3 Personal data spaces

3.41 Background

The technology area is simply described as "personal data spaces" and is described in the consultation as

"Personal data is everything that identifies an individual, from a person's name to telephone number, IP address, date of birth and photographs. The next generation Internet aims to develop technologies to help us achieve greater control of our personal data, knowing what is being shared and with whom."

3.42 Who selected this as very important

347 (77%) of the 449 respondents stated this technology area is very important making it the most important area as considered by the consultation. There's a near even distribution of the age groups rating this very important, consistent with the overall age profile participating. 43% are in the middle of the age bands (35-50) with 31% older and 26% younger than this group.

3.43 Which sector and level of expertise

For those that rated this area as very important: 47% were researchers which is high considering that 38% of total respondents were researchers; 22.7% actually work in this area and 44.67 have a good understanding of the area, suggesting this is a reasonably well qualified response in comparison with most of the Technology area results.

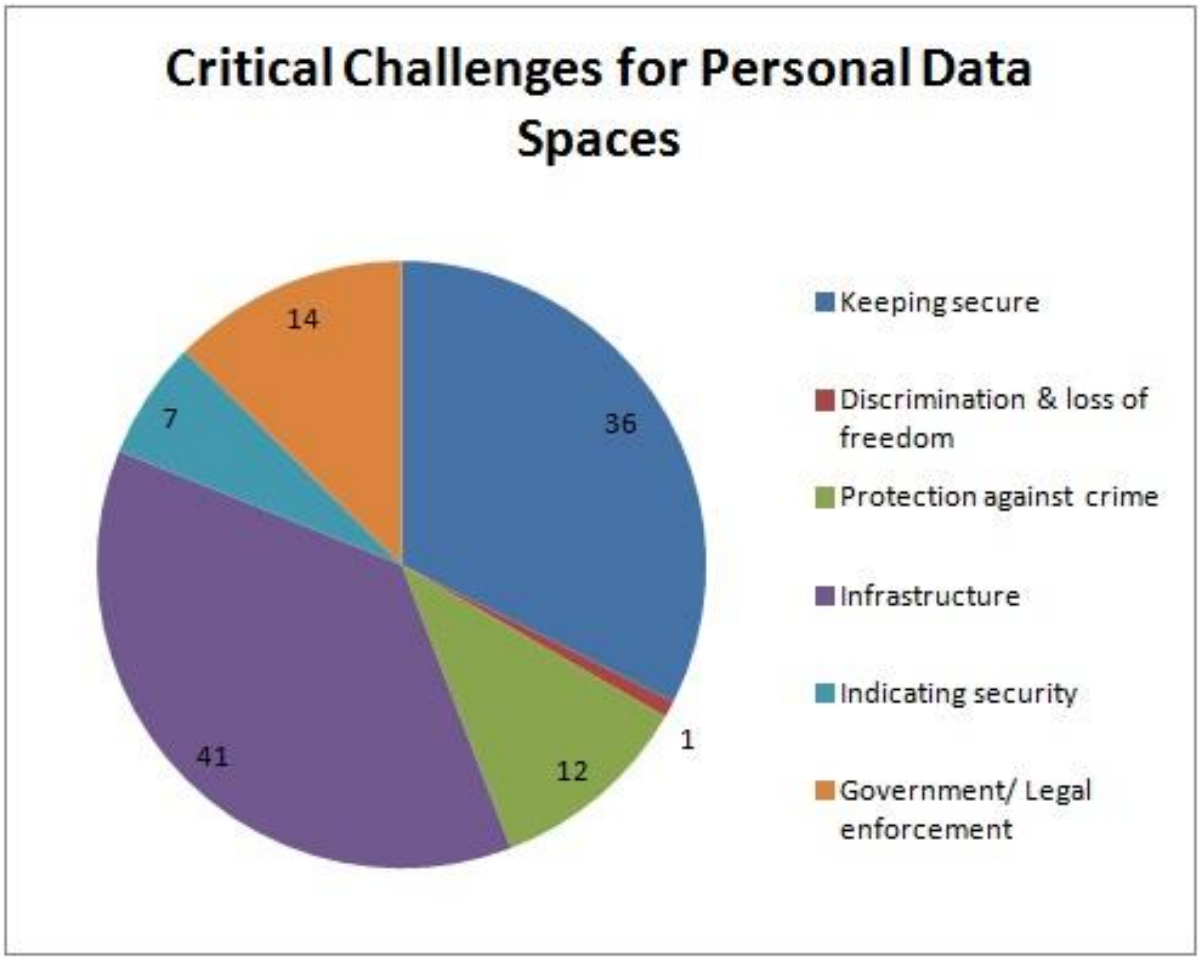
What is your expertise in this technology area?

		Answers	Ratio
I work in this area		79	22.77 %
I have a good understanding of the area		155	44.67 %
I have just general knowledge		102	29.39 %
No Answer		11	3.17 %

3.44 Research and Innovation Challenges for Personal Data Spaces

Participants were asked which are the greatest challenges in the technology area. Their responses were free-form but I've made a broad categorisation:

- Keeping Secure - Challenges that relate to keeping an individual's data secure from abuse by big business and cyber criminals alike. In this area we see issues related to health data (for example).
- Discrimination and Loss of Freedom - The specific issues associated with abuse of data to support discrimination
- Protection against crime - Challenges that reference specific crimes
- Infrastructure - Challenges for the creation or support of infrastructures both to enable benefits and minimise exploitation of personal data
- Indicating Security - Challenges to give users clear signals and controls over use of their data. Includes education of citizens
- Government/ Legal enforcement - Challenges where greater governance, laws and policies need to be proposed.



Infrastructure - example answers from the consultation

- "Data-mining algorithms' accountability, prevent data moving across contexts"
- "Privacy-aware Access Control in Social Network, Privacy-aware Data Mining"
- "Blockchains, Big data, Open data"
- "Community-based services and self-hosting managed by local communities."

Keeping Secure - example answers from the consultation

- "How can people be equipped with the skills to be able to protect their personal data?"
- "How to facilitate data collection for investigation without losing privacy."
- "SECURITY systems that assure citizens that their data is stored safely (both governmental and corporate) in a manner that they can see (transparency), are able to opt out of corporate data storage, and the rights to edit items that are incorrect or defamatory..."

3.45 Initiatives

74 submissions were made overall to the request for relevant initiatives. MyData initiatives across a number of countries are most commonly cited by participants. Nervousnet, NEM European Security Platform, Netcommons and GDPR are all mentioned by 2 participants each.

All other areas were mentioned by just one participant only and range from investigatory power bills in nation states and directives from the EU to individual PPP projects. See the table in Annex 1.

3.46 Relation to Values statements

83.3% of those that considered personal data spaces to be very important also considered *data sovereignty* to be the highest importance among the value statements and that *diversity and pluralism* were the next most important values to pursue.

In general, the group that considered personal data spaces to be very important also scored *all* value statements at least 2 percentage points higher than those that had considered the technology area of lower importance. The greatest variance between this group and the whole questionnaire regards values is on values:

1. *'Internet should ensure citizens' sovereignty over their own data and protect privacy'* (83.3% of this group rated the data sovereignty as very important compared with 74.8% of all participants) +8.5%
2. *'Internet should be more resilient, secure and safe, especially for children, elderly and people with low digital skills.'* (60.23% of this group rated this value as very important compared with 54.6% of all participants) +5.6%

3.47 Conclusion

Overall this was the most important of the technology areas to address according to the consultation results.

Those that consider this Technology to be very important appear to be well qualified and represent all age groups in the study, though there is a bias in this group toward research and academia.

They recognise the trade-off between the benefits of Innovation possible with IoT and Big Data and the need to prevent abuse of personal data.

- The main challenges they identify are in;
    - Keeping data secure; educating and enabling citizens to keep personal data secure both from criminals and big business. Providing the assurances, transparency and freedoms for citizens to control the data that's held on them whilst not overly limiting access to innovative services.
    - Infrastructures; creating and supporting infrastructures both to enable benefits and minimise exploitation of personal data. Enabling privacy aware access control be it in social media or data mining. Accountability for responsible use of personal data to prevent it crossing contexts has to be well understood, assigned and respected.

- Interesting observation from one respondent: "Who are the bigger villains re. personal data? Big business or the hackers?"

The values this group related most to were those of sovereignty over data and diversity, pluralism and the right to choose. Interestingly they departed from the others in the consultation by rating a resilient, safe and secure internet of slightly higher importance than the average.

In dealing with Personal data we're dealing with the trade-off between the benefits of innovation reliant upon IoT and Big Data and the need to prevent abuse of personal data. The challenge is to keep personal data secure and assure citizens of their control over it whilst implementing infrastructure that enables privacy controls and assigns accountability for its responsible use.

3.5 TA 4 Distributed architectures and decentralized data governance

3.51 Background

Distributed architectures and decentralised data governance is described as below in the consultation;

"Distributed open hardware and software ecosystems are capable of supporting decentralised data management (so that each piece of user-generated information remains under the full control of the entity who generated it, and is subject to on-demand aggregation by third parties), leveraging on decentralised algorithms based on blockchains, distributed ledger technology (DLT) or peer-to-peer (P2P) technologies."

3.52 Who selected this as very important

107 (23.8%) participants thought this area very important.46.7% of the respondents were researchers or part of a research institution which is above the average of 38% and the age profile with 36.0% of respondents above the modal age band is skewed toward the older or the participants in the consultation.

3.53 Which sector and level of expertise

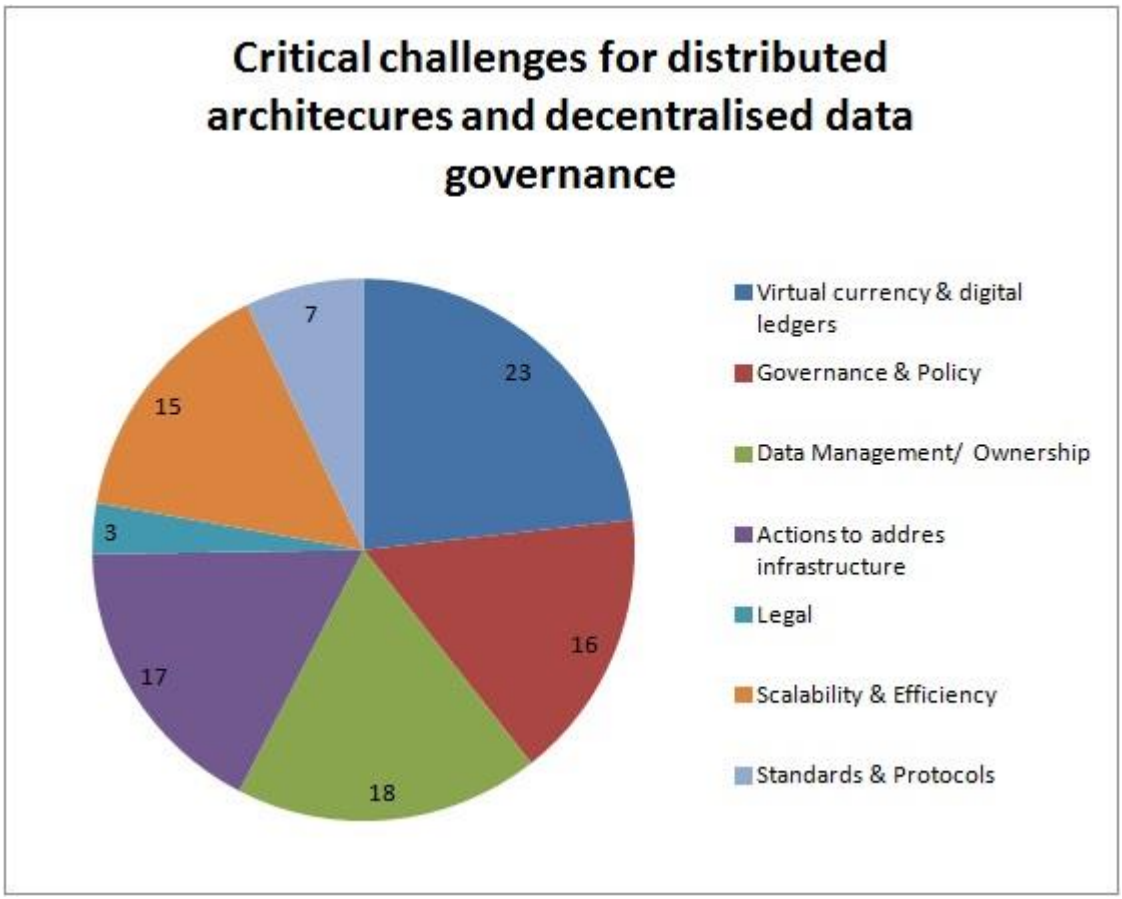
30.1% of respondents work in the area and another 36.2% claim to have a good understanding indicating that these may be well informed responses.

3.54 Research and Innovation Challenges for Distributed architectures and decentralised data governance

Participants were asked about the critical challenges in this technology area. Of those that rated this area very important 99 challenges were put forward. These are categorised as below:

- Virtual Currency & digital ledgers - Challenges relating to currencies used through distributed services. Most responses in this category related directly to blockchain.
- Governance & Policy - Those that determine the handling of identity, accountability and balancing sender and receiver rights.
- Data Management - Challenges of security, privacy and ethics in handling data in a self-organised and distributed systems.

- Actions to address infrastructure - Reinstating the original concept of the internet as a truly decentralised network
- Legal - Addressing the need for data base operators to behave diligently and ethically
- Scalability and efficiency - Creating a more sustainable, resilient and eco-friendly system for trusted services.
- Standards and protocols - Determining the interoperability standards and formats and open protocols enabling more open innovation.



Virtual currency & digital ledgers were the most popular segment in the responses (23%), then Data Management/ Ownership, Actions to address infrastructure and Governance and Policy.

Virtual currency & digital ledgers - example answers from the consultation

- "An open European distributed ledger technology platform with smart contracts."
- "There is quite a number of trials in the financial sector but more is needed to put these technologies in use."
- "How to communicate to traditional companies that blockchain is radically different from their traditional business, and when they try to assert centralised control over "blockchain" it's not a blockchain anymore."

- "…new decentralised algos with more mature operational support functions (revocation, refund, trace, etc.)."
- "...verification and authentication on an open public ledger."

Data Management - example answers from the consultation

- "A key challenge is to keep data only at the user level and allow on-demand access by third parties. Such a system would disrupt the current business model of the internet actors, but I think for the best."
- "Balancing data security and safety with enforcing privacy legislation and related human rights, as well as data access control and oversight."
- "Data, algorithms, and our technology must be owned by individuals, not corporations."
- "Give citizens ways of tracking their own data and choosing what to share to who under what context."
- "Interdisciplinarity and transdisciplinarity, decision-making, ethics, ownership, complexity, usability, techno-optimism, locality, the importance of face-to-face contact to build trust, conviviality."

Actions to address infrastructure - example answers from the consultation

- "Collective action platforms, seamless means of participation,"
- "Decentralised approaches to coordinate discovery and identification under control of end-users."
- "Developing a diverse enough infrastructure of the internet is important for cyber-attacks and a single point of failure."
- "Distributed architectures of the future need to comprehend emerging developments including hardware-enabled accelerators."
- "For practical reasons they need to be as autonomous as possible: self-managing, self-optimising, self-healing."

Policy & Governance - example answers from the consultation

- "Governance of distributed systems is critical"
- "Balancing sender and receiver rights; The network will do its best to serve the interests of the sender AND the receiver."
- "Peer production and services and network governance."
- "This area is useless unless Europe enforces effective anti-trust laws that are implemented on the spot."

3.55 Initiatives

Just 51 initiatives were named in this group and very little repetition (only netcommons is named twice). It indicates (and some of the comments validate this) that the area is not well coordinated on initiatives. The full list is in the Annex 1.

3.56 Relation to Values statements

For those that rated this area of 'distributed architectures and decentralised data governance' (TA4) very important the values they rated highest were regarding *data sovereignty* (80.8% of respondents) and that *the data should not be concentrated in a few proprietary platforms (77.8%)*.

These are both high scores showing a strong correlation between the technology area and both these values.

3.57 Conclusion

The group that consider distributed architectures and decentralised data governance very important are well qualified in the area. The values they rate highest relate to sovereignty of data and that data should not reside in a few proprietary platforms.

The proposed challenges fell naturally into 7 categories. There were a number of specific requirements that emerged in analysing their free text answers including the continuance of work on blockchain in particular and the need to deal with the power demands for this technology.

The main challenges identified were;

- Virtual currency and digital ledgers; Communicating the business benefits of these technologies to existing businesses in a compelling way to assure collaboration around new decentralised algorithms with more operational support functions and thus trigger a potential financial revolution.
- Data Management; Allowing citizens greater awareness of their own data and control over its use by others even beyond the initial commercial interest.
- Actions to address infrastructure; A diverse infrastructure for the NGI to be robust and future-proof to enable ever greater autonomy.
- Governance and Policy; The governance of a distributed network is critical for the NGI. Technology needs to support effective governance that balances the sender and receiver rights and supports existing and developing legislation. The principal is to keep the personal data from distributed sources under the control of the individual.

The fairly even balance between these categories suggests a multi-disciplinary approach, the requirement for which was nicely captured by one participant;

> "The issues related to distributed structures, whatever they may be, remain difficult to grasp and trust. The reason is that we are so accustomed to pyramidal structures with clear chains of command. Yet, as Yochai Benkler aptly argued in his well-known book, The Wealth of Networks, these modes of social organizations can unleash unexpectedly extraordinary results. Learning how to grow such networks, and make them reach their objective will require studying such networks from an interdisciplinary perspective where hard sciences, including mathematics, and social sciences must collaborate."

The correlation with the values of data sovereignty and the avoidance of the creating a concentration of data

in proprietary platforms is strong, suggesting a concentration of work in this area needs to address these two values as a priority.

3.6 TA 5 Software defined technologies

3.61 Background

In the consultation this technology area is described thus;

"There is an evolution towards software-defined technologies. These may provide more functionalities and control for the allocation of resources, configuration and deployment, and may open new opportunities to develop the Internet."

3.62 Who selected this as very important

151 participants considered this a very important technology area. 48.3% of those that rated this as a very important area were researchers (38% of the respondents overall were researchers). The age profile is heavily skewed toward the older groups as only 16.5% of the respondents are between 18 and 34 and 39.7% are over 50 years old.

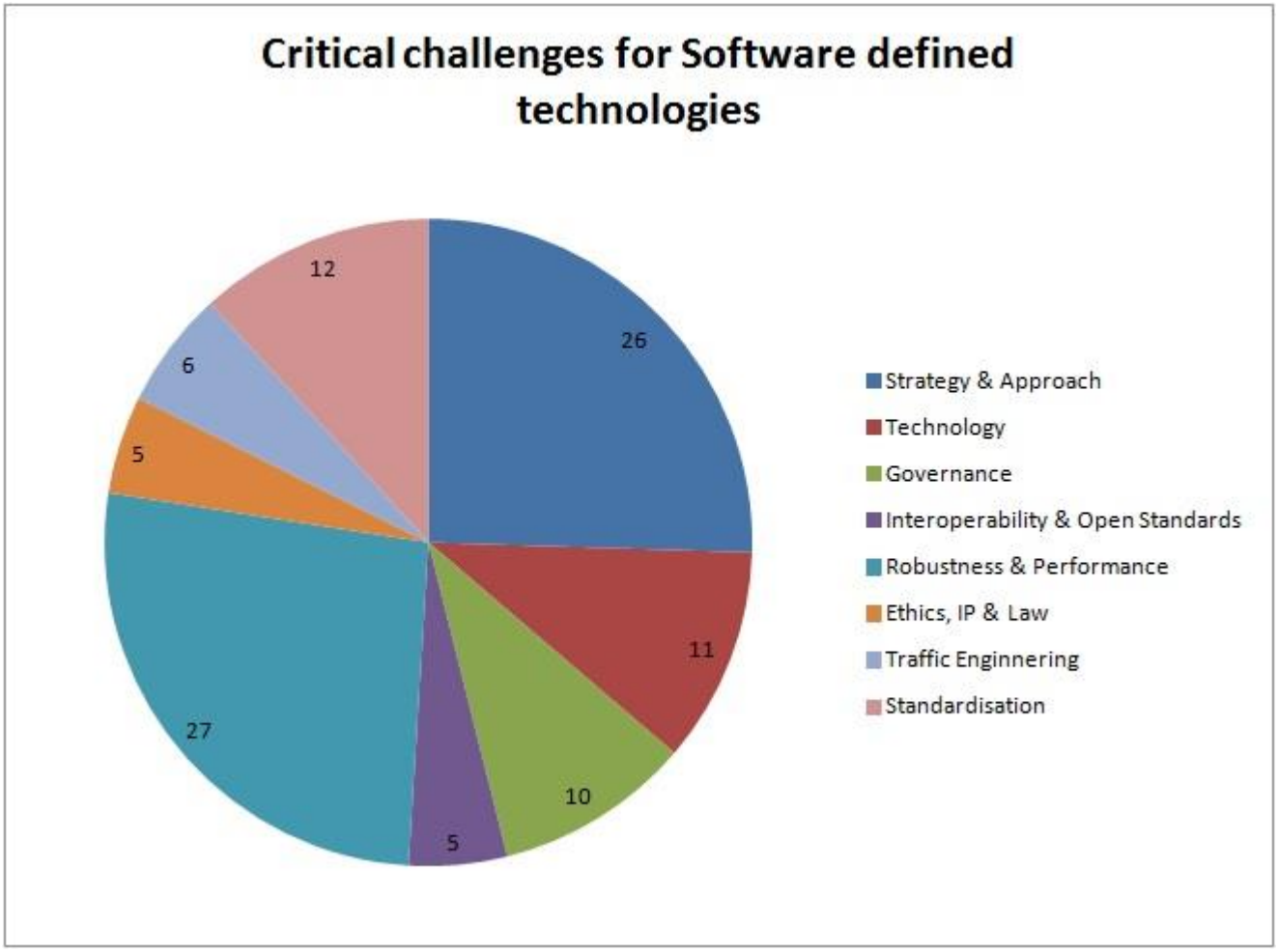
3.63 Which sector and level of expertise

The experience in the area is strong amongst those that rated this very important. 37.8% actually work in the area and 33.1% have a good understanding of the area.

3.64 Research and Innovation Challenges for Distributed architectures and decentralised data governance

Participants were asked about the critical challenges in this technology area. Of those that rated this area very important 102 challenges were put forward. These are categorised as below:

- Strategy & Approach - The proposed methods of identifying, implementing and assuring sustainable expertise in this subject area.
- Technology - Specifically proposed technical implementations in the technology area
- Governance - Automated and human control and intervention in the use of these technologies in multiple domains
- Interoperability & Open Standards - Adoption of standards to assure interoperation with existing technologies, preventing lock-in and enable complicity with open standards.
- Robustness & Performance- Challenges that need to be met if SDT can improve the robustness and performance of service in a scalable way.
- Ethics, IP & Law - Protecting the IP as it's created and inventing ethical services that code law as algorithms.
- Traffic Engineering - Developing and improving existing transmission equipment, providing new low cost IoT devices and defining the specifications for SDT traffic engineering.
- Standardisation - Future-proofing with extensible machine-readable standards, Open APIs standardised software protocols.



Within this group there was a strong set of challenges set at a high or strategic level (27/ 102) and relatively few (11) proposing specific technical challenges. There were a range of challenge comments that related to the improvements to performance and robustness that a Software Defined Technologies would bring to the NGI.

Some key quotes in these areas are provided below;

Robustness and performance- example answers from the consultation

- "Cloud computing is one of the most powerful and efficient tool for businesses, however, its full potential cannot be realised if loaded with conventional networking hardware."
- "Ensuring security and satisfactory performance of the software-defined technologies."
- "How to cope with the complexity and at the same time manage trust and security.

- "Increasing competitiveness of SMEs; Developing capabilities for Open Source and APIs; Optimising Life Cycle Management **Strategy & Approach - example answers from the consultation**
- "Balance of sharing technologies and protecting commercial/innovation privacy. Co-developments with major players useful, but pushes out small enterprises and over-centralises the technology. "
- "community-based decision making and incentivisation, privacy, market mechanisms "
- "Self-reconfigurable, hyper-agile software. The system must be able to evolve on its own without programmers intervening. Self-adaptive algorithms for evolving contexts".
- "Virtualization as a means to replace the software without impact to the customer or the user."

Standardisation - example answers from the consultation

- "It's important that open APIs allow impact on fast and standardized... " services
- "Future-proof, extensible, machine-readable standards and protocols need to be defined to support the introduction of arbitrary resources to a system, exposing all capabilities (including previously unknown functionality)."
- "To reach the point where software based technologies can take over some of the functions of hardware elements, in-software specification, validation and testing (the equivalent resilience levels in hardware) for real time processing functionality are needed. The efforts must therefore go first into software specification."

3.65 Initiatives

FIRE, Future ICT and NESSI are the 3 broad initiative areas where previous work is recognised by more than one of the participants. Only 38 participants proposed relevant initiatives. The full list is in the Annex 1.

3.66 Relation to Values statements

Data sovereignty is the strongest value identified by those seeing Software Defined Technologies followed by *diversity and pluralism* and in third place the *avoidance of data* held within proprietary platforms.

3.67 Conclusion

The group that consider this technology area very important are well qualified in the area. The values they rate highest relate to sovereignty of data and that diversity and pluralism are very important. The Computer Defined Technologies as seen as very important by a segment of proposers at a slightly more mature end of the age spectrum studied.

The proposed challenges fell naturally into 2 main categories that were described at a fairly high level, but with some specific areas to attend to.

The main challenges identified were;

- Robustness and Performance; The NGI can be made robust if the agility possible with the Computer Defined Technologies is embraced and the right methodologies employed for SME's to take a role in this are adopted.

- Strategy & Approach; Co-developments may be needed to fulfill requirements for virtualisation and for more self-adapting algorithms. Methodologies are proposed but the protection of the created knowledge will be important.
- Standardisation; Efforts are needed in software specification as more functionality becomes embedded in soft rather than hardware. The standards need to be future-proofed to accommodate even the unknown future functionalities that will be required.

An approach to Computer Defined Technologies is needed that optimises their ability to improve robustness and performance in the NGI. This will involve a focus on standardisation and a strong methodological ideology that guides call participants toward significant results.

3.7 TA 6 Networking solutions beyond IP

3.71 Background

The consultation describes this technology area as;

"The current internet has certain limitations derived from its protocols that were developed in the 70's, like the transmission control protocol/internet protocol (TCP/IP) and its limitations on mobility, IP address management and task limitation. Quality of Service (QoS) is another problem derived from TCP/IP, which is a problem generated by the inherent nature of networking technologies and the focus on pumping data from point A to point B as fast as possible without focusing on how the data is sent. The internet of the future should be able to overcome these limitations."

3.72 Who selected this as very important

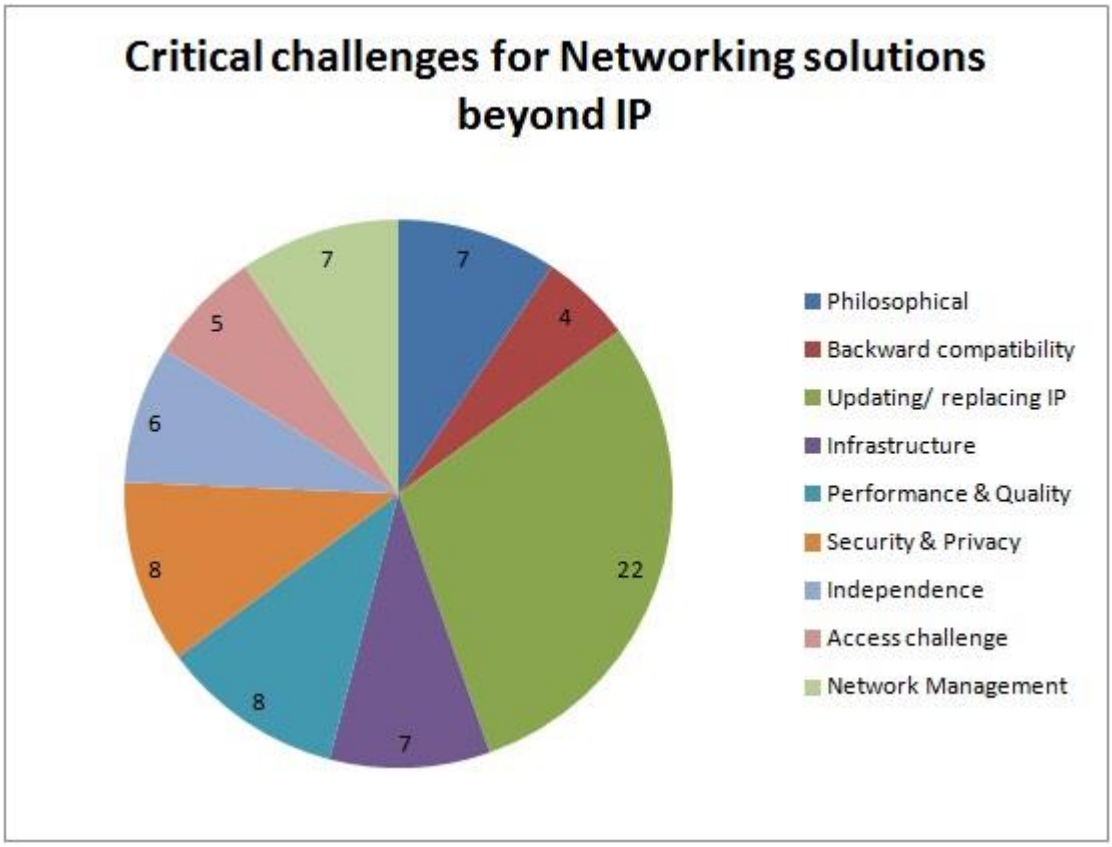
In this area the age profile appears to have attracted a younger profile with 26.1% of the respondents in the age bracket 18-35, 40.7% in the age group 35-50 and 33.1% in the 50+ age group.

3.73 Which sector and level of expertise

As with all those that selected "very important" to a technology area there is a bias toward the research community (46.7%). Only 26.1% of this group work in the area and a further 30.7% claim to have a good understanding of the area.

3.74 Research and Innovation Challenges for Networking solutions beyond IP data governance

For those rating this as a very important technology area there were strong proposals for replacement of IP or at least upgrading it. There was also a strong awareness of the cost of ignoring backward compatibility. Some of the responses could be described as philosophical (more so than in other areas) but there was an awareness of the need for practical solutions in the areas of network management, the challenges of access (geographical or on new protocols like 5G), security and privacy, quality and performance, retaining (or gaining) independence from the ISPs and other technologies where commercial interests lie.



Updating/ replacing IP- example answers from the consultation

- "Clean slate architectures, landing IPv6 in real deployments, making IPv6 networks secure and resilient."
- "Development of alternative mechanisms and networks"
- "IP is an obsolete protocol that a lot of old people push. We need to scrap IP and think from scratch."
- "Next Generation of IP, non-packet-based network protocols."
- "Keeping backward compatibility and designing an optimal migration path."

Performance& quality - example answers from the consultation

- "High throughput, low latency and secure communications are key. Challenges remain at infrastructure and architectural levels rather than access networks/devices.
- "API development and usage... IP address management, dynamics, security "
- "One of the main research challenges of the NGI is to have a new high-speed TCP protocol that is capable of serving applications from IoT to real time video, and 5G networks."
- Challenge: "How to develop the tools that will control the rate of transmission of information from A to B."
- "Content centric networking to optimize the tradeoffs between storage and communications."

Security and privacy - example answers from the consultation

- "Security against pervasive surveillance is the key technical challenge. The key operational challenge is getting any form of adoption going. "
- "Security is an add on to current internet protocol. It has to be built into the protocol."
- The challenges of ..."maximising Interoperability, privacy, security and resilience..."..."in Smart City environments, e.g. intelligent mobility."

3.75 Initiatives

Just 26 related initiatives were mentioned of which only FIRE and 5G PPP's were cited by more than one participant. There was a comment that suggests the area was thinly covered in previous calls,
"The EC has always supported technology evolution, and large elements of standardization, but with not enough weight given to architectures and regulatory principles."
A full list is provided in the Annex 1 and includes relevant regulations and work under way among the giants of the internet.

3.76 Relation to Values statements

The most strongly supported value for this group was regards *sovereignty of data* (156 respondents rates this of highest importance). Next highest was for *pluralism and diversity* at 138 and the lowest was that the '*internet should be "more human - social, easy, immersive, emotional"'.*

3.77 Conclusion

The group that consider this technology area very important are not as well qualified in the area as in other technology areas studied. The values they rate highest relate to sovereignty of data and that pluralism and diversity. The consequence was the emphasis on security aspects alongside the palpable need for an improvement over the current IP.

9 categories were identified among the responses on challenges. The largest area of work identified was in the improvement or replacement of the current IP technologies to deal with foreseeable changes in the way the internet will be used. However there are strong views and proposals equally on independence (from those with commercial interest), Security & Privacy, Infrastructure and Network Management. The number of philosophical statements suggests this is an area where more "thinking" as well "doing" is needed.

The main challenges identified were;

- Updating/ replacing IP; The Next Generation Internet may benefit from a clean slate approach, perhaps non-packet-based. However, backward compatibility issues must be addresses and an optimal migration path between the existing and next generation replacement is needed.
- Performance and Quality; IoT, real time video and 5G networks place a strong demand for high throughput, low latency and secure communications, creating significant challenges upon the NGI infrastructure and architecture. A new high-speed TCP protocol and tools that will manage and control the rate of transmission of information from A to B are important areas in need of development.

- Security & Privacy; New networking approaches may demand that security is built within the protocol. Maximising security and resilience while assuring good interoperability are key technical challenges.

The few initiatives and the lower level of expertise of participants in this area of the consultation could be the result of not reaching the right people, or it could be that this area has not been adequately supported by collaborative initiatives in the past. The quote below considers some of this work and the barriers it faces in becoming adopted effectively.

"A lot of research has been done already, for example in relation to the Recursive Internet Architecture (RINA). The challenges now are how to get this technology deployed in the face of vast inertia and vested interests. Innovation is required in the formulation of regulation and purchasing policies so that these new solutions are not excluded."

3.8 TA 7 Artificial Intelligence

3.81 Background

The consultation describes this technology area as;

"Artificial intelligence will also change the Internet. Inspired by how the human brain works, mathematical models can learn discrete tasks by analysing enormous amounts of data. So far, machines have learnt to recognize faces in photos, understand spoken commands, and translate text from one language to another. But this is only the beginning. Artificial Intelligence will greatly sharpening the behaviour of any online services and be core technical enabler of the future Internet."

3.82 Who selected this as very important

Artificial Intelligence was viewed by 257 participants as very important, the second highest after personal data spaces. The age profile was close to the average for the consultation with 24.1% below the age of 35, 44.8% in the 35-50 year old bracket and 31.1% of the over 50's.

3.83 Which sector and level of expertise

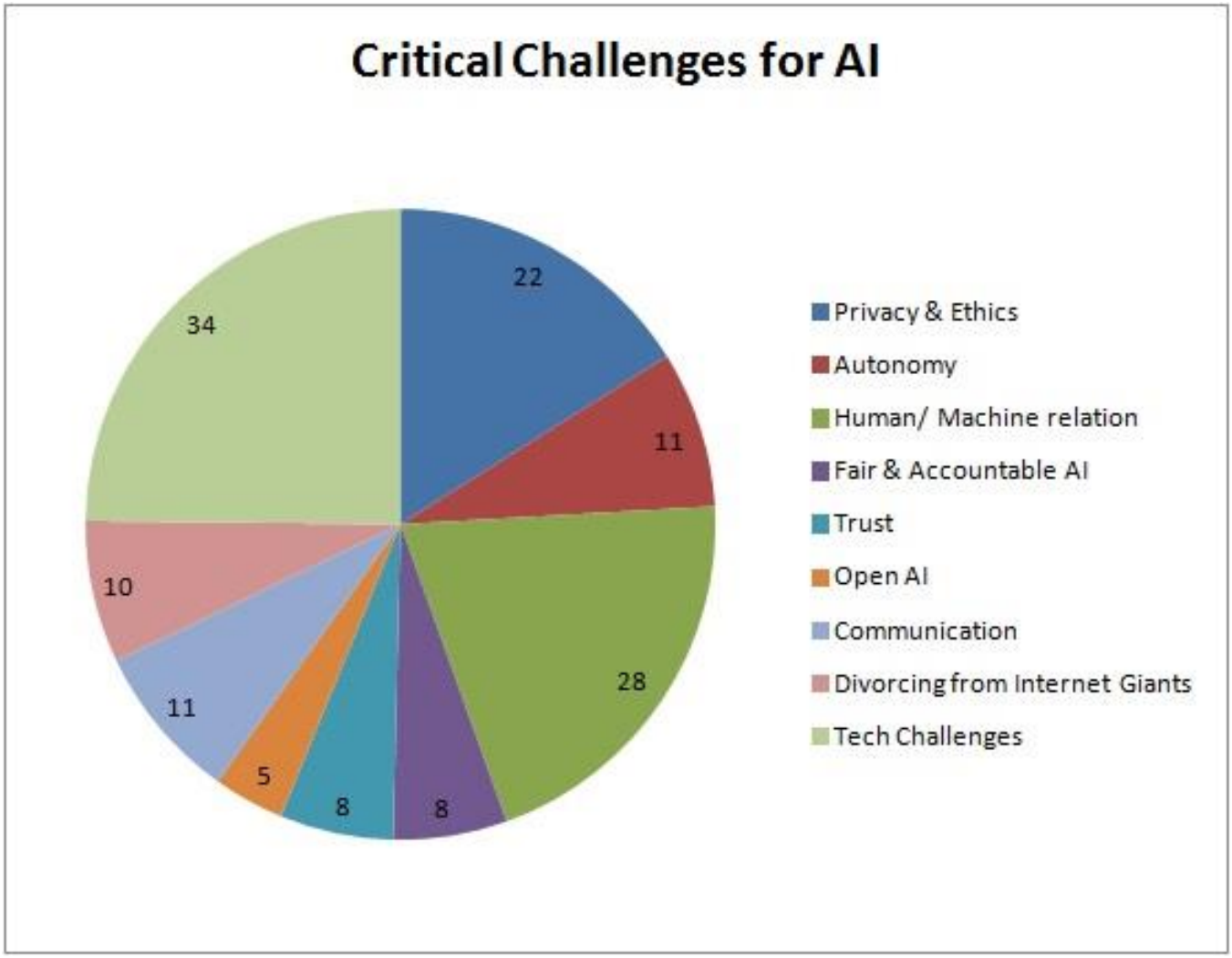
Researchers outnumber the other sectors significantly again with 46.3% representing 8% higher than the average and indicating the enthusiasm researchers hold for this area.

However, of those who considered this are very important", only 24.5% currently work on the area and 37.4% have a good understanding of the area.

3.84 Research and Innovation Challenges for Artificial Intelligence governance

The respondents were asked to identify the critical challenges for this technology area. These were categorised by popularity of theme. Specific technology challenges and how these are addressed were identified by 34 participants, 28 specified aspects relating to human and machine relations to be most critical,

22 identified ethical and privacy challenges and 11 each identified Autonomy and Communication challenges. Divorcing (or independence from) the internet giants in this technology area was expressed by 10 and lower numbers identified the importance of dealing with more "accountable", fair, trustworthy AI.



Tech challenges - example answers from the consultation

- "To make the Real AI, it is essential to go beyond the human brain. But this is like trying travel faster than light."
- "There is lots of good research happening in these areas but no top-down coordination to bring together the different disciplines. ...Internet is seen as something for engineers. This delegation to the technical class is deadly."
- "Linking Neural Network Technology with Symbolic reasoning : machine learning that does not only abstracts and organise information (e.g. photos, speech, text translation) but machine learning for reasoning (learning rules, how to apply them, in which order ... for problem solving, for decision taking)."
- "Autonomous vehicles; Automated insight extraction from data; Automated data science."

Human/ Machine relation - example answers from the consultation

- "...efficient placement of "human factor" within the connected processes while avoiding "Kafkaesque" outcomes; strict data protection and privacy regulation"
- "Finding broad application, human interfaces, ethical issues"
- "Is becoming increasingly essential to drive personalised models using big-data"
- "Stop thinking about Human-Machine relations with a master/slave model; for AI to evolve it needs autonomy; autonomy means lack of human control; make neural networks share with humans its process of thinking-, keep 'human-in-the-loop'."

Privacy & Ethics - example answers from the consultation

- "Creating the basis for a long term project. Implementing Asimov's 3 laws in all AI and working from there."
- "Ethical framework; legal issues related to liability; transparency of algorithms and data use; accountability"
- "How do we encode our morality into the algorithms? Do we even have a good idea of our morality? Who gets to decide?"

3.85 Initiatives

35 responses were gained when asking for related initiatives in this area. They include some FP7 and Horizon 2020 projects. The IEEE ethical discussions initiative is the most popularly covered, mentioned by 3 participants. Data protection regulations are mentioned and projects from the big internet players like Google. The full list is in the Annex 1.

3.86 Relation to Values statements

185 of those rating this technology as very important also rated the value statement on *sovereignty of data* at the highest level. Secondarily *diversity and pluralism* (169) and thirdly (162) the *avoidance of data concentrated into a few proprietary platforms*.

3.87 Conclusion

This is clearly an area that interests many and, despite only a few respondents actually working in this area, many more believed they had a good understanding of the area. For those that saw this area as very important their visions are strongly in line with retaining data sovereignty, diversity and pluralism and not allowing the data to become concentrated in proprietary platforms.

The critical challenges are technical, concern human/ machine relations and concerns over privacy and ethics.

The main challenges identified were;

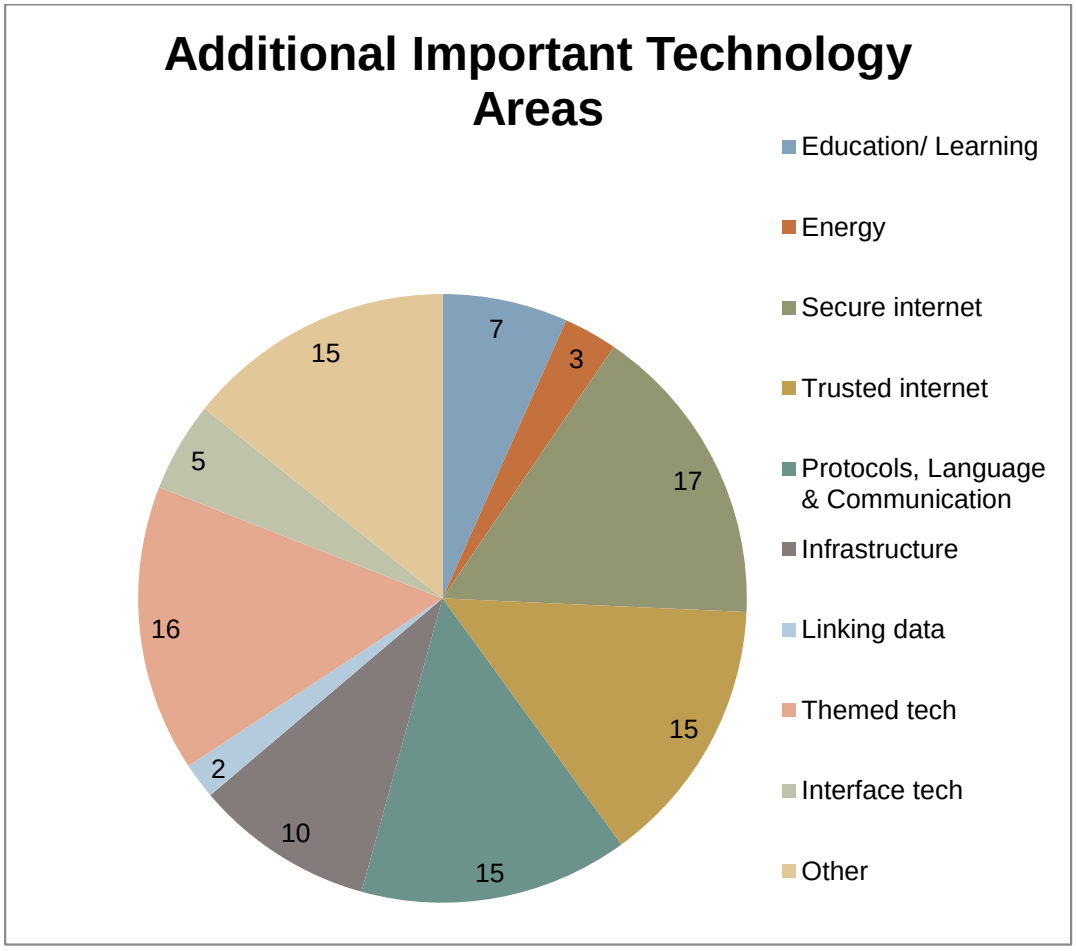
- Technology challenges; This technology area is necessarily interdisciplinary and needs a top-down vision to shape the needed activities as well as application to strong use cases (for example, autonomous vehicles).

- Human/ Machine relation; The impact of greater autonomy and responsibility by systems rather than people requires efforts into communication, ethical understanding (perhaps a move away from "master vs slave concepts regards machines) and the inclusion of human factors within these decision "making"(as opposed to decision supporting) mechanisms.
- Privacy and Ethics; Ethics regarding algorithms is an essential area and deserves a long term project commitment to implement well documented theory into practice if a proper and actionable ethical framework for AI is to be created.

The technical challenges in AI are easily identifiable from an engineering standpoint, but it is the interdisciplinary approach that will assure a workable ethical framework.

3.9 Additional important technology areas

105 participants gave an additional technical area they considered very important. 72 of the 105 claim to work in these areas and the remainder claim to have a good knowledge of these areas. Many of these areas have already been visited under the different Technology areas in the consultation. The main emergent themes are below in order of popularity:



3.91 Secure Internet (17 proposed TAs)

Proposals for Encryption, Cyber security and digital forensics were proposed and the formal methods for software implementation in more decentralised systems. A secure network that provisions for the protection of novel systems despite an insecure telecom infrastructure is needed and should include regulatory technology, "law embedded in code".

"The events of mass data leakages have shown that data encryption must be implemented at all stages of storing, sending and processing. There is a need for new types of protocols, algorithms and technologies which will encompass guaranteeing protection of privacy of data at all stages but still provide guarantees for public safety. It means that technology should protect privacy but public safety bodies (police and military) at a request confirmed by a court can remove a seal and access encrypted data. Specialized schemes, standards and protocols would need to be developed to facilitate such a system."

Related initiatives (for example) are FP7 HOMER, Privacy protection in an Encryption AtRest-InTransit-InProcessing model, UK Home Office Small Business Research Initiative: Digital Forensics, ERC CIRCUS / H2020 NEXTLEAP.

3.92 Themed Technology (16 proposed TAs)

There were a number of technology areas proposed that covered broad themes and prescribed methodologies to be applied to those themes. Smart Cities, Smart Citizens, Quantum technology, Cloud computing, Space and increasing autonomy in machines and manufacture (robots and cars were the most popular areas) are all areas proposed. User centred methods for achieving success in these is needed.

"Developing autonomous systems that will be supportive for the humans, at the same time safe and secure, and that can be controlled if the need occurs."

Related initiatives are;

- A situation-aware information infrastructure (EPSRC/UK project): https://netlab.dcs.gla.ac.uk/funding/epsrc-a-situation-aware-information-infrastructure
- A map exploiting global (twitter) media feeds and network topologies to identify the onset and effect of natural disasters and cyber-incidents: https://netlab.dcs.gla.ac.uk/sai2/
- European Open Science Cloud, Graphene Flagship, Human Brain Project
- Networld2020/NEM Joined working group.

3.93 Protocols, Language and communication (15 proposed TAs)

Overwhelmingly this category favoured language technologies and extended to natural language analysis and understanding. One quote sums most of these;

"Technologies are needed for communicating in our own language not only with computer systems, but also with other people, mediated by computers. Research and innovation challenges are in reaching higher quality and reliability and avoiding unclear and misleading communication. Applications are not only in machine translation, but also in multilingual information search and access. Systems which assist specially challenged people (e.g. aphasics, dyslectics, deaf and blind) are also needed."

Related initiatives are META-NET, ELRA, CLARIN.

3.94 Trusted Internet (15 proposed TAs)

Intrinsically dependable networking and services are needed by industry and increasingly all users of the internet. Ideally transparency of algorithms, deployment of distributed ledger technologies and value centred, often bottom-up, design will assure exchanges of reliable information through trusted services. This could both create great services and also push existing platforms toward better privacy controls by design.

"A crucial issue with modern Internet is the lack of trust in the information and content that is retrieved from online sources. There have been numerous cases where false or misleading information reached and influenced a very large number of Internet users. Even though, there are numerous efforts that try to tackle the problem through fact-checking and hoax debunking, a large number of Internet users are faced on a daily basis with false or misleading information. Furthermore, the dominance of social media platforms such as

Face book make access to information largely dependent on the content filtering and retrieval mechanisms that are implemented by these platforms. To this end, NGI is in need of new tools and systems that help assess the credibility and veracity of online information and content, as well as tools that facilitate access to diverse information."

Related initiatives are COST action 0801, REVEAL project (http://revealproject.eu/), InVID project (http://www.invid-project.eu/) and FuturICT 2.0, Pheme (FP7), LaBChain.

3.95 Infrastructure (10)

A number of people proposed technology areas that dealt with the physical infrastructure of the internet. Areas specifically rated very important were the storage and processing components, wireless technology (including 5G), computer hardware, Physical layer network design, hybrid multiplexing technologies and even the basics of moving over from paper based trading.

"All the technology areas above <<proposed in the consultation>> seem to forget the need for a new generation of physical network components to replace the links of today with new ones capable of higher data rates, the routers of today with new higher capacity systems, as well as the storage and processing components of today with new elements that implement the new network functions."

Related initiatives include Recursive INternet Architecture (RINA) research, such as PRISTINE, ARCFIRE, OCARINA projects etc.

3.96 Education/ Learning (7)

These proposals concern the impact of NGI on aspects like human health, cooperation and might exploit multidisciplinary studies on digital organisations (for example) to understand these effects. Meta modelling and test bed approaches are put forward as methods.

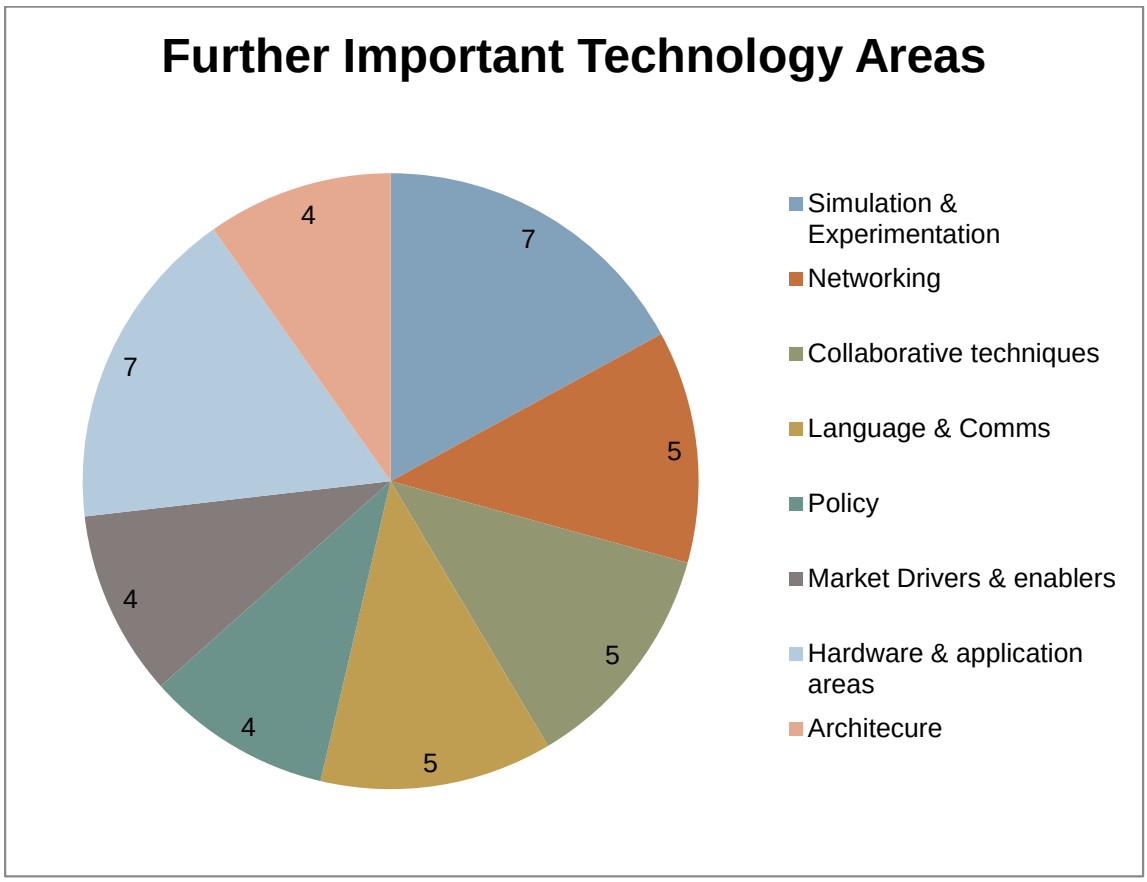
"What should citizens know about these new technologies? How to teach them to deal with all of these new technologies? How do they learn to use them? How to improve formal/informal learning strategies in this field?"

Related initiatives include

- The TRANSMEDIA LITERACY / H2020 project is close to these challenges > https://transmedialiteracy.org/
- FIRE initiative
- EDRi, Xnet
- CHIST-ERA call 2015 "User-Centric Security, Privacy and Trust in the Internet of Things"
- NESSI.

3.97 Further Technology area

Of those that responded to the above request for technology areas not covered in the consultation a second additional "very important" technology area was proposed by 49 participants.



In this group there was an even distribution of proposed technology areas from the participants.

Simulation and experimentation; This group spanned proposals for large scale pilots, IoT Platforms and pursues experimentally driven research via simulation and Socio-Geonomics.

Hardware and applications; Robotics, quantum computing, neurobotics, biotech and 3D printers made to operate more sustainably employing smart materials and being deployed to improve collaboration and human achievements such as surgery.

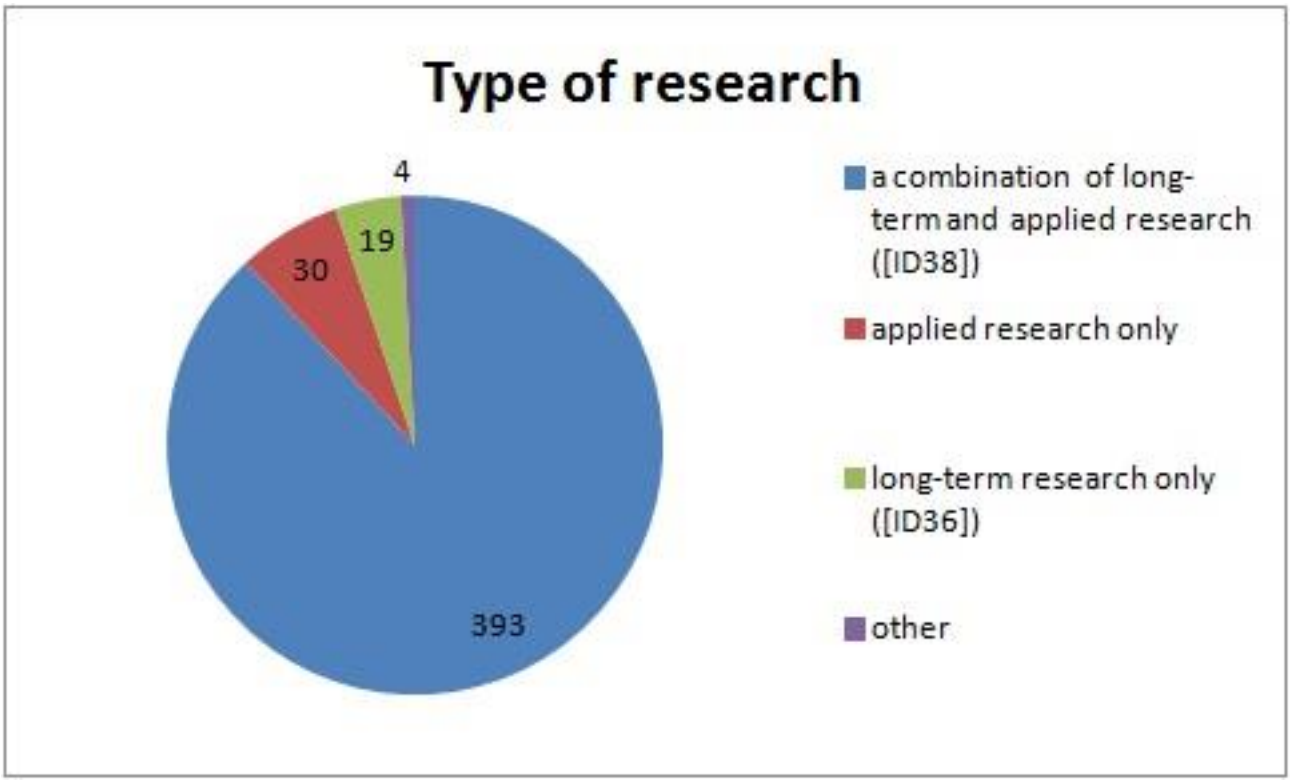
Networking; Covering WiFi,5G and network applications (distributed computational systems that exchange information).

Collaborative techniques; Standardised open data and open computing support this area of collaborative makers, researchers and citizens. There are comments that Europe falls behind the USA and China in these methods and, again, that collectively we must be able to denote the trustworthiness of a system in use vs. the facelessness of the major platforms in use today.

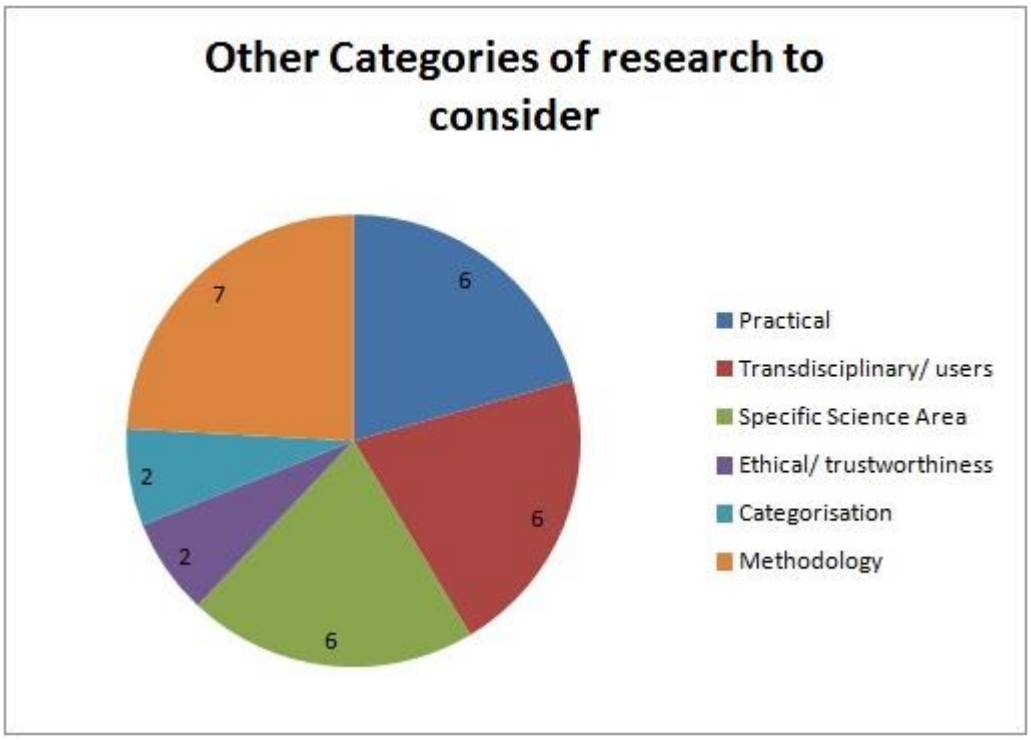
Language and communications; Knowledge (including Semantic Document) management and Language technologies dominate this area. "Language is a social sensor and serves as a bridge between humans and machines - investment into language technologies simplifies communication for humans and eases understanding on the side of machines. Today we can process language, but we don't understand it - so, investment into language understanding (semantics) is one of the key enablers for the future."

3.10 What type of research and who does it

Overwhelmingly (88.1%) the appetite is for a combination of long-term and applied research as seen in the below.



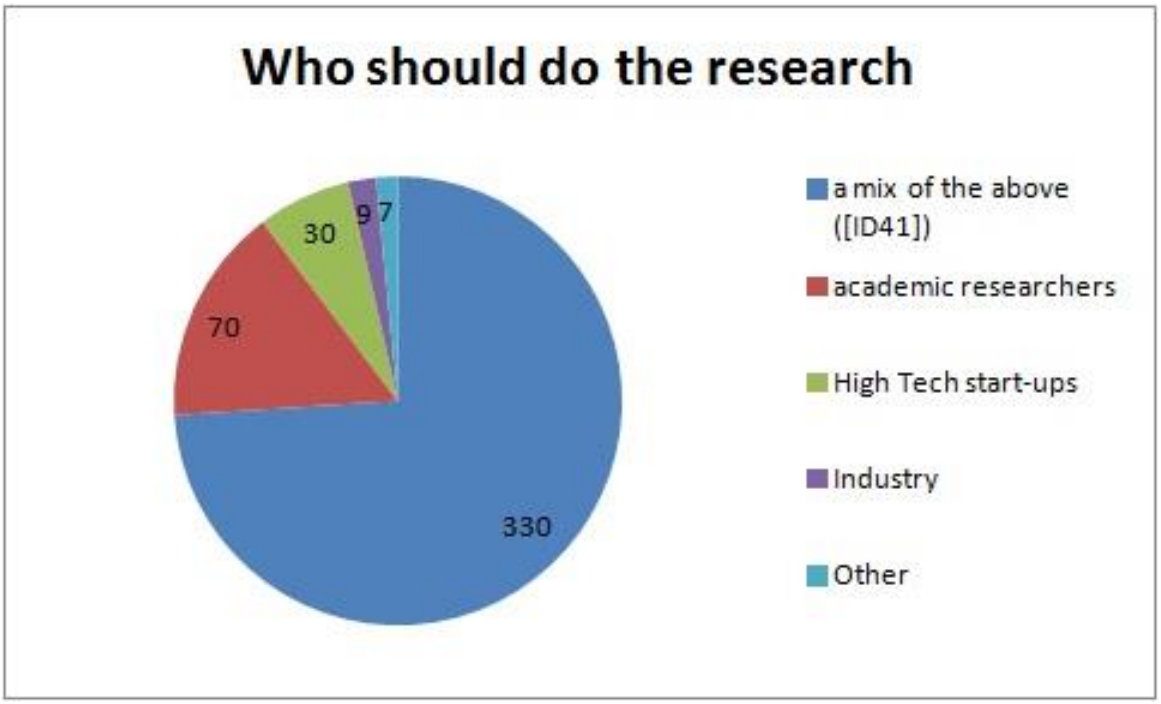
The participants proposed 32 responses to this section. After de-duplication this became a list of approaches to research and suggestions for alternative ways of categorising and phrasing the research types.



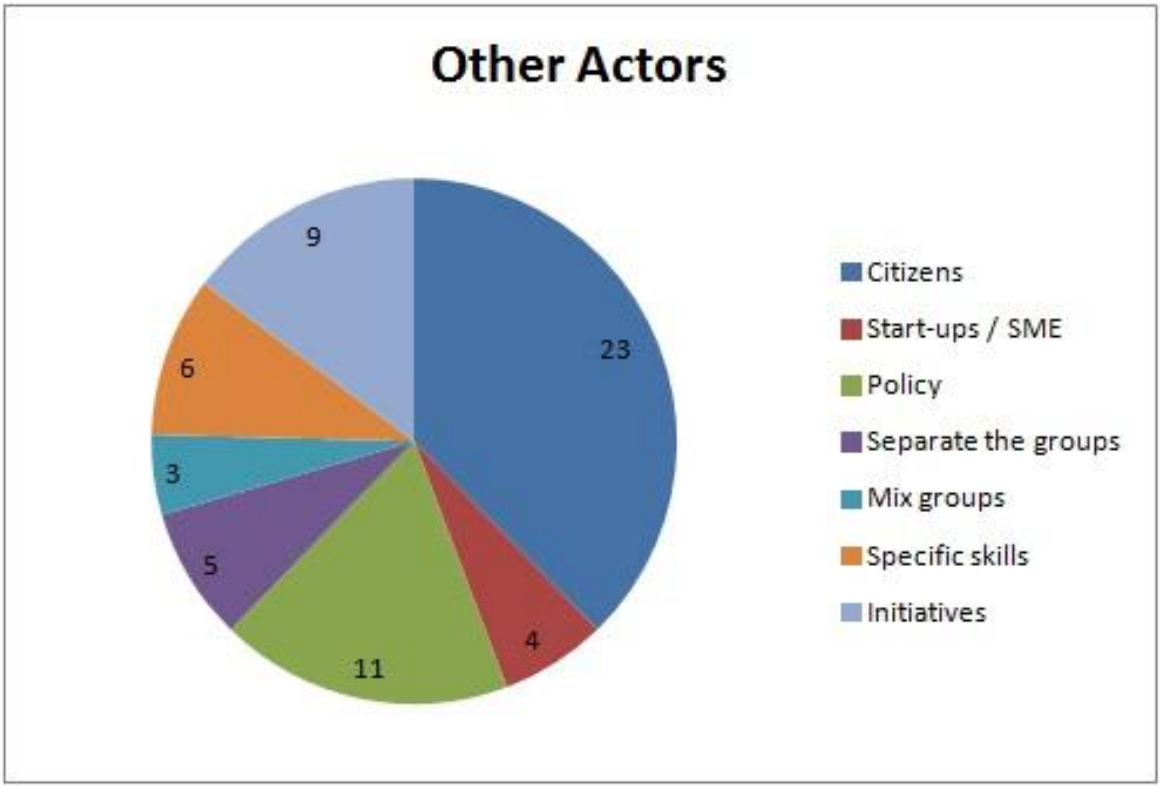
Overall there was support for the categories of the type of research proposed in the consultation (long term research, applied research and a combination). The comments that emerged from the "other types" can be categorised in priority order:

- Methodology - 7 suggestions for the methods of conducting research were made. Summarising, these involved using foresight to direct long-term research and determine the best methods to apply the outputs of LT research into today's applications. Exploiting vertical requirements to drive research and using start-ups to implement the outcomes were proposed.
- Practical - 6 practical considerations were put forward regarding evolutionary (step-by-step) approaches to embedding experimental research findings into business, perhaps by focusing on the current "known holes". Start-ups and civil society will provide examples.
- Transdisciplinary/ Users - Transdisciplinary research is needed but a user focus is essential to direct the work.
- Specific Science Area - Social Sciences and Humanities, Biomedical, Social and Psychological work is needed as well as an understanding of complexity and cognitive science.
- Ethical/ Trustworthiness - Work should focus on making the internet more trustworthy
- Categorisation - Perhaps consider the categories of research as system orientated, experimental and theoretical. This removes the expectation on them being considered long or short in duration.

As to who should do the research, again a combined proposal (74%) is favoured (see below).



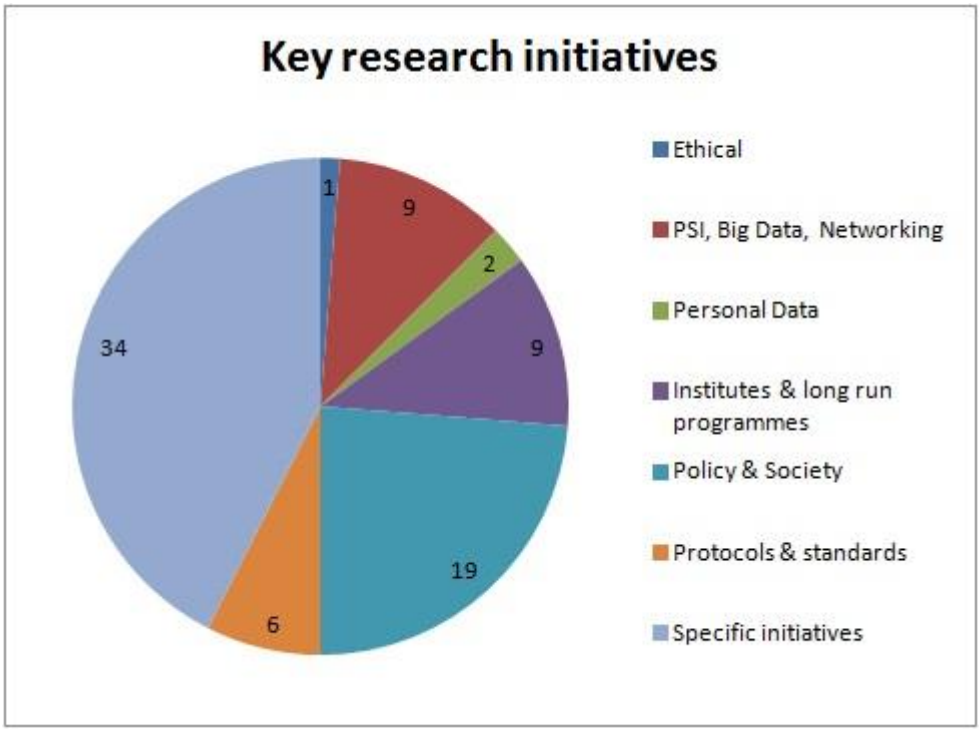
The participants were asked if any other actors should take part in the research. 63 suggestions were made. After de-duplication 44 suggestions were provided and are shown in Annex 4.



The other actors desired by those responding to this question is overwhelmingly in favour of citizen involvement, policy makers and regulators and those engaged in relevant initiatives.

- Citizens - 37.8% of the respondents wanted citizen involvement. These include representative bodies but there were specific requirements for women, students and activists.
- Policy - 18% of proposers favoured those involved in policy and regulation activity. These could be in public agencies or even banks.
- Initiatives - 14.8% favoured those involved in relevant initiatives; innovation platforms, think-tanks, cluster initiatives, crowd funding, hackathons and the open source community.

Finally the participants were asked to provide a list of the key research initiatives in their organisation or country. There is little duplication in the list and it is provided in Annex 5.



A number of specific initiatives are provided by the participants. Often they are already involved in these initiatives in some capacity.

- Specific Initiatives - 42.5% specified initiatives that are already under way. This include initiatives from national and international programmes and is heavily balanced on EC funded projects. Repeated themes are seen with the Smart initiatives, 5G, IoT and language technologies.
- Policy and Society - 23% of the feedback against this question were about policy and society and include Peer networks, digital learning, e-democracy, e-procurement and bridging the gap between those people that are internet capable and those that are not.
- PSI, Big Data and Networking - 11.3% of responses fell into this category. The dynamics of public sector information usage and big data are sited as are the environments (e.g. AR) for manipulating,

outputting and understanding their outputs. 5G and WiFi initiatives feature and prototypes for alternatives to IP are included.

- Institutes and Long running programmes - 11.3% of the responses related to these. In the main the respondent has named the institution (e.g. W3C, Alan Turing Institute).

3.11 Conclusions on Understanding the Technology Areas

Overall there was enthusiasm for the technology areas (TAs) proposed. Particularly from the research community who dominated (near to 50%) of those who selected any of the areas as "Very Important". However, investigating this further (removing researchers from the consultation results) still retains the same order of priority for the top TA's as TA3 (Personal Data Spaces) and TA7 (Artificial Intelligence) as the most important areas.

Personal Data Spaces is clearly the most popular of the technology areas. Keeping the data secure and providing the right infrastructure dominated the proposed critical areas. For Artificial Intelligence there is a stronger emphasis on technology challenges, human machine relations and the ethical aspects.

Additional technology areas proposed highlighted a focus on security in general and then more specific themed technologies around applying autonomous systems in Smart cities and Smart citizens. The desire is for trusted systems to be developed and language technologies are strongly seen as an important investment to achieve this.

Further technologies leant more toward simulation and large experimentation as well as more hardware orientated projects such as robotics.

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.

Proposed methods for research stem from foresight as a way of directing research and exploiting evolutionary results into today's technology. Transdisciplinary approaches are important but the participants pragmatically suggest these are guided by a real focus on the user and the "known holes" in the current internet. Use of social sciences is proposed to guide this research.

There is an overwhelming desire for more "citizen" involvement as "actors" in the research. These include representative bodies but there were specific requirements for women, students and activists. Policy makers and regulators are desirably involved and could span government and commerce (including banking).

Many of the initiatives proposed are ongoing with established institutions. Often they are funded through national and EC programmes. Repeated themes are seen with the Smart initiatives, 5G, IoT and language technologies. There is a strong appetite for more initiatives that address Policy and Societal issues. These embrace peer networks, digital learning, e-democracy, e-procurement and bridging the gap between those people that are internet capable and those that are not. The on-going work on PSI, Big Data and Networking may provide good starting points for prototypes.

The participants' involvement in very relevant sounding initiatives is well expressed in the tables of Annex 3-5.

4.0 CONCLUSIONS FROM THE CONSULTATION

4.1 Values

4.11 Overview

Ensuring citizens' sovereignty over their own data and the protection of their privacy is deemed the most important value proposed in the survey. Clearly the respondents' en-masse agreed that *concentration of data in a few proprietary platforms* is a significant issue today and felt strongly that the *Internet should ensure diversity, pluralism and a right to choose*. These values were consistently and strongly held by those supporting the most important of the technology areas (TAs).

The consultation has also been useful in surfacing new values too which will be of use in understanding what motivates target communities.

4.12 Internet should be more human - social, easy, immersive, emotional.

This value statement appealed to just 28.5% of respondents to the consultation. The appeal is felt mostly by the older age group research community with previous involvement with Horizon 2020. This vision statement therefore is going to appeal more to older researchers involved with existing projects.

4.13 Internet should avoid the concentration of data in a few proprietary platforms.

This is the third most important value.

There is a close relation between this value and the Personal Data Spaces (PDS) Technology Area (TA3). There are strong concerns over the impact of the few proprietary platforms upon the protection of personal data in particular. Those that valued this statement highest rated PDS and Software defined technologies the most important TAs.

The higher age profile and the familiarity these participants have with Horizon 2020 means this value is perhaps likely to attract those already engaged in research funded by the EC. This can be useful if progression with existing projects is desired, but may be counter-productive if opening up to new perspectives and attracting new participants.

4.14 Internet should ensure diversity, pluralism and a right to choose.

This is the second most popular of the value statements and is clearly an important value.

Those that considered this value strongest also consider that TA3, Personal Data Spaces, is very important and TA 4, Distributed Architectures and decentralised data governance is next biggest.

It is also noteworthy that the value appeals to a younger demographic. The dominant sector for the respondents is in the research area.

4.15 Internet should ensure citizens' sovereignty over their own data and protect privacy.

This value statement is deemed the most important of the survey according to participants.

Those rating the importance of this value highest also selected Personal Data Spaces as a very important TA. Therefore an NGI with a focus on personal data spaces may help in addressing the issues of sovereignty over data.

Analysis by age, sector, country, experience or involvement with Horizon 2020 demonstrates this is a consistent view and would be an attractive vision to pursue to attract new participants.

4.16 Internet should be more inclusive, participatory and transparent.

There was a strong bias toward the research professions for the value statement. But industry (others), public employees and (to an extent) civil society have a relatively positive response to this value statement.

4.17 Internet should be a level playing field for new entrants and new economic models.

Researchers again dominate those with the highest scores for importance on this value statement. The response by country indicates that this value was thinly supported across the geographies with only Greece appearing to support it more strongly than others.

The value does resonate more with the youngest age group than any of the others.

4.18 Internet should be more resilient, secure and safe, especially for children, elderly and people with low digital skills.

This value statement attracted a lot of interest relative to most others, particularly within the oldest age group. The subject matter is highly relevant to this group and its attraction to those that have not taken part in the H2020 programme and its appeal to the specific countries (Belgium, Bulgaria and Greece) may be a useful insight.

4.19 Internet should be a real agent of change towards sustainability.

This value statement was not broadly seen as very important by the respondents, but for participants living in Greece, Ireland and Sweden it clearly has some resonance.

There is an appeal to the older groups in the consultation.

4.110 Other Values

Visions of a trusted, inclusive internet, seen as a basic human right and mindful of the protection and safety of its users and their data prevailed. But there were also those with a vision for greater freedoms to innovate on the internet and a recognition of the tensions between these two visions.

"The European policy must ensure sovereignty of citizens, enterprises, on their data and digital services to enforce the benefit of all stakeholders in the switching towards the digital society."

vs

"Internet should be out of the hands of governments and their agencies."

When considering alternative values greater auditing and controlling tools for the internet were desired by a minority as were educational opportunities, fairness and transparency and the notion that the internet should not be mandatory.

Objections to the proposed value statements include that they are too service orientated and did not consider the network requirements and that too many concepts were wrapped up in a single value statement.

4.2 Technology Areas

4.21 Overview

The greatest enthusiasm for the Technology Areas (TAs) proposed was from those engaged in research. However as the top TAs (TA3, Personal Data Spaces, and TA7, Artificial Intelligence) remained the most important areas even after researchers were removed from the data, it is clear the importance is universally recognised.

For Personal data spaces, Distributed architectures and decentralised data governance and Discovery and identification tools, but also many of the other areas (including areas proposed by participants), a focus on data security and recognition of the need to provide the right infrastructure were persistent themes emergent from the consultation. For Artificial Intelligence the focus is on technology challenges, human-machine relations and more ethical aspects.

4.22 Discovery and identification tools

Balance is needed between security over data and creation of desirable services that improve lives. Respondents that consider this a very important area believe;

- Assurance is needed by a fearful public over the use of their personal data and security of the services and devices they use. This should be provided by adoption of security standards in manufactured IoT products and their services that are assured beyond the vendor's initial period of (commercial) interest.
- A balance between simple accessibility of services and security is needed that allows IoT to best serve humans. A challenge is to make devices at lower cost and exploit the available spectra whilst still enabling the interrogation of those devices (for security reasons) and making them a sensible part of linking a user's profile with the events they are interested in.
- Non-proprietary, extensible, future-proof, trustworthy standards are needed for the IoT to support end to end connectivity between the Internet and the edge networks connecting these devices. Semantic repositories are needed in a more context aware internet composed of more highly complex resources.

Beyond the importance this group held to the values of data sovereignty and diversity there was a strong bias toward the value of avoiding the concentration of data within a few proprietary platforms.

This technology area attracts experienced academic/ research respondent in the older age bracket. The area is already extensively covered by a great many initiatives.

In dealing with Discovery and identification tools we're dealing with the trade-off between security over data and creation of desirable services that improve lives. The challenge is to assure security over personal data whilst developing performant devices and services that interoperate to provide quality in discovery independent of the proprietary platforms.

4.23 New forms of interactions and immersive environments

Those rating this TA very important share concerns for the issues of *data privacy, diversity and the concentration of data into proprietary platforms*.

- The critical challenges fall mainly into the areas of:
    - Human-Machine Interface; Striving for intuitive interfaces by embracing various human motor and sensory inputs to really offer an immersive experience.
    - Social and Human Science; Understanding the Psychological & biological effects and the threats and opportunities for industry and citizens of the constant VR world.
    - Exploiting for Research and Commerce; Supporting industry 4.0, embracing immersive distant collaboration and creating market driven products and services.
    - Performance; Miniaturization of devices. An NGI that deals with the packets reliably and with minimal latency. Developing the tools for work-flow and process improvements including the advancement of battery technology.

New immersive environments will interact with all human senses and abilities to input and make requests. This needs a human science approach to understanding the impacts on society in balance with the many opportunities it presents to the European research and industry base. Key investments are also needed in technology that will improve performance and make this technology area ever more pervasive.

4.24 Personal data spaces

This was the most important of the technology areas to address according to the consultation results.

There is a trade-off between the benefits of Innovation possible with IoT and Big Data and the need to prevent abuse of personal data.

- The main challenges are in;
    - Keeping data secure; educating and enabling citizens to keep personal data secure both from criminals and big business. Providing the assurances, transparency and freedoms for citizens to control the data that's held on them whilst not overly limiting access to innovative services.

- Infrastructures; creating and supporting infrastructures both to enable benefits and minimise exploitation of personal data. Enabling privacy aware access control and enforcing accountability for responsible use of personal data.

The values this group related most to were those of *sovereignty over data and diversity, pluralism and the right to choose.*

> In dealing with Personal data we're dealing with the trade-off between the benefits of innovation reliant upon IoT and Big Data and the need to prevent abuse of personal data. The challenge is to keep personal data secure and assure citizens of their control over it whilst implementing infrastructure that enables privacy controls and assigns accountability for its responsible use.

Those that consider this technology area to be very important appear to be well qualified and represent all age groups in the study, though there is a bias in this group toward research and academia.

4.25 Distributed architectures and decentralised data governance

This is the third most important TA. The proposed challenges fell naturally into 7 categories with 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.

The main challenges identified were;

- Virtual currency and digital ledgers; Communicating the business benefits of these technologies to existing businesses in a compelling way, collaborating on new decentralised algorithms to trigger a potential financial revolution.
- Data Management; Allowing greater awareness and control for citizens over their own data and its use by others.
- Infrastructure; A diverse future-proof infrastructure that enables ever greater autonomy.
- Governance and Policy; Technology needs to support effective governance that balances rights and supports legislation. The aim is to keep personal data from distributed sources under the control of the individual.

The fairly even balance between these categories suggests a multi-disciplinary approach, the requirement for which was nicely captured by one participant;

> "...social organizations can unleash unexpectedly extraordinary results. Learning how to grow such networks, and make them reach their objective will require ... an interdisciplinary perspective where hard sciences, including mathematics, and social sciences must collaborate."

The highest values for this TA are in *sovereignty over data and data not resident in proprietary platforms*.

4.26 Software defined technologies

Challenges in this TA fell into 3 main categories described at a fairly high level with some specifics.

- Robustness and Performance; The NGI can be made robust if the agility possible with the Software defined technologies is embraced and the right methodologies are employed for SME's to take a role in this.
- Strategy & Approach; Co-developments may fulfil requirements for virtualisation and self-adapting algorithms. Methodologies are proposed and the protection of the created knowledge will be important.
- Standardisation; Software specification is essential as more functionality becomes embedded in soft rather than hardware. Standards need to be future-proofed to accommodate unknown future functionalities that will be required.

An approach to Software defined technologies is needed that optimises their ability to improve robustness and performance in the NGI. This will involve a focus on standardisation and a strong methodological ideology that guides call participants toward significant results.

The values rated highest for this TA are in *sovereignty of data and diversity and pluralism*. The Software defined technologies are seen as very important by a segment of proposers at a slightly more mature end of the age spectrum studied.

4.27 Networking solutions beyond IP

The group that consider this technology area very important are not as well qualified in the area as in other technology areas studied. The values they rate highest are in sovereignty of data and pluralism and diversity. The consequence is the emphasis on security aspects alongside the palpable need for an improvement over the current IP.

Improvement or replacement of the current IP technologies is needed to deal with foreseeable changes in the way the internet will be used. Developments should be independent of those with commercial interest, and need to cover areas of security & privacy, infrastructure and network management. As much "thinking" as well "doing" is needed in this TA.

The main challenges identified were;

- Updating/ replacing IP; 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.
- Performance and Quality; A strong demand for high throughput, low latency and secure communications is foreseeable, placing significant challenges upon the NGI infrastructure and architecture. A new high-speed TCP protocol and tools are important areas in need of development.
- Security & Privacy; New networking approaches may demand that security is built within the protocol. Maximising security and resilience while assuring good interoperability are key technical challenges.

Few current initiatives are identified and the lower level of expertise of participants in this area of the consultation could mean that this area has not been adequately supported by collaborative initiatives in the past. Or perhaps it is just a highly specialised area involving a distinct community.

> "A lot of research has been done already, for example in relation to the Recursive Internet Architecture (RINA). The challenges now are how to get this technology deployed in the face of vast inertia and vested interests. Innovation is required in the formulation of regulation and purchasing policies so that these new solutions are not excluded."

4.28 Artificial Intelligence

This is the second most important TA, despite only a few respondents actually working in this area, many more believed they had a good understanding of the area. For those that saw this area as very important their visions are strongly in line with retaining data sovereignty, diversity and pluralism and not allowing the data to become concentrated in proprietary platforms.

The critical challenges are technical, concern human/ machine relations and issues over privacy and ethics.

- Technology challenges; This technology area is necessarily interdisciplinary and needs a top-down vision to shape the needed activities as well as application to strong use cases (for example, autonomous vehicles).
- Human/ Machine relation; The impact of greater autonomy and responsibility by systems rather than people requires efforts into communication, ethical and the inclusion of human factors within these decision "making" mechanisms.
- Privacy and Ethics; Ethics regarding algorithms is an essential area and deserves a long term project commitment to implement well documented theory into practice if a proper and actionable ethical framework for AI is to be created.

> The technical challenges in AI are easily identifiable from an engineering standpoint, but it is the interdisciplinary approach that will assure a workable ethical framework.

4.29 Other important technology areas

Additional technology areas proposed highlight a focus on security in general and then more specific themed technologies around applying autonomous systems to Smart cities and Smart citizens. The desire is for trusted systems to be developed and language technologies are strongly seen as an important investment to achieve this.

Beyond this, simulation and large experimentation, as well as more hardware orientated projects such as robotics, are proposed as alternative TAs.

4.30 Types of research, who should do it and initiatives to follow

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.

Foresight should direct research and guide the exploitation of evolutionary results into today's technology. Transdisciplinary approaches are needed. Importantly research needs guidance by the social sciences, user needs and awareness of the "known holes" in the current internet.

The "citizen" 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.

Relevant initiatives exist within established institutions and are often funded through national and EC programmes. The most popular in the consultation involve Smart initiatives, 5G, IoT and language technologies. Initiatives that address Policy and Societal issues should embrace peer networks, digital learning, e-democracy, e-procurement and e-learning. Finally, the identified on-going work on Public Sector Information, Big Data and Networking may provide good starting points for prototypes.

"The internet should be a place for citizens to create and contribute to global society, not merely consume and 'like' content. Citizens should have agency, not 'be the product."

ANNEX 1

Initiatives listed for each technology area

Technology Area	Initiatives
TA 1 Discovery and identification tools	Fi-NEXT, FET, Open disruptive Innovation SME Instrument, LSPs, EIP-AGRI Operational Groups, Smart Specialisation Strategies 1) Internet of Things Twente and 2) LoRa network agile-ion.eu, Jolocom.com, ethereal.org AIOTI FIWARE Foundation Nouvelle France Industrielle / IoT domain Alcatel, Internetoffensive Österreich, Bosch ARVIDA project (VR immersive interaction) www.arvida.de autonomous vehicles, advanced manufacturing, smart grid/home Blue Horizon (https://bluehorizon.network) CHIST-ERA call 2015 "User-Centric Security, Privacy and Trust in the Internet of Things" Cité Internet des Objets in Angers, France. New Industrial France initiative. EIT Digital Urban living and Networks Action Lines... CLARIN Climate KIC, COMMIT (NL) Computational Socio-Geonomics/Metaloger, The Peoples' Toolkit Connecting Europe Facility, Conversational Interaction Technology Innovation Alliance, Cracking the Language Barrier Data Protection Regulations: Regulation (EU) 2016/679 and Directive (EU) 2016/680 of the European Parliament and of the Council of 27 April 2016 Data protection, Consumers rights DIMECC, Industrie 4.0, HVM Catapult Dowse EC CAP projects; RI projects; eIDAS, which introduces unrealistic and technology-specific expectations EU Antitrust Agency, EU Digital Agenda EU IoT6 and mDNS (bonjour / avahi) EU CASAGRAS2 with the RFID capabilities for identification. UK national project from Peter Kirstein, Handle System to use OIDs for identification of any thing. European Smart Cities, Hour of Code euroVR, EFFRA Exploring Blockchain for the IoT Factories of the Future Fed4FIRE, Evergrow(DIMES) FIT IoT-LAB in france FiWARE Floridi research group on "new digital ethics". Free flow of data initiative; European copyright law; national health and safety laws (will need revision)

	Funkaboda standard for webb development in Sweden Future Internet PPP, 5G PPP, Big Data PPP FuturICT 2.0, nervousnet, IOT-A GDPR, EPCIP Gemalto, Chaos Computer Club e. V. Germany, IoT-EPI, IMS2020 guifi.net H2020 hackair H2020 NEXTLEAP / ERC CIRCUS / ERC SECOMP H2020 POINT; NetWorld2020 i4MS, euRobotics, EFFRA IERC - European Research Cluster on the Internet of Things FIWARE AIoTI IETF, IEEE Industrie 4.0, 4th Industrial Revolution DMDII Industry 4.0 IoT Large Scale Pilots; IoT-EPI is a European Initiative for IoT platform development IoT Learning and Education Initiatives IoT Sweden IoT Technologies applications & services based on IoT Jasper CCPlatform IOT-EPI, AIOTI for the connection of devices and objects, 5G for seamless connectivity, NESSI Makers Faire Mevaluate, Iot Italy. monitor babies | Help elder people to stay longer at home | Home driven by IoT (energy consumption etc.) nervousnet, FuturICT 2.0, IOTA New Skills Agenda for Europe, Digital Skills and Jobs Coalition OneM2M, UK government investment Plattform Industrie 4.0 (D) SAIL, NetInf, iCore secure data places, TNO Studies on Terminology and Ontologies; e-Lexicography; Ontology based lexical and terminological resources STW Robust Cyber-Physical Systems Tech City Launchpad 2: London and Cambridge Internet of Things The Alliance for Internet of Things Innovation; IoT Research Cluster (IERC); The Collaborative Research Centre (CRC) MAKI The former German-Lab project (http://www.german-lab.de/) The ToMaTo testbed on demand (ToMaTo on CloudLab http://groups.geni.net/geni/wiki/GEC23Agenda/EveningDemoSession#ToMaToonCloudLab) The New IoT Wi-Fi Standard: HaLow, The Things Network Thingful.com, Biotope H2020 project, Thing2Data national finnish initiative UK Safer Internet Centre World summit on the information society, W3 Consortium, consumer technologies association xLiMe

TA 2 New forms of interactions and immersive environments	- Plattform Industrie 4.0 , Germany - Allianz Industrie 4.0, Baden-Württemberg/Germany - Industry 4.0, Politechnico Milano, Italy - The Better Alliance for Kids under DG CNECT should look more closely at these new technologies and foster a communication and discussion between civil society organisations and the ICT companies involved in VR to help monitor and address any problems early. 3Dinternet initiative in Spain: http://www.internet3d.es/ 4 TU initiative (NL) 5G-Now, IRATI, PRISTINE Future Internet PPP, 5G PPP, Big Data PPP, SPARC EU Robotics, NEM etc apple, Huawei, samsung etc BBI Blue brain CAPs -CEF Telecoms Work Programme 2016 and 2014 Chaos Computer Club e. V. CLARIN Connecting Europe Facility, Conversational Interaction Technology Innovation Alliance, Cracking the Language Barrier Cooperation cPPP Creation-oriented initiatives like "Creative Europe" should be reinforced with more interdisciplinar collaboration (IT, Communication and Art departments could participate in the development of new narrative prototypes). Data Protection Regulations: Regulation (EU) 2016/679 and Directive (EU) 2016/680 of the European Parliament and of the Council of 27 April 2016 DEMOLA DIVILAB, NEM Do not know of any. EPSRC Internet of Things Research Hub, Immersive education (immersiveeducation.org/vr) Europe needs a basic infrastructure for natural language processing (NLP). All language processing applications (search, mining, writing, speech, translation, etc) depend on such NLP infrastructures. EuroVR Association Even our unit has multiple projects in the field, not going to start naming things. Fachgruppe VR/AR der Gesellschaft für Informatik (D), Virtual Dimension Center VDC (D) FET, Game Company Startups in England, France, Germany, fitness | clothes FIWARE FuturICT 2.0, IOT-A General Data Protection Regulation Germany, Italy, France H2020 ACT5G H2020 and societal challenges H2020 KRISTINA (http://kristina-project.eu/) Human brain project

	I ignore EU initiatives in the areas I am familiar, Scientist have to Cooperate with dreamers/visionaries to answer the Technological challenges before conceiving the intended objectives whether for facing autonomous navigation of blind persons or for facing cancer diseases using IoT Technologies. I will share details of my growing consortium with prospective further partners ICT for healthy and active ageing , horizon 2020 AAL ICT @ AN EARLY AGE , TRAINING OF CARE GIVERS OR EARLY CHILDHOOD EDUCATION TEACHERS ON COMPUTER SKILLS WHICH WILL IMPROVE THEIR TEACHING IERC, ETP EPoSS, Germany In Spain there is an initiative to foster research in the language technology area. Innovate UK: Cross-platform production in digital media. IP TV Proximus Belgium, IP Studio VRT Belgium Maker Faire Rome. many interaction // Dialogue projects from H2020 N/A n/a NEM European Technology Platform nervousnet; projects around MOODs at TU Delft, ETH Zurich and University of Bologna No EU initiative on such matters yet to my knowledge. (See earlier question for security and privacy related projects) None Observatory for Responsible Research and Innovation in ICT (UK EPSRC funded) http://www.responsible-innovation.org.uk/ ; UnBias Emancipating Users Against Algorithmic Biases for a Trusted Digital Economy (UK EPSRC funded) http://unbias.wp.horizon.ac.uk/ ; IEEE The Global Initiative for Ethical Considerations in the Design of Autonomous Systems https://standards.ieee.org/develop/indconn/ec/autonomous_systems.html p2p foundation, dyne.org, chaos computer club/re:publica. Privacy & Security Recursive INternet Architecture (RINA) research, such as PRISTINE, ARCFIRE, OCARINA projects etc. RoboLaw Project; Startup Europe Initiative; Accelerator Assembly; some of BONFIRE's experiments in crowd interfaces and information sharing e-Lexicography; Ontology based lexical and terminological resources The development of the Visual Processing Unit (VPU) by Movidius now acquired by Intel. The EC has issued policies regarding the Smart Grid, and has carried out a few demonstration projects in the protection of critical infrastructures. However, contrary to the leading roles European initiatives have had in wireless communications, architectural aspects and their consequences have been left too much to manufacturers. No concrete efforts have been made to create certifying bodies and trust. The EuroVR Association (http://www.eurovr-association.org) - Salento AVR 2017 (http://www.salentoavr.it) This is a research area that is mainly driven by Industrial Research Labs in the US and Europe. Yet EU H2020 calls on IoT focus more on the devices interoperability (the “Web of Things”) and less on the

	advanced analytics of the streams of data “things” produce or consume that could stipulate human-cognizant interactions. Preliminary projects that deal with Fog/Edge computing challenges (see ICT-06-2016 call). Tilt brush (https://www.tiltbrush.com) is an amazing project by Google that shows how painting can change in the future thanks to Augmented Reality and the immersive experience. Various project of the Cyber Research Center at Tel Aviv University; Tevhnology and Society Foresight activities in Israel, Europe, US... Vision for Healthy Aging (EC/CNECT); Industry Alliance on the Internet of Things VISIONAIR (FP7), VR/AR development taking place in Startup ecosystems (industrial research not so state-of-art).
TA 3 Personal data spaces	The EU Copyright reform. Databox project AIOTI, CAPS Big Brother awards Big Data in Healthcare Symposium (Munsbach, Luxembourg) Big Data PPP Chaos Computer Club e. V. CHIST-ERA call 2015 "User-Centric Security, Privacy and Trust in the Internet of Things" Ciberexperto (www.ciberexperto.org) Cloudera, NetWorld2020 Codice di regolamentazione della privacy. The Alliance for Internet of Things Innovation (AIOTI) Future Internet PPP, and 5G PPP, Cyber security initiative Cybersecurity PPP, EU Data Protection Regulations Big Data PPP, COALA.global "identity & governance working group" eID EOS, NESSI ePrivacy directive EU Antitrust Agency, EU Digital Agenda EU FP7 project "PRACTIS" EUBrazilCloudForum Eurojust European digital agenda FLAMINGO; the GDPR FP7 DAIDALOS FraunhoferFOKUS/Jolocom "Identity on the Blockchain", FuturICT Knowledge Accelerator and Crisis-Relief System, Europe GDPR GDPR GNUnet, I2P, ARPA2 H2020 FIRE H2020 FIRE ARMOUR

	FP7 epSOS H2020 NETXTLEAP / ERC CIRCUS HAT https://ind.ie/ethical-design https://tacticaltech.org/projects/security-box IERC - European Research Cluster on the Internet of Things Innovate UK Quantified Self Contest CAPS projects My data initiative NEM European Technology platform nervousnet, z-cash netCommons, confine, abc4trust EIT Digital Digitial Infrastructure and Accelerator New Skills Agenda for Europe Bretagne France S3 Regional Cyber Strategy, OpenPDS, Passenger Name Record (PNR) Plan Excellence Cyber France, Free flow of data initiative; Regulation of data portability including personal data portability; saferinternet, Norton secure data places, TNO digi.me silver economy ,horizon 2020 AAL SoBigData Spain, France, Italy SwellRT platform The Qiy Foundation (www.qiyfoundation.org). The worrying implications of the UK's Investigatory Powers Bill. USEMP project (http://www.usemp-project.eu/), US/EU Privacy Shield Agreement; TYPES project (http://www.types-project.eu/), ReCred (http://www.recred.eu/)
TA 4 Distributed architectures and decentralised data governance	- EU mortgage/credit directive: clarification on the data necessary to carry out creditworthiness. - Big Data in financial services (can banks use/sell the data about their clients: payment patterns...) maidsafe; decode (H2020) * Our work @ Ind.ie: https://ind.ie * The Nature of the Self in the Digital Age This is the original English version of an op-ed I wrote for Zeit Online. (https://ar.al/notes/the-nature-of-the-self-in-the-digital-age) * Recent talks: Øredev: https://vimeo.com/190855745 Doku:Tech: http://observer.com/2016/10/aral-balkan-dokutech/ (embedded in article) * Recent interview: http://www.bosslevelpodcast.com/aral-balkan-and-ethical-design/

	* Ethical design manifesto: https://ind.ie./ethic AIOTI Betfunding blockchain-based crowdfunding, Backfeed blockchain-based reputation system, Ethereum blockchain-based platform Big Data Management Purpose of use of Big Data Data mining of Big Data Big Data PPP, The Alliance for Internet of Things Innovation (AIOTI) and European Cloud Partnership BlockchainX.ch, ethereum, nervousnet Blue Horizon (https://bluehorizon.network) CAPs Chaos Computer Club e. V. CHIST-ERA call 2015 "User-Centric Security, Privacy and Trust in the Internet of Things" CLARIN Cloud computing initiatives Data Market Austria: https://datamarket.at/ Data security D-cent, P2pvalue, UIA 2016-17 Co-City Turin, WeGovNow DECODE EGI, HPC Europa, EUROGRID, NESUS Energy Web Foundation (private/Global) EPSRC funded Databox project (http://www.databoxproject.uk/) EU Antitrust Agency, EU Digital Agenda EU ICT Research projects (FP7, H2020) EU project decode European Digital Currency & Blockchain Technology Forum; idea of Central Register for Bitcoin users; Free Flow of Data; Fed4FIRE FI-ware FraunhoferFOKUS/Jolocom "Identity on the Blockchain" Free computers in libraries - keep the numbers increasing to improve access FuturICT 2.0 GNU Taler: blockchain-less, taxable digital currency. GnuNet: decentralized alternative network for many applications GNUnet, I2P iCore IERC - European Research Cluster on the Internet of Things FIspace GS1 - EPC IS Imperial College Centre for Cryptocurrency Research Innovate UK Competition: Protecting Data in Industry; Peer to Peer Foundation https://p2pfoundation.net/; Distributed Ledger Services for i) Online Contract Settlement (EIT Digital); ii) Land Registry (UK and Sweden); Fintech (back office settlement), iii) Development Aid Programmes LaBChain - Consortium initiated by Caisse Des Depots with 30 partners : banks, insurance companies, startups Luxembourg initiative Luxembourg Stock Exchange blockchain

	Maher Faire Roma. MAZI H2020 project, http://mazizone.eu, netCommons H2020 project, http://netcommons.eu NESSI netcommons, confine, p2pvalue PRACE Privacy, Security & Open source Sovrin, Ethereum The Directive on security of network and information systems (NIS Directive) - Directive (EU) 2016/1148 of the European Parliament and of the Council of 6 July 2016 The project Ethereum was bootstrapped via an ether pre-sale during August 2014 by fans all around the world. https://www.ethereum.org/ UK research council initiative on Distributed Ledger Technologies Virtual Assembly (France) Jolokom (Germany) virtual currency legislation
TA 5 Software defined technologies	- VITAL (VIrtualized hybrid satellite-TerrestriAl systems for resilient and fLexible future networks) (www.ict-vital.eu) - ENDEAVOUR: Towards a flexible software-defined network ecosystem(www.h2020-endeavour.eu) - SONATA NFV: Agile Service Development and Orchestration in 5G Virtualized Networks (http://www.sonata-nfv.eu) • The European H2020 project INPUT (In-Network Programmability for next-generation personal cloud service support) defines a virtual image to be a software instance in the network. • 5G PPP projects: • The European H2020 project 5G Exchange addresses cross-domain orchestration and control of SDN/NFV services to allow interoperability across different administrative domains, enabling a future eco-system involving Telco and IT providers. • H2020 project proposal FiveGO (5G Operating Platform). 5G PPP, Networld2020 Big Data PPP, and Future Internet PPP Chaos Computer Club e. V. Development,innovation,future EDA project CORASMA EDA project MAENA (2017) EU ICT Research projects (FP7, H2020) Factories of the Future FI-PPP, FIWARE FI-Next Free flow of data; Data protection regulation; Telecom rules; French ANR Reflexion Project; French ANR LISP-Lab Project; FuturICT 2.0 H2020 5GPPP, FP7 NetIDE, some WGs in the IETF H2020 INPUT

	H2020 FIRE SoftFIRE FP7 Ekonet IEEE SDN Initiative, EU SoftFIRE Industry 4.0 is the most known Introduction of NFV in 5G Lean startup initiative Maker Faire Roma NESSI, SELFNET, FIRE, FIWARE NetWorld2020 NovaGenesis ONF, NFV@ETSI, ... Open Source Strategy of EC, French-German joint declaration on "Innovation and new technology", EU countries' Open Source-related policy initiatives listed in Open Source Observatory Annual Report OpenCompute (http://www.opencompute.org) Ouishare.net (governance and concepts), Jolocom, Ethereum Polarsys.org (including Capella by Thales Group) and initatives related to Embedded Linux and Open Tracing technologies Recursive INternet Architecture (RINA) research, (such as PRISTINE, ARCFIRE, OCARINA projects etc.); InnovateUK-supported PEnDAR project, looking at verification and validation of the performance of distributed systems. SARNET Snabb, OOCRAN Studies on Terminology and Ontologies; e-Lexicography; Ontology based lexical and terminological resources OpenFlow for software routing, but it is time for new work on making cloud and container-based workflows portable with their data. Trilogy 2, Superfluidity Autonomous cars are the next endeavor to benefit from IoT; Funding is being guaranteed by National sources through structural fund and H2020 open calls;
TA6 Networking solutions beyond IP	- FP7 project XIFI - FP7 project FI content 2 - H2020 project FI core - H2020 project C3 - H2020 project FI NEXT EU Directives and national implémentations (1) Flexilink: research collaboration between Birmingham City University and Nine Tiles to develop better-than-IP routing technology including prototype implementation, see http://www.ninetiles.com/docs/IBC13%20v1.1.pdf and http://www.ninetiles.com/Flexilink_details.html (2) ETSI ISG NGP 5G, NESSI Data Protection Regulations: Regulation (EU) 2016/679 and Directive (EU) 2016/680 of the European Parliament and of the Council of 27 April 2016 The Directive on security of network and information systems (NIS Directive) - Directive (EU) 2016/1148 of the European Parliament and of the Council of 6 July 2016 ESA, NASA deep space communication protocols ethereum, IOTA ETSI NGP 001: Next Generation Protocols FIRE, 5G-PPP French ANR LISP-Lab Project. Future Internet PPP, Cybersecurity PPP, 5G PPP

	Future internet, European cloud platform GEANT ICN2020, GreenICN InfraHIP (http://infrahip.hiit.fi), SCTP project. Unfortunately, the RINA work is impractical and not meant for production use. Internet society of Nigeria.,cyber control system IoT6 project IOT-A IRATI, PRISTINE, NovaGenesis NGP QUIC (https://datatracker.ietf.org/doc/draft-tsvwg-quic-protocol/) is an interesting project by Google that aims to push the adoption of a UDP-based protocol to replace TCP/IP communication for HTTP based services. The protocol has been proposed as a standard to the IETF. QUIC provides multiplexing and flow control equivalent to HTTP/2, security equivalent to TLS, and connection semantics, reliability, and congestion control equivalent to TCP. Recursive INternet Architecture (RINA) research, such as PRISTINE, ARCFIRE, OCARINA projects etc. RINA, PRISTINE, 5GINFIRE RITE, L4S, BEACON SeLF-ICN, H2020 POINT Social Linked Data (MIT), Ethereum, Jolocom The EC has always supported technology evolution, and large elements of standardization, but with not enough weight given to architectures and regulatory principles.
TA 7 Artificial Intelligence	- French Industrial Solution "Data Economics" Institute for Artificial Intelligence (http://ai.uni-bremen.de/) conducts leading-edge research in the intersection of robotics and AI. • Telenor in collaboration with the Norwegian University of Science and Technology (NTNU) and research institute SINTEF is establishing a lab focused on AI and big data at NTNU campus in the Trondheim. • Human Brain Project (https://www.humanbrainproject.eu/participate/horizon-2020) for its potential impacts on the AI innovation activities. A new initiative is required Accenture and IPsoft team up to launch AI initiative AIOTI, SPARC PPP and Big Data PPP Chaos Computer Club e. V. Currently many MEPs invite to round tables around AI/Algo tranparency. Politicians in the driving seat? - Where is real research?. H2020 Big Data PPPs completely miss this part. Data Protection Regulations: Regulation (EU) 2016/679 and Directive (EU) 2016/680 of the European Parliament and of the Council of 27 April 2016 The Directive on security of network and information systems (NIS Directive) - Directive (EU) 2016/1148 of the European Parliament and of the Council of 6 July 2016 deep mind Drones Self driving cars Robots ECAI EIT Digital; Innovate UK Competitions: Manufacturing and Materials; Robotics and Autonomous Systems Applications

	Europe has pretty much given up on addressing its multilinguality challenge. The current initiaves are limited to an internal statistical Machine Translated project MT@EC (CEF.AT) and attempts to achieve Interoperablity also on content level (ISA). Flagship on the brain and near-flagship on complex systems have generated much activity. But what are the results -- is it too early still? fp7 MULTISENSOR (http://www.multisensorproject.eu/), H2020 KRISTINA (http://kristina-project.eu/en/), fp7 SocialSensor (http://socialsensor.eu/) Fragmented and scattered FuturICT 2.0 Google Assistent, BMW, SONY H2020 topic 17: Cracking the language barrier http://kconnect.eu http://www.mlplatform.nl/researchgroups/ Human Brain Project. EurAI, the EU association for AI (formerly ECAI), NESSI Cambridge (Centre for the Study of Existential Risk), one in Oxford (Future of Humanity Institute). IEEE ethics discussions, FuturICT 2.0 Indect, AI Initiative, IOT-EPI, SPARC, European Robotics Initiative Institute for Artificial Intelligence; Machine Translation Service; Jolocom Maker Faire Rome. META-NET, Cracking the Language Barrier MT@EC / Industrie 4.0 / OpenCog (http://opencog.org) is an open-source software initiative aimed at creating beneficial artificial general intelligence with broad capabilities at the human level and ultimately beyond. OpenAI (https://openai.com/) OpenAI is a non-profit artificial intelligence research company that aims to build safe AI, and ensure that AI's benefits are as widely and evenly distributed as possible. The IEEE Global Initiative for Ethical Considerations in Artificial Intelligence and Autonomous Systems Smart Data Forum, Berlin Capital AI Studies on Terminology and Ontologies; e-Lexicography; Ontology based lexical and terminological resources Tieto Corporation nominated AI to their top management team UnBias Emancipating Users Against Algorithmic Biases for a Trusted Digital Economy (UK EPSRC funded) http://unbias.wp.horizon.ac.uk/ ; IEEE The Global Initiative for Ethical Considerations in the Design of Autonomous Systems https://standards.ieee.org/develop/indconn/ec/autonomous_systems.html xLiMe

ANNEX 2:

Challenges for each technology

Technology Area	Challenges
TA 1 Discovery and identification tools Privacy, Safety & Security Human/ Machine interaction IoT Deisgn Protocols & Legal Interoperation & Standardisation Data Management Search tools Performance Other	primarily, safety issues. Small devices are nowadays not resilient to external attacks. Reliable and simple indoor positioning systems Consindering an extra definition of machine data User authentication is viral to the safe and secure management of the internet. human machine interaction, augmented reality Cyber security, communication protocols Semantic Repository - Context Awareness and Machine Learning Security of devices, updates, data processing, energy consumption, end-of-life and waste disposal transparency, access to control, awareness IoTS to be expanded to IoTS P (people). In this world it is all inter-connected and inter-dependent. The 'people' component will need a new science of the symbiosis of cognitive people, intelligent devices and living models of society and human behaviour data security; open standards so that any tool from any supplier will work together The ability to opt in and out of 'unconscious connection' to the internet - giving users control and ownership. Pervasiveness is a large issue. Younger generations assume constant connection and are less phased (or purely unaware) of the Big Brother aspect, but complete reliance and a lack of choice is not necessarily beneficial for society. Privacy and security issues need to be sorted out. Artificial Intelligence, Speech Technologies, Natural Language Technologies, Big Data, Visualization Security of the Home devices participation, openness, democracy protocols, fusion, and goal oriented selection of device entities (sensors & actuator); adaption of in time configured sensor-actuator systems (or cyber physical systems) to adapt to changing environments and upcoming device and service infrastructure. Security of personal data. Security of "Things" Recommendation, Search and Discovery Apps and Services beyond Google an Co allowing anywhere anytime anybody to share and discover experiences IOT behaviors design (how to communicate to user) Haptics design Child- IOT- Interaction Privacy Application Areas

	User Experience evaluation and design Ethics The discovery and interconnection of IoT devices have a risk of moving into hands of few players due to the lack of global and inter-operable standards (in form of specifications or applicable open source software). The emergence of global, federated and inter-operable platforms is key for IoT success.
	Respecting privacy according to the degree desired by the individual
	Security - manufacturers may not have incentives to periodically upgrade the hardware of these one-off merchandise against new attacks. Should it fall into the job of the government or civil organization?
	storage patterns, iteroperability
	We need to figure out ways to link devices into meaningful semantic units and link them to events we are interested in. A problem is that most relevant events are rare making such linkage difficult.
	Security
	simple standardised web-interfaces that have to be supported without modification/variation (low energy draw)
	How can we enable people with the right digital skills and which skills will be needed in the mid- to long-term?
	The security and the privacy is always the biggest concern for children, the second opinion is that people on all levels don't have the ability to manage their own data once it's out there Privacy of information Anonymised personal data Practical useability of data Correct business rules when using gathered data Correct automated processes
	Discovery, security, compatibility
	How central human (ethical) values are threatened by IoT, not only privacy, also dignity, freedom, autonomy, social justice
	Resiliency, Security, collaborative algorithms, standards to manage (fleets of) IoT devices
	Distributed identity management using digital ledger technology.
	clear identification of connected devices, data sovereignty, social entrepreneurship
	Big data research and Big data analytics
	more user friendly on all platforms/ visual and audio
	Higher reliability and availability
	New structure to ensure security, privacy & new technology
	Modeling and simulation, Autonomous systems
	Prevent id falsification. Currently the internert is place for all kinds of questionable content and actitivies because it is so easy to become unaccountable for the actions taken (free right to act but no responsibility).
	Security of personal data. Security of "Things"

	Privacy & security, reliability. - Identification, naming, search of objects and related services - IoT Operating Systems (key and urgent if we dont want google to control with android/weave/brillo) - Sensors interaction Preserve privacy, possibility to create personal "body bubble" where I am not "visible". Operating systems that give me real choices to for example send or not WIFI beacons in a proactive fashion. Means to measure impact on privacy of a technology or a service so that I can take a decision knowingly as a user. Software to map my environment in terms of all these headless devices. Standardisation of protocols privacy (how to use IOT at home and disconnect these objects), energy consumption of these protocol & environmental impact & health Increasing interconnectivity by several orders of magnitude amplifies risks of global, cascading, problems. It also opens the possibility of - to use a financial metaphor - of bubbles as a result of extreme interactivity. Increased connectivity and interactivity raise the needs for cyber security. And increasing cyber security threaten many areas of privacy. Balancing all these requirements will be absolutely fundamental. Security and Privacy related issues should be the main priority. In particular security-by-design and privacy-by-design are key concepts currently unused for internet scale designs. Using existing EU projects such as ERC CRYSP / ERC CIRCUS / ERC SECOMP / H2020 NEXTLEAP as a reliable security and privacy basis would ensure a safe basis for a very innovative EU initiative that can quickly be leveraged in favour of the European economy. Blockchain technology is mandatory Integrations, synchronicity, ethics Standardisation, interoperability, device discovery, privacy Decentralised approaches to coordinate discovery and identification under control of end-users. Management of data ownership. data safety The constant change of the Internet must be considered. In particular, we should investigate all kinds of mechanisms in communication systems, the adaptation, interaction, constant optimization, and evolution thereof. Where the term mechanism describes both, communication protocols and parts thereof. Today mechanisms providing equivalent functionality under different conditions coexist, since an adaptation of legacy mechanisms to traffic conditions, bandwidth, etc. is limited. Particularly mobile usage induces highly

	fluctuating conditions, which would require the runtime adaptation of the communication system by means of transitions between functionally equivalent mechanisms. A future Internet architecture should enable automated transitions between functionally equivalent mechanisms in communication systems at runtime. It includes the coordination of multiple concurrent transitions, which influence each other. The interface between the devices, the web (some devices don't have their own electronics), and humans.
	security / privacy and connectivity (sensority: enlarging the connectivity of sensors ==> protocols for sharing information)
	data privacy, decentralised technologies like blockchain and linked data
	As suggested previously NGI should focus RTD effort in enhancing technologies as IoT Jasper CCPlatform, for Launching-Managing-Monetizing NON existent Services, replacing usage of Products, covering Humanitarian needs as blind persons navigation but also Business oriented applications as autonomous vessels' vehicles navigation which are still in infancy age, By combining www and IoT a NEW generation Cloud-based applications that I am not in condition to propose NOW, but should be generated by means of an interactive dialog of participants, allowed to propose whatever they imagine, without frontiers & specifications, to be further capitalized by dreamers not only scientists but artists & poets EU wide, encouraged by other attracted citizens, followers of this EC.NGI admirable EC initiative, to be also Managed & Handled by EC as break-through ICT initiative, capitalizing on human intelligence & professional dedication/belief to the targeted objective..
	FIWARE, IoT EPI, SME instrument
	Identification and Communication with connected IoT devices
	Ensuring adequate security of connected IoT devices, for example through minimum security standards, e.g. not shipping devices with default admin passwords.
	These digital devices and physical objects shall help and assist human but must be controlled, must not interfere human and normal social life, and, when and where required, must not invade our private sphere.
	Cybersecurity
	Interactive houses, medical devices, cybersecurity.
	Interoperability
	privacy, supercontrol, loose of freedom of decision, filter bubble, discrimination on the big data, inequity
	Security and health care.
	Smart cities and factories, manufacturing, automotive, security, education
	Privacy, data protection
	privilege life skills to co-design infrastructures platforms and devices include people's experience in designing
	Security

	devices must manifest themselves and identify
	Define a unique ID for each sensor
	Keeping the decentralised architecture of the internet intact, which is difficult because there is a battle going on to inject the need for centralised 'platforms'.
	Interfaces that allow people to manage trust relations between devices and services. This interface should be as easy as switching tv channels. AI in support of the individual to live and behave responsibly in society; Self-organisation as a means to make society as a whole less vulnerable; innovation through multi-disciplinarity, i.p technology and social sciences
	limitting the range of an IOT packet so that it can only travel the appropriate path's
	Alternative social media, decentralized networks, new forms of discussion (not just responses), work group software to get things done in small groups.
	man-machine interfaces, trustworthiness, dependability
	health and on- and in-body sensing and actuation modalities.
	Collecting data and managing big data assets; Protection of data collected by devices; Influence of Internet of Things on people's social behavior and economic decisions; Possible exclusion of lower income groups which will be deeper; Difficulties for digitally excluded on labour markets; New challenges in the area of cybersecurity; Transparancy on the obejctives and data being colected; keep some of the interface visible.
	Security, updates, open standards
	Tools that allow users to automatically discover services based on their profile. Low cost and low price of IoT devices and accommodation of their functionality in the current available spectra, as well as, security of operation will be a major issue.
	Big data Vs Smart IoT, Tecnology and sustaibility, security and Privacy, Small Smart Cities, Smart home and Smart Living.
	IPv6 - critical to the developement of the IoT - please read this: https://www.academia.edu/5569126/Philosophical_Rant_on_IPv6_Objects_gaining_identity_
	Privacy, Transparency of Algorithms VS. A.I., Machine learning Privacy and equal access to the systems
	Medical and sales, as assistive technologies
	Legal issues regarding who owns the data and who may use it.
	security, privacy, data sharing, interoperability
	Standardization and development
	Transparent data lakes, integration with AR & VR tools
	It is important and it should be more a "proximity" and context-aware Internet to filter content by location. The emerging Physical Web is a good example about this opportunity.
	Behaviour, sociology, maker movement, robotics, industry 4.0
	Responsible research approaches and viewing humans as actors not data providers or factors. IoT technologies need to protect peoples privacy, while creating value and increase quality of life.

	Security and privacy. Child Protection and safety online
	Data Sharing, Interoperability, Discover the human side of the Internet of Things
	Cybersecurity security, trust, privacy, identity, attestation of devices, end-to-end solutions
	-technical enhancement of manufactured products such as connected cars, where IoT connectivity could enhance the operation and value of the vehicle; -automation of industrial processes, including remote monitoring and control; -collecting data about the behaviour of individuals through their interaction with smart environments and objects. For example, using wearable technology (smart watches, fitness monitors) to collect consumer data. This big data has potential to generate commercial value through targeted marketing and services; -data connectivity across transport networks, energy networks, health and care systems and smart cities to improve operational efficiency (eg, more trains using the same tracks) and service experiences, and introduce new services (eg, timetable information). challenges: 1) defining different clusters, level and kinds of relationship aspects of various IOT and associated application servers. 2) new security encryptions for constrained devices, 3) a flexible network layer for efficient communication
	Security, Privacy, Market enablement, Blockchain (authorization), Non-Repdiation, Microtransactions
	natural language understanding
	Discovery of services and devices in the internet of things if very important given the freedom that exists for everybody to publish such services. Therefore there is a need for developing tools and technologies that will facilitate the discovery of new services and devices, as well as understand the way to interact with them. Current challenges in the web are still focusing to the discovery of relevant web content and services, whether in the internet of things will further expand to the discovery of new devices, interactive objects and more importantly to identify the way to interact with them.
	The Internet may come in different forms, in order to operate in an optimized way in different environments. For example, a Hard Real-Time network versus a Content Delivery Network might attract completely orthogonal architectures that operate in distinctive ways, but are somehow connected. In this way, Discovery and Identification tools need to operate independently of the underlying technology, being at the information access level or at the Internet(s) level.
	Biomedical , telemetry, avionics, telecommunications

	Sustainable Production of cheaper Chips; 5G roll-out; Low-cost installation methods for glass fiber; Seamless mobility of IoT devices. Ubiquitous connectivity of all devices over different access technologies.
	- End to end connectivity between the Internet and the edge networks connecting the devices - Fog computing and context-aware networking - Identification of objects and devices and chain of responsibility to an individual or organisation - Extensible, future-proof middleware, APIs and standard protocols to integrate objects (hardware and software) in added-value services and applications - Truly systems-of-systems designed for interacting to form totally new and unpredictable services - Massive scaling, especially in scenarios where reliability and real-time data processing are required - Heterogeneity of data and devices - Issues related to sensor mobility. WSN were designed for fixed sensors. The sensor mobility is changing this scenario. - Optimal Storage and data representation Language technologies will be critical for these challenges. It will be necessary to work on linguistic (not statistical) methodologies and techniques to analyze languages. It is necessary to work on lexical semantics and terminology, to create ingenious dictionaries useful for human and machine users. Extensible, future-proof, trustworthy standards, APIs and protocols that support the complete life-cycles of potentially highly complex resources - hardware and software. Should comprehend resource identification, registration/advertisement, discoverability, configuration, consuming of the resource, management, upgrading and disposing. Must handle hyper-scale, heterogeneous and dis-aggregated resources.
	First, the security of IoT devices, as well as, with regards to IoT security, the contradiction in obtaining sufficient security levels and device/device integration cost levels. Second, there is insufficient interoperability, which sees proprietary interfaces proliferate. Third, the certification and test of IoT devices and systems, which will often be the weakest nodes in services. Finally, it is important to explore how people are going to interact with IoT, what kind of feedback is provided, what kind of action is possible, what kind of explanation is available on the system's actions, all this being the basis for establishing trust in IoT. On top of this, applications are of course key in this process.
	Decentralized storage and processing of data; privacy-protecting digital identity management; cryptographic security; industry-agnostic plugin opportunities to decentralized IoT data transfer infrastructure; scalability
	scalability, interoperability
	Naming and name resolution.
	Privacy concerns regarding personal data collection by malicious agents/objects. Both participation and transparency are important. But how to make the participation experience seamless while also providing full/the best level of transparency, is a challenge.

	Dem Menschen wird vermehrt das Denken abgenommen und dabei wird er immer Gläserner. Eine Aufgabe wird es sein den Menschen trotz IoT M2M VR usw. anreize zu geben das Sie auch ausserhalb Ihrer Digitalen Blase denken (wollen) und Entscheidungen die von Maschinen getroffen werden nicht achtlos anzunehmen. Denn Die Steuerung der Maschinenwird in Zukunft duch unser Verhalten geschehen. in Anlehnung der Klassischen Behavioristen
	- There will be a necessity to integrate analog buttons to disable connectivity on these devices to guard against remote hacking with a "hard reset" feature to enable the restoration of factory default settings and firmware in case of a hack. - A balance will need to be struck between the various ways in which these devices connect to the Internet and between each other. Ideally, IoT should only be connected to the Internet when absolutely necessary. In most cases, IoT can simply operate via mesh networking using WiFi, Bluetooth or 5G to interact with other IoT in the same room, without the necessity to go through the Internet.
	on the short run: Reliable high performance communication infrastructures are a precondition for effective M2M communication and for providing SMEs and mid cap companies with equal starting conditions in the digital economy. Development of high speed broadband infrastructures is a precondition for effective M2M communication of connected devices. CyberSecurity must be improved: on government level: CSIRTs cooperation across Europe is crucial. Establish sufficient capabilities in the areas of prevention, detection and reaction to threats in order to strengthen cyber-resilience in Europe. On medium run: A reliable 5G network is essential for the deployment of connected cars. timely global standards Long term: Innovation in IoT shall be market-driven: PPPs such as EFFRA's "factories for the future" ensures that those projects receive funding that are well absorbed by customers. This is especially important in the IoT field where trends and demands are changing fast.
	ensuring free data flows and data protection, international trust and cooperation, standardization
	health related impact of new devices, waves or digital implant (increase of myopia)
	Proper implimentation of BCP 38 and other security meassures to try and avoid DDoS that can potentially break the internet. Standard and secure protocols for interaction.
	Native distributed discovery mechanisms for the transport layer of the internet were key elements for the

	scalability of the internet as such. But up until now the internet has not had similar distributed mechanisms allowing businesses and people to freely discover and interact with each other. This has led to a concentration of power with a few private discovery hubs, a.k.a. platforms, that typically charges 10-30% of the value traded between parties that are introduced to each other by the platform. Therefore, we now we need to establish native and distributed discovery mechanisms for the application layers of the internet, allowing companies and individuals to freely make themselves and their services discoverable in a controlled way. This will eliminate the need for common platforms and favour business models, where vendors and customers have each their service providers as we know it from banking and telephony. For consumers this may be "Personal Data Spaces" (see Tech Area 3). Keeping boxes secure and ensuring owners can keep them secure, even when the company that made them, don't care anymore (IMHO force a responsibility on those who produce devices to support them FOREVER - OR release as complete open source, so anyone can "fix themselves" if they're able. Security, connectivity & privacy of the IoT devices IoT will invade our daily life and there is a need to put barriers to avoid people to become unable to manage them. IoT will feed the future content and media with additional useful information (i.e . Meta Data) that could help service personalisation and accurate search. 1. Generalization of resource virtualization and network infrastructures (to limit the number of resources) 2. Increase in flow rate and ubiquity, taking into account the constraint of the limitation of spectral resources 3. The need to improve the energy efficiency of networks, equipment and uses 4. Design, management, control, security and data associated with connected objects IoT will invade our daily life and there is a need to put barriers to avoid people to become unable to manage them. IoT will feed the future content and media with additional useful information (i.e . Meta Data) that could help service personalisation and accurate search. Service discovery, safe networking, and security. friendly interfaces, apple effective respect of ethical rules, consumers'rigths protection, property of personal data, education and training and tools against unwanted messages coming when opening opening mails resulting from invasive business models of the digital economy There should be a good balance between easy accessibility to the devices and services around users and security issues. Fingerprint is defined as a set of information elements that identifies a device or application instance that can be used to single out, link or infer a user, user agent or device over time. This is a combination of information able to identify a specific device or application instance and through which it is possible to track (as occurs through

	cookies) the Internet behavior of users associated to a device. And the peculiarity is that the fingerprint is available not only to the website publisher. By using the internet, one can expect that each service will then be identified in dictionaries available somewhere in cloud infrastructures. One challenge can be related to the parsing of such large dictionaries. In somehow, we can envision a search engine with a specific DSL to look for particular devices. Interoperability aspects are also a challenging issue. speaker identification using biometric technologies (voice, finger print, face recognition, etc.) Security of data Everything as a service; data management; IoT for specific applications (e.g. precision agriculture, smart fisheries, etc) People underestimate the fear people have towards these products. They have the fear because they can't understand the jargon revolving the products or they don't know where their data is going, privacy issues etc. We need to find an effective way to market it to people of all ages and backgrounds. In the IoT context, many “smart things” shall be identified and discovered by applications. Web semantic, semantic search engines, not relational data base will be important technologies for this purpose. One of the desired achievement of the NGI initiative is to create a human-centric environment, so the awareness to be “interacting” with a device is an issue to be addressed. Data exchanging between devices can build a complex information on individuals’ habits representing a real “identification” of them. Therefore it is important to address the following issues: 1. Security of data models: the “security by design” concept can be sufficient for an industrial process where the data are kept under strict control in an automated way. For individuals the issue should be further investigated, since matters related to citizen’s rights are involved. 2. Identity issues, i.e. all the tools that can put under control the identity of a person in relation to the single datum. To address this area, scientific/technological activities should be aligned to societal needs at large. Examples of challenges that have emerged over the past few years are: from machine learning and Artificial Intelligence to collective intelligence; Mechanism design, feature ICT systems enabled to incorporate the values and ideals of spontaneously emerging social systems; Decentralized storage and processing of data; Privacy-protecting digital identity management; Enabling autonomous, self-organizing systems and concepts in the Internet of Thing; Finance 4.0: measuring externalities, pricing and trading them in a crowd-sourced way; Building circular economy and sharing economy Navigating the physical-digital world as one seamless space; using physical objects to influence the digital world

	and vice versa (e.g. for medical aid); data ownership (usage agreements); safety in order to avoid physical or digital damages data management (privacy, security, storage, processing, fusion,...) - security - pluriform supply - - data owndership - more general legal & governance issues - open, transparent standards Devices connected to the Internet of Things should not be allowed to transfer data to platform operators without the consent of the user of the device who generated the data. All the data generated by a device should be channelled through the personal node (see below under Technology area 3) of the user. The user will then decide whether, which of the data generated, under which terms and conditions, how often, for how long and in which form (aggregated; anonymously; under pseudonym) shall be transferred to the platform operator. Technology (including Internet of Things) should always serve people and not the other way around. Every human being should have a right to say "no" and to say "yes" to enter into interaction with technology. It means that technology must be always accessible and inclusive but also a human person must have a right to be excluded from interaction at any moment. IOT security and privacy, data protection It is necessary to oblige the use of IPV6 and guarantee security to prevent hacking Awareness of the connected devices that surround us and collect information on our behaviour privacy issue, opt-in/opt-out (right to choose), resilience of the citizen (at legal level, which tools are available to recover a safe and secure situation?) Small entrepreneurs and people in rural areas ability o interrogate headless devices and their backend systems to understand what they are actually doing, not just what they say they are doing discovery and exposure of stealth devices or undeclared back-end data gathering/sharing It is essential to devise and drive the adoption of non-proprietary (open) standards for IoT, and to ensure that these maintain privacy and security, and prevent the domination of supranational giants like Google.
TA 2 New forms of interactions and immersive environments Performance Policy Ethical responsibility Human Machine interface	- Designing for VR and AR so that they are intuitive and easy to use. - For the moment, VR has only been tested regarding its "positive" potential like developing empathy, learning, health (overcoming trauma for instance)... This is simply because testing "negative" effects is unethical. But as third party content is being developed for VR, research will have to monitor the impact on gamers/users and see if extra violent/shocking/gory/sexual content has negative lasting consequences on users. - The physical impact on eye strain also has to be studied closely since the eye, in VR, keeps a single focus point which is unnatural compared to the real world which requires constant adjustments. Other

Interpretive technologies Social & Human Science Policy & Legal Infrastructure Security & fall-backs Exploiting for Research and Commerce	symptoms like Game Transfer Phenomena where users' bodies manifest physical reactions in the real world transferred from a virtual environment. - intuitive content search - all applications of augmented reality to locate service, get additional information, learn, repair, etc. - location based solutions for transport sector - Voice as the fastest input method to all computer systems - Removing language as a barrier to technology exploitation - Related organisational and knowledge management concepts ("agile enterprising") virtual innovations services for health guidance and prevention for aging well "human access control" - the ability for a human to control access to (and tagging/tracking of) themselves. 1- Security & Privacy 2- Every connected devices have the hability to produce some computation power and trusted distributed computing ressources could be securely networked together to achieve MAJOR improvements over current. Hence a lot of quality of life improvements (forecast, scientific computing...) 1. Integration of the various motor and sensory capacities of the user, including BCI (Brain Computer Interface), natural displacements (locomotion), generalized haptic feedback, touch simulation and spatialized sound reproduction. 2. Fluidity of the collaborative interaction and availability of solutions allowing transparent remote interactions: natural character of the interaction in cooperation, representation of the distant activity and the emotions of the different participants for example. 3. Credibility of the virtual human interaction, especially in the restitution of emotions and non-verbal languages. 4. Qualitative and quantitative progress (performances) in the perceptual restitution of virtual environments. Ex: holography, stress feedback, environmental simulation, etc. 5. Functional credibility and semantic enrichment of 3D environments. 6. Integration of the real in the virtual (3D acquisition) 100% programmable transmission equipment, e.g. telecom masts and sender/transmitters in cars, devices A critical challenge for any machine-mediated interaction, be it human-human mediated by computers/online platforms or human-machine, is the degree to which automation impacts the freedoms/agency of the users. How to provide a easy-to-use service without undue manipulation of the

	user. as these systems move from laboratory experiments towards being offered for use by general citizens, how can we anticipate the social/societal impacts these systems will have. Responsible Research and Innovation (RRI) methods are becoming increasingly important to be applied to the ICT domain.
	A delay-aware network: many of these applications will require very low latency and the network is best-effort so we need to understand what these applications need in terms of network performance. Clearly much more is needed than just that but it is not my field.
	a wide range of challenges carried out by multidisciplinary teams in topics addressing the creation of reliable market ready technological innovations related to all of the above challenges ranging from augmented and virtual reality, behaviour, human-computer interactions, haptics, human-human interactions through computers, machine-to-machine, spatial recognition and geographic information systems.
	acceptance of the people
	access to high speed high quality connectivity on demand (IP TV applications) Achieve QoS (e.g. low latency) required for interactions again security is of fundamental importance. Besides that, speed is currently lacking, especially for virtual reality. The capability to combine different solutions, e.g. compatibility and open standards are also important.
	An EU wide and coherent approach to Citizen science where co-benefits across different policy areas are maximised (i.e. Internet for the environment: what are the major EU initiaitves to which citizen science could contribute? What takes to make different EU instruments to work together to deliver on a large scale already tested solutions?
	Applications across all sectors of the economy, e.g Games, Health, Entertainment; Brain computer interfaces; Design. As an example: Develop algorithms and intelligent software technologies and tools for combining live actors and CGI for films, games, live experiences and transmedia productions that can interact realistically in real time to improve high end production. Motion enhancement and animation blending technologies also have applications in training, engineering and sports.
	AR and IoT, VR in design in industry with end-user, VR/AR and human issues (e.g. cyber sickness, ...) Artificial Intelligence, Speech Technologies, Natural Language Technologies, Visualization
	Awareness of the devices that surround us and collect information on our interaction with them
	Balancing replacement of human work with mechanization and robotization; Updating labour law regulations to address the most vital issues; Optimizing growing procedures with usage of new technologies; Social inclusion of the inhabitants of less developed areas; New challenges in the area of cybersecurity;
	Battery improvements, Energy and Sustaibility and connectivity. Being able to deliver not just sufficient capacity but tight statistical bounds on packet loss and delay in order to ensure smooth and consistent experiences.

	Challenge 1: high speed, intelligent content and context aware user centric networks Challenge 2: enable anybody, anytime, anywhere to be capable of real-time interaction, Challenge 3: total immersion, Challenge 4 :sense of presence and embodiment (embodied social networks), including emotional and non-verbal social signals (empathy, entrainment, co-creation, contagion).
	cognitive robotics, co-creative intelligence
	collective platforms for action, participatory forms of decision making, bridges between VR and real, communal life
	Communication between humans and machines in industrial environments
	Computer ethics, impact on employment, security of data
	computer vision; voice recognition; (again) local data processing unless necessary to connect outwards; possible healthcare challenges
	Concerning policy and education: young people should be prepared to make 'flexible' choices to prepare them for robotics and increasing automation
	Concurrency, transfer speeds, connection availability
	Contextual interfaces conversational interfaces, low barrier augmented reality, human in control
	decentralised technologies, data sharing and privacy with strict regulation according to GDPR and stricter designing services with a reasonable blend of automation and human control
	develop a wise approach beyond smartness, oriented to compassion follow the physicians' motto "non nocere"
	Development of AR/VR framework for the easy creation of environment and contents. Proper literacy about AR/VR
	Display-less interfaces, accessibility for marginalised groups such as disabled and elderly Distribution methods and channels, Accessibility
	Es ist zu beachten, daa die "Steuerung" der Bevölkerung in Zukunft nicht durch eine APP passiert sondern noch immer weitgehende durch freie politische Entscheidungen der Bevölkerung

	ethic, education to let people know how to use it and be aware of what they do. Ethical AI, data sovereignty and privacy, easy accessibility and usability Forms of interaction with machines influence the way in which we interact with other people. For instance it should be prohibited that technology implicitly takes decisions about lives of human beings. Examples follow. 1) filtering of Resumes (CVs) using specific keywords leads to a situation that technology influences which candidates can have a chance to talk to a human being -- prequalification tests of knowledge are acceptable but usage of search filtering should be prohibited as a form of keyword-rasism. 2) Credit risk scoring and recommended loan decisions lead to a situation that loans can be given to irresponsible persons or software can have a bug leading to mass scale errors. Researchers from Social and Human Sciences should play a key role in this area of research. No more money to tech guys (and I'm a tech guy)! Frame interaction models on an ethical background Good access with right bandwidth and latency, security and trust for IoT and usability. Grid computing technologies Hands free augmented reality, access to good information, artificial inteligence. haptics (and proxemics) standardisation, interoperability, trust Health safety How to build immersive environments from a large distributed set of sensors how to deal with health and safety with remote control vehicles human behaviour, democracy, collective behaviour, collective intelligence Human centered solutions Human interactions in a blended physical and digital space; Impacts on human health; Impacts on social interactions Human-cognizant Machine-to-Machine (M2M) and Machine-to-Person (M2P) interaction: aims to predict user needs and complete tasks without users initiating the action or interfering with the service. While this is not a new concept, according to Gartner cognizant computing is a natural evolution of a world driven not by devices but collections of applications and services that span across multiple devices, in which human intervention becomes as little as possible, by analyzing past human habits.

	Latency/reactivity are of course important issues when end-users' devices are going to interact with cloud services as well as direct voice interaction between human and devices. human-machine interactions incorporating emotions and sentiments ; human-human interactions mediated by devices; speech to speech translation human-machine interfaces, integration of bio-technology I think with next generation technologies that become extremely close to us or requires intergration with the body, these need to need to be made with augmentation in mind and being detachable rather than permanent intergration with our bodies. This allows common interfaces to be developed and means that the technologies can then be upgraded easily over time,. Think of a sugar monitoring device for example, it must must use common interface defined from regulations and standards, and then over time it gets better because the manufacturer never has to worry about developing a new interface. Identity of devices/assets and Identities of data users Image recognition, flying devices, big data immersive distant collaboration In Language technology both research in NLP, Natural Language understanding as well as dialogue managment and natural language generation in order to achieve Conversational Interfaces that allows for human-computer interaction. This should be possible in all Languages so the citizens of Europe can use their mother tounge to communicate. Research into Interoperability subcomponents used to process language with new standards and easier archictectures. New ways of handling multimodality for real both in augmented, virtual reality and interaction with devices being able to capture different modalities (face, haptics, gaze, speech, text) and combine it intelligently. Research to overcome the drawbacks of deep learning when applied to language technology to identify approaches that can benefit from the pros of symbolic approaches and are less data dependent. interdisciplinary effort Interoperability, standards and communication protocols Investigate the existing sensors' capabilities in collecting digital infos to be processed & interpreted for decision making, in facing performances and even deceases as cancer converted in IoT Technologies for better understand the way the cancer cells develop & neutralized medical treatments by adapting their nature to obtain annihilation of medical treatments It is strategic for Europe to develop its own applications and platforms. The strategy of the European Commission over the past decades has failed miserably at this point because of their dependency on traditional German and French software & telco companies that had NO IDEA about the internet and

	internet culture. Nothing has changed here. What should be supported are emerging P2P initiatives from below, run by young people. The funding rituals in Brussels are complete inaccessible to young people and small players. Horizon 2020 is a nightmare in this respect.
	Knowledge using the devices, their purpose Lack of computer in communities, massive computer introduction to schools especially in early schools, Lack of face-to-face interaction and its "how to" knowledge. Security and privacy. Psychological & biological effects of constant VR world. Responsibility in computers-humans/computers interactions. (example : road accident between 2 self-drive cars)
	language and speech technology, artificial intelligence Language technologies will be critical for these challenges. It will be necessary to work on linguistic (not statistical) methodologies and techniques to analyze languages. It is necessary to work on lexical semantics and terminology, to create ingenious dictionaries useful for human and machine users.
	Legal issues affecting the transformation of the human being.
	lightweight, long lasting, sustainable power sources
	mainly cultural challanges for a more open vision of Internet NOT as a "machine", rather as a very powerful Non-Human Partner for many Human activities, interests, dreams...
	making virtusl reality more mainstream and widely used (virtual environment to be used on any device) over the network; for example online virtual reality business solutions and products that can be interacted with and shared over the network; IoT Virtual Reality will create more data to be handled; upcoming application Virtual Reality in healthcare (self-help, remotely located services)
	Methodologies and tools for process & workflow improvement
	Mobile VR, AR as interface for field force, ...
	Modelling, understanding, tracking, and predicting online and offline behaviour
	More knowledge about human language communication (including multilingual communication) is needed and must be transformed into new technologies for language communication for human-computer interaction, but also for better communication between people speaking different languages.
	Natural interaction, Multi-modality, Efficient deployement of Virtual and Augmented Reality
	natural language understanding
	Network latency issues must be further tackled to minimise the delay for any remote processing of real time information, e.g. as may be required for merged reality or autonomous transport scenarios with internet-scale deployments.
	Nowadays novel devices allow for the creation of immersive experiences. The main future challenge

	lay in the area of mutlimodal interaction between human and machines. Regardless of the environment (virtual or augmented reality, avatar or robot communication in real world) there is a need to develop a more physical interaction between the machine and human. The machine has to understand and react not only to the human voice but also react to emotions, gestures, expressions and the overall human behaviour in order to really offer an immersive experience. In addition, humans should be able to interact with content in order to facilitate exploration and knowledge gathering. This reveals also the need for new ways of content representation that will allow for novel and immersive ways of interaction.
	observe the three laws of robotics.humans should always be in control.
	One of the challanges is related to the interaction between the public goverments and the citizens themselfs. This are considered as human-human interactions however due to the nature of the relationship not a "classical" human-human relationship. I would definitelly put some more focus on new research areas related to the new and innovative ways of reaching the citizens by the new forms of interactions. More precisely I am talking about the possibilities related to e-governments and the axis of government-citizens and government-companies (private sector as such).
	Platforms for IoT Application Development, Platform for Multiplayer Applications and games
	Privacy, security, open standards, social change Psychological/Medical effects of HCI (in particular brain interface) and high-level immersion in VR/AR environments
	Reliability and trustability of what is offered
	Reliance on internet connected devices will accelerate even more exponentially than they have done in the last 10 years.Understanding the security of internet-connected data is crucial as is who can access the cloud and control access to the internet (cyber-security); locally and globally.
	Remote and inmersive representation, with full sensitive experience Research and innovation should be market driven and technology neutral. This is especially important in the IoT area where demands and technical feasibilities are evolving at high speed. PPPs such as EFFRA's "factories for the future" ensures that those projects receive funding that are well absorbed by customers. All the areas mentioned in the introduction text (AR & VR, haptics etc.) need still a lot of research. As mentioned in the previous technology area comment, artificial intelligence could have an important part to play also in connection with these technologies. One challenge might arise from legislation as e.g. GDPR and ePrivacy draft regulate processing of personal data and in the case of ePrivacy even M2M data. If strictly interpreted the legislation might hinder innovation or make solutions costly and/or cumbersome.

	Robot or human, the cyberman is an extended biological body with devices like an exo skeleton, binocolars or infrared view operated in the eye or ...
	Security and privacy concerns
	Security. Storage. Speed.
	see above. Self managed and social human.
	See earlier reference to CSG/M, The P:eoples' Toolkit
	SLC - Safety Loss Control, Disaster Preparness, Disaster & Crisis Management, Crime Prevention, Education & Training, Simulation, Desicion making processes, process monitoring, Resilenz, Ethic & theological discoursing & dialog, discourse analysis, human interface influence. How IoT influences human-human interaction. How IoT influences and transform inter human communication and interaction with the social environment. Benchmarking strategies, Massiv knowledging processes & managing, Heuristic, Technology Assessment
	speech & visual interaction; AI & unsupervised machine learning
	technical development of Life long batteries or other energy sources, minimazation of the devices
	The addictive nature of technologies, the ethical limits on engineering geared towards addictive responses, the impact on democracy of creating dependency rather than empowered citizens.
	The borderline between being always available and having the freedom to choose not to be reached easily
	The Brain Computer Interfaces (BCIs) are gaining more and more attention both for supporting people with cognitive or physical disabilities to communicate with their environment, as well as to increase the interaction capacity in human-machine system (e.g. gaming contexts). As they become more mature, BCIs are expected to gradually replace the existing mouse, keyboard and touchscreen interfaces, offering more natural and inclusive ways for interaction. Virtual reality is gradually making its way to mainstream consumer devices by offering radically new experiences. Nevertheless, although the latest high-quality headsets have partially alleviated the problem, VR is still unable to remove the dizziness causes by the bio-logical disarray of a person moving virtually but not physically. Thus, new paradigms for VR interaction will have to be developed in order to facilitate its prolonged usage. The current keyboard-touch screen interaction will be overtaken by new paradigm: voice, gesture, attitude, context awareness. These are enabled by computing and networks by also a lot by Artificial Intelligence strategic assets, that will be synergic between network and cloud data centers. AI will be central to all interactions. Also Augmented Reality (AR) and Virtual Reality (VR) will mature: in

	particular huge improvements are still needed for the display technology (much higher resolution – up to 32K per eye, true HDR, higher refresh rates) and for real-time tracking (to be extended from the user's head to the user's whole body and the external environment both for AR and for inside-out VR tracking). Eye and face tracking are important to enable lifelike social interactions with other users in VR. Next generation networks, with very high bandwidth and low latency are key to enable the distribution of new kinds of contents like light fields and 3D/360 videos. The futue interactions with machines will be through language (chat bots, Alexa, etc.) This requires Natural Language Processing (NLP) capabilities for all EU languages. This is exensive to deliver because the effort multiplies with the languages support. Therefore game changing products are only available to English speakers, if lucky also for German, French, and Spanish The other European citizens are excluded. Industry will not supply this, since many languages do not have enough speakers. .
	The impact in our professional and private life
	The interaction between human activities, technology, environment (spaces and places) and policy making
	This - bandwidth consuming - ways of interaction should be strongly supported. But it is very importnat to assure also - as alternative! - a possiblity to interact with "very low, extremly low" bit rates. All the promises of "complete coverage averywhere with high biot rate" are an illusion. At latest in case of a failure (or attack!) this will be gone! A fall back is necessary!
	This "area" is not one "area". "Raising" should be "rising". It would be better to divide the problem raised in three different categories and approach them in the context of a fast-accelerating intensification of digital possibilities: 1. How do digital agencies (computers, machines, etc.) relate to each other against the backdrop described immediately above? 2. How do humans relate to digital technologies, whatever they may be, and how do they produce them? 3. How do human relate to each other in such a drastically changed technological context? The most fundamental questions will have to do with humans themselves, and, recently, President Obama has raised the issue that all of this will ultimately amount to the need for a deeply revised social contract. In short, what kind of society do we need when cognitive tasks are filled by digital machines (e.g. X-rays analysed by machines, rather than trained doctors, etc.)
	This is a very important and very relevant technology area. With regard to my area of expertise, research and innovation support for the area of interactive systems needs to be intensified. As stated above, in the future many connected devices will be headless so that other means of interaction are needed. Language is the most natural means of interaction between humans and other humans and it is also the natural interaction method of choice between humans and machines. Interactive systems that can interpret and react to spoken language in a robust and precise way, providing high quality responses, is a key research area that Europe needs to concentrate on.
	This technology area is the heart of the NEM European Technology platform, a PPP has been

	described but not yet accepted (I²C : Immersive and Interactive Content PPP). several research activities have been already identified : 1 - Storytelling Creation for I2C 2 - Mixed content Immersive Technology 3 - Content Generation Tools for I2C 4 - Science, technology and arts in Immersive and Interactive Media 5 - Direct Support to Startups and Microenterprises 6 - Support to Intermediary Organizations This technology area is the heart of the NEM European Technology platform, a PPP has been described but not yet accepted (I²C : Immersive and Interactive Content PPP). several research activities have been already identified : 1 - Storytelling Creation for I2C 2 - Mixed content Immersive Technology 3 - Content Generation Tools for I2C 4 - Science, technology and arts in Immersive and Interactive Media 5 - Direct Support to Startups and Microenterprises Activity 6 - Support to Intermediary Organizations This will indeed become very much the trend in many areas: in scientific research, museums, libraries, schools. Even driving cars or piloting planes will make enormous use of this technology. It is, however, very important to ensure that we have the proper infrastructure and capacity across Europe to make use of these new trends. To develop new forms of interactions and immersive environments, we need to combine mathematical modeling with massive computer simulations, data science, and large-scale experimental approaches. This includes laboratory and web experiments, crowd sourcing and citizen science, virtual and augmented reality, and multi-player online games. To develop new narrative formats for these new devices

	to generate haptic sensations; to use haptic device for medical simulation
	Understanding human behaviour, criminology Understanding human language, and reproducing it; making more realistic models of humans (especially movement); protecting what rights/laws humans need to respect when it comes to interaction with computers.
	usability
	User collaboration and participation in content creating will be very important.
	User control and user awareness to interaction
	user embodiment in the virtual environment through non-invasive technology : this will broaden the range of health-related applications (exercising, rehabilitation) and the general assessment of virtual prototypes through the end user body actions.
	User empowerment
	User interaction with devices, services and information has to be made simpler, given that the increasing amount of those that will continue to occur. In parallel, use experience (e.g., via augmented and virtual reality), needs to be taken to the level of simplicity that exists today on the usage of a mobile phone and its apps.
	Virtual reality, acoustic VR and AR, personalised 3D audio, HCI, haptics (cheap and reliable)
	Virtual reality, robots, articficial intelligence.
	Virtual Travel. VR-based collaborative product design.
	VR
	wearable technologies, optical technologies, human-computer-interaction
	What happens after finger-display interfaces? Gestures identification. Brain to computer UX.
TA 3 Personal data spaces	Main issues will be in the area of security, privacy and ethics. Perhaps not as straight forward is the challenges to use data spaces for serious purposes (learning, personal development, personal health management, etc)
Resilient, Secure & Safe	
Human Immersive Emotional, Eas	Making personal Data handling easy (for me as a user). It is annoying, that you have to click accept every time you go to a new web page
An Agent Internet	
Level Playing Field, New Participa multistakeholder	Privacy, User Control, Accessibility, Performance Standards for decentralised, secure and more transparent user modelling; regulation to avoid "walled gardens"
Democratic, Participatory, transpa	- Data encryption for storage and transmission of personal data
Inclusive Open to Change	
Diversity, Pluralism Right 2 Choos	- Standards for secure storage and retrieval of personal data
Infrastructure	
	- Multi-factored identification services personal identification technology, encryption Trust, secuirty, data mining

	Achieving a fair cost distribution in the whole chain: i.e. network infrastructure that delivers (for the Googles of the earth) costs a significant amount of money and create quality jobs for Europe. Finding a limit between privacy and the current economic model on the Internet, based on targeted advertising and big data; tools which are accessible to people; distributed storage Is a philosophical mainly, the division between private and public life * decentralised data acess encoding, prevention of hacking without removing the ease of access for the data owner security (Almost) everything connected to the internet collects data about it's user. Users are not always informed what is captured, who stores it, who else has access to it, what happens to it. Whilst it is an aim to inform users, there are equal numbers of people who would wish to access or control the flow of that data for personal gain (so it will be a massive challenge to make this more transparent and accountable). The volume of data captured about a single individual is likely to be so large that they will be overwhelmed unable to process or make valuable use of it. This is likely to lead future generations to become laissez faire about it, just ignore the fact that this data is collected (this is a common bi-product of the generational effect) and long term not worry or care about this providing this information and increasingly more information. Blockchains, Big data, Open data privacy versus collectivity, ownership versus participation/collaboration Being abel to assess the privacy of a device or service Security of data Privacy, Data protection, open data, open source Software platforms, Ethics How to assure one's unique identity is critical. For example, imagine a near future wherein people could simply vote by using their personal smartphone. It would be highly recommended here a way to assure uniqueness of vote. Security of personal data, approachable recourse to legal protection and accessible education for people about personal data storage, usage and transmission. The provided characteristics are not attributes of the Internet but Internet services. Internet is the global data network, which allows the services to be created. In the service space, understanding what data is collected, control thereof, and allowing portable identities are important. In addition, how personal data can be used. Especially, when personal data is collected from IoT. Also understandable and controllable security is important. Capturing, representing and respecting users' privacy concerns and requirements Make personal data management practical and transparent for end users, ensure long-term availability

	of data, efficient access and querying mechanisms both with intuitive user interfaces and with programmatic means (APIs). Make personal data management systems accountable and trustworthy. Enable novel forms of personal data use (e.g. per-use licensing). Strike an optimal balance between utility/value, simplicity, rich feature set and affordability of personal data management services. Understanding what is happening with one's data in a concise manner. Controlling what is happening with one's data in a concise manner, e.g. "share picture only with the depicted", "share landscape photos without people with public" Security. Storage. Speed. avoiding privacy, promoting freedom, promoting fraternity Work towards more smart technologies for data protection/anonymization/encryption and less verbose internet practices on using and sharing private data. Next to this direction, of particular importance is also the need to develop methods that will quantify the amount of personal data disclosed by individuals as a result of using social networks. Internet growth and non-disclosure of private data are two mutual contradicting tendencies that cannot be fully satisfied. Thus, in the next generation internet private data should be treated as a currency instead of a forbidden assets. Towards this direction, the regulatory and legal framework should become more mature in treating private data similar to the market of gas emission, where the highest bidder is allowed to pollute in a controllable manner. Similarly, internet companies may be allowed to use private data (under the consent of individuals) by paying the cost of countervailing measures. How to provide real services, not dumping responsibility on individuals but providing sensible defaults. Challenge is to create a simple decentralized server less model with simple self managing methodology. We need to dissociate and distribute individual's identity from their locations and attributes to eliminate single place of compromised data. Personal data spaces are important, so are commercial and business data spaces. Privacy of data and data governance: - How to allow individuals to maintain control of their personal data? Individuals should have power to determine how their data can be used and to benefit from the value of their data. - How to give services the authority to access and use personal data? - In the future Internet, these issues need to be addressed at all layers, especially edge computing and cloud computing. Educate users on consequences of sharing

	education and awareness of privacy risks Identity and management of secure Identities; "Uberization" of assets through data provisioining - without creating monopoly platforms For long has networking research aimed to provide an aspect similar to user identification abstraction. This ability allows users to be identified through several identifiers, which can be used interchangeable and allow for automation. For example, a user's mobile phone could simultaneously broadcast his personal citizen ID, allowing the garage door for his/her home to be opened automatically upon arrival. Similarly, when in traffic caused by an accident, his/her Health Doctor ID would allow the phone to trigger a response that, upon interacting with other cars and city road lights, would create a pathway allowing the doctor to assist any casualties. cybersecurity, criminology , digital forensics, international standards and law - Efficient replication algorithms and novel approaches to ensure persistence of data and privacy. - Evolution of cryptographic solutions (stronger, enabling searches and computations). For instance, Quantum cryptography can change the paradigm of password use. Other identification means, including biometrics, may be required to replace passwords. - Approaches for the combined use of personal and open data - How to involve people in decisions on their own data. New trust and policy models and technologies to protect data throughout its lifecycle...spanning capture, transmission, storage (potentially redundant and remote), and destruction. By and large, individuals, companies and institutions, have not been given the tools to express their choices on opt in/opt out of data privacy. Some political or institutional forces are favouring full access, and feed hefty policy debates without offering any solutions. The way how the statement "The next generation Internet aims to develop technologies to help us achieve greater control of our personal data, knowing what is being shared and with whom" has been formulated demonstrates the illusion. We are already live in the era where privacy is a myth. It can be partly the truth if the person does not use Internet, which is impossible. Any human leaves own electronic track. Being dependent from 3rd party services (e.g. free e-mail service providers) or social networks like FB, Twitter, Instagram, etc. we do not know how the data are stored, for how long and with what purpose they are processed, by whom. A lot of signals appear that technologies of personalised advertising and psychometry are used or can be used for spurious purposes. Design and scalability of the backend; privacy-protecting digital identity management; societal change in the way data privacy is addressed Autonomous systems to enforce users and "things" trust and privacy policies. With the advent of cloud technologies, data privacy concerns are crucial, as highlighted by recent data violation episodes of various cloud-based companies. On the other hand, storing data locally is not

	necessarily more secure and may require to give up some advantages of cloud-based storage (e.g. global accessibility, protection against data loss). A great challenge in this sense is enabling full control on public clouds of owned data. This does not only related to technology (even though the definition of common standards to guarantee data access tracing, etc. is key), but it is also a matter of regulations and policies. Another aspect is the complexity of security technologies that limits their adoption by many consumers. NGI should foster the development of 1) data access tracing policies and standards to be adopted by data hosting providers and 2) intuitive and and simple solutions to protect and secure data so as that such solutions can be easily adopted by prosumers/consumers. Privacy Data privacy by protocol design; Transparency archive of data shared; Data deletion option including all copies; Make the Internet forget all no more relevant data; ... Es muss der Bevölkerung erklärt werden welche Auswirkung Big Data Analysis so wie die weitergabe von privaten Daten hat. Erst dann kann die bevölkerung entscheiden welche Daten Sie preis gibt. Wobei natürlich auch noch aufgeklärt gehört was alles gesammelt wird und werden kann. How can people be equipped with the skills to be able to protect their personal data? The data privacy is a huge discussion, everyone is uploading data with no control after it, if we check the data control opportunities is it in the most situations not possible modernise privacy and security for personal data is very important For example auditing tools for individuals, and tools that help individual users to find out and control information about themselves. How to exchange data with service providers that process data, without giving up your privacy The liability/responsibility should not be with the (end) users, but with data and computer professionals. Also, a European code of conduct for data and computer professionals should be enforced. Personal data spaces designed with privacy as main driver and distributed, secure, using digital ledger technology. But the door must be kept open to "traditional" internet technologies by using API's to applications and data repositories managed by organisations/companies/government holding personal data. The bridge should be designed with security and privacy in mind as well. personal data safe boxes, personal data tracking, right to be forgotten, public oversight of gov and corporate held data Consumers should not only be seen as passive subjects that need protected and defended but they should be given an active role as 'the owners' of their data that can actively use them.

	- The EU should especially work on net neutrality and ensuring that the Internet (the backbone and the connection to the Internet from the ISPs point of connection to the backbone up to the users' home) stays as neutral as possible with open, quality operating standards and with as little filtering or censorship as possible. The biggest threat to an open Internet is copyright law for digital content which would slow down the development of the Internet down to a crawl to minimize copyright infringement (even though this has nearly no effect on copyright violation). The technology for an "open" or "decentralized" Internet is being developed by passionate open source programmers (like the Internet Archive Foundation) (see the Decentralized Web Summit held in San Francisco last year). What they need is public funding with no strings attached, and no crippling regulation which might "kill" their initiative or push them to "sell" their creation to "for profit" companies. What kind of methods could be used to give individuals easy tools to control their data, is there a place for personal data brokering agents? Improvement in the field of cybersecurity technologies are needed to ensure also personal data privacy. increase citizens digital skills ownership of internet data, personal data safety, personal data use, personal data price, personal data should be paid to people giving them for free or in exchange for service, it should be made clear that people are giving their personal data in exchange for something and the terms of the exchange very clear information security on all layers of the OSI model, prevention of cybercrime Data Security Security issues and education about cyber security Achieving control of one's personal data. User centric ways for storing data - Privacy & Security A challange will be how to trust companies outside the EU, they will will publically say one thing in

	agreements, but do as they please behind the scenes. Secure, pratical and usable encryption for all users and everybone like old, children and people with low digital skills. Identity Management and security Up until now there has been no sustainable business models for Personal Data Spaces, and Privacy/Security as key sales arguments will not make it alone. Many "Comparison" services have been established with the intention of serving consumers, but they almost enevitably turn into B2B marketing agencies for a selection of companies (e.g. see https://www.gov.uk/government/news/cma-launches-study-into-digital-comparison-tools). Hence the challenge for Personal Data Spaces is to gain competitive economical advantage by being able to cut out other current infomediaries, such as search engines, market places, and comparison tools. The provision of native internet discovery options as proposed for Tech area 1 could provide the basis for sustainable business models that also eliminate most of the need for data sharing by rather aggregating product and service data to provide decision making support based on analytics hosted on "the consumer side". stop facebook from owning everybodys data. force them to perhaps enable people to have their own diaspora setup (or other open source facebook equivalent) - and be able to work with those using facebook. Cyber security, MyData - new ethics for privacy. Data that is partly physical and partly virtual. Blockchain and ultimate privacy. How to give public dental care to Edward Snowden so that CIA can't track that but the ID is still managed. How to support privacy yet enable some kind of limited and controlled sharing of personal data. How to control the life cycle of data. Ownership or personal data and who is allowed to do what with it; Privacy from large-scale tracking and data collection; Right and ability to see what data has been collected and right and ability to redact it Again, Privacy & security, reliability. Building awareness in users. User data needs to encrypted as it goes thorugh many network elements. Making Enryption easy and usable by non tech users also. Guarantee confidentiality, but also ownership and integrity of personal data Empowering people with their own data: (1) Ensuring that individuals have the ability to access & use the personal data that organizations have about them; (2) Creating "digital homes" wherein persons can collect, store & process their data, under their control, and to their own ends; (3) Creating the right conditions for these "homes" to be secure, scalable, interoperable, easy to use, and reasonably

	immune to "capture" by one or another mega-platform; (4) Exploring the new world of person-centric data-based services... See VRM, Self Data, PIMS, MyData, etc. Enforce the ability to retrieve one's data for me it is all related to two themes: User centric internet - Hide technology to the user - Measure and manage quality of experience - Privacy: move computation near the user (home, mobile), keep data at home on or mobile, nano data center - Localized services - Intuitive search - Data life time management Distributed data mining - Distributed recommendation/analytics/personalization - Distributed privacy - Processing encrypted data - Distributed data storage and data analysis architecture international respect of privacy Common vision throughout Europe Security, Protection of data, Simplification of Information systems -> too much information Putting unbiased agencies in place to measure privacy and publish results on how good specific services are in terms of protecting my privacy. It will be a question of trust and hence privacy and trust are linked. transparency / sovereignty of my personal data and protect privacy.

	How to give individuals control over their data ethic, privacy local intelligence, education about this subject Monetizing many activities on the Internet tends to rely more and more on profiling. This places privacy issues on a collision course with commercial needs. How to balance these two dimensions correctly will be crucial if we are to preserve a society with fundamental, demoncratic, values. Privacy by design is not a key concept in the current industry community. This provoke an irrevocable slow down of the internet economical extensions due to the fact that people are not willing to trust private third parties with private informations that could be used without authorization. A key concept could be that a private information is always in possession of the user and that third parties have to be explicitly authorized by the owner to use the information. This is technologically possible but the private sector companies tend not to use such methods because privacy is not currently considered as an important issue over business decisions. Pattern recognition methods homomorphic encryption, software quality achieve privacy of the collected data Data Security, Data Management One of the key future concerns is to manage of people persona data. Today the GAFA and any internet service provider collect information and use them even they are false or old. There is a need to create a single personal data base manage by the user himself and accessible by service providers on demand. That need research but also regulation in order to impose this model. 1. The security aspect of fixed, wireless and data-based telecommunications networks. 2. Security and intrusion detection must be built in and available in security solutions. 3. The guarantee of the authentication of persons and access rights. 4. The security of embedded and mobile systems as is closely related to the connected objects in their security dimension. 5. The modeling of threats and attacks is an important objective. It seems necessary to strengthen this very important line of research in order to understand the nature of the constantly evolving threat to information systems. 6. There is a lack of use of cyber security in the digital society and especially in markets such as the intelligent house, autonomous vehicle, smart city, energy, etc. One of the key future concerns is to manage of people persona data. Today the GAFA and any internet service provider collect information and use them even they are false or old. There is a need to create a single personal data base manage by the user himself and accessible by service providers on

	demand. That need research but also regulation in order to impose this model. Change communication paradigm so to ensure privacy. Have network traffic control so to respect sovereignty of content. inclusive effective iterative design for innovation from the concept to the market applied ethics including privacy by design , privacy by default , sustainability of economic models taking in account the great diversity of factors needs priorities and wishes impacting the possible exploitation models targeting old persons Alternative Privacy Models & Interfaces: The traditional “notice and consent” online privacy model (in which users assert their privacy preferences by interacting directly with information presented on a computer or mobile screen e.g. by clicking “I agree”), breaks down when systems provide no mechanism for user interaction. Even if a user is able to express informed consent of their privacy preferences to IoT devices, a privacy interface mechanism needs to handle the large number of IoT devices a user must control. Data Repurposing & Life-Cycle Transparency: Big data analytics of aggregated personal data represents a substantial risk of privacy invasion and potential discrimination. This risk is amplified in the IoT by the scale and greater intimacy of personal data collection. Personal data has personal and commercial value that sources and collectors value differently, both individually and in aggregate; both parties have legitimate interests that may conflict. how to boost R&D in these areas while safeguarding the privacy and other rights Security of data, a more wide-spread "security hygiene" (knowledge about basic cyber security rules) should be more resilient, secure and safe, especially for children, elderly and people with low digital skills. Educating the people about personal data privacy, why it is important and where it is violated. privacy, Management of data ownership. THis is porbably the MOST critical area. But technology is not enough to solve this. There is a need of very close interaction between technology an legal rules. I envision an enforced by low brogerage of personalized data: The end application will NOT be allowed to colelct such data. There will be intermediate broker, storing the "personal data" and making them available only to properly trusted applications following strickt legal contracts. user empowerment, cyber security and safety, transparency, law and legislation the consume has to trust the technology related to area 2: one of the most important feature of the human brain is to forget. How can we implement such a feature in the Internet? The following research is of key importance: 1) mitigation of the dangers posed by quantum cryptanalysis 2) anonymity technology. Besides, obviously, the next generation internet must get rid of personal identification of users even for mobile devices. Location tracking and behavioral profiling are

	an unacceptable price to pay for connectivity. Connecting any more sensors to the internet compounds the already grievous privacy problems and must be discouraged, rather than proposed as a "vision". I think that this is primarily a policy issue; policy makers will have to get more actively involved into that and then technologies can support. Big Data - potential and limitations, benefits and threats autonomous self sovereign digital identities / identity management The right to use the internet anonymously must be protected. develop fog computing. complexity, education, usability of alternatives to centralized platforms I am personally sceptic in adapting strict regulations for IPR, since confidentiality reduces criticism of RTD/ECT cyber-security, data privacy Surveillance; policy issues; open source intelligence statistical techniques; application areas (e.g. Healthcare, etc) identification and authentication, data protection and cybersecurity for devices and systems. A wide range of research and innovation actions addressing such topics as cybersecurity 1. Iconography to concisely communicate purposes of data use. 2. Zero personal data methods automated advertising. 3. A concrete privacy by design framework or rule book. The New Generation Internet must embed the mechanism for trustworthy data source authentication, data authentication, data access control by authenticated and authorised roles or entities, with all respective data protection (encryption, integrity, availability, completeness, etc.) Privacy Privacy, databases, cybersecurity. Cryptography privacy, supercontrol, loose of freedom of decision, filter bubble, discrimination on the big data, inequity Privacy-aware Access Control in Social Network, Privacy-aware Data Mining The intervention of government Easy and intuitive interfaces privacy, data protection Using Big Data for social good, privacy-by-design privilege life skills to co-design infrastructures platforms and devices include people's experience in designing consider research and knowledhe as commons community network-based distributed and decentralized services

	Privacy make PERSONAL, PORTABLE clouds that integrate email, blogging, really distributed social networking... into ONE "box", that is as easy to set up as it is today to get a gmail or facebook account self-hosting and community-based hosting of local services, local and community networks Community-based services and self-hosting managed by local communities. user controlled encryption & transparent authentication systems with perfect forward secrecy all information related to a person must be seamlessly under her/his control explicit authorization to use/access personal data must always given at ANY time it happens internet-conncetd personal data centres ensure right to be forgotten The availability of huge amounts of Personal Data (PD) enables new applications and businesses but also raises privacy concerns. PD are currently collected by a multitude of organizations ("organization-centric") and individuals are normally left out of the life-cycle of their PD, acting only as PD producers with limited possibility to control and exploit their data. A new user-centric model has to be promoted, enabling people to have greater transparency and control over their PD. PD store (PDS) platforms can deliver services enabling such a scenario, empowering PD owners with trusted capabilities to collect their data, audit and control their exploitation, in compliancy with the EU GDPR. This would create new ecosystems around the idea of the "bank of personal data". Such a shift of paradigm from organizations to citizenry would offer to users better services based on their holistic digital footprint and ensure their sovereignty and awareness on who is using their data and for what. To protect privacy, the next generation Internet should take into account the design and scalability of the backend, the privacy-protecting digital identity management, and any societal change in the way data privacy is addressed. At the same time, it should regulate the ownership and legal protection of scientific and technological results. Feasibility studies to lower the amount of shared personal data (including that information that is already available today); Options to trace the combined use of data where at least one component includes personal data; Mechanisms to inform people about each use of their data (access and processing) avoidance of frauds (and cybercrime in general) private cloud | Data location in the EU | security challenges Identity management securing privacy (encryption), protecting against hacking ongoing This has a very high legal component. We should have international laws protecting personal data. Do

	not allow corporate lobbying to stand in the way, else we can stop this whole initiative. On the technological level, a service that aggregates personal data and is triggered by the person itself and is tied to a non profit organisation a person trusts would be needed. Choice and transparency in this trust org - service - person triangle is very important. Individual control on use of personal data; distributed data storage; applications working on distributed data environments with full protection of privacy; trusted management of personal health data. pointer (url, uri) IP-packets, internet in clouds Laws are not enough. The legal approach of Europe is failing because privacy is NOT regulated by lawyers. Nothing was done against internet monopolies. It takes 10-20 years to do something against Microsoft or Google. This is a joke. On top of this, he whole anti-terrorism approach of the EU itself is undermining all basic belief in privacy, so what are we talking about here? In a permanent state of exception there is no Increase truthful transparency and stop the system from controlling humans. Privacy indeed full control of the user/citizen/consumer but in such a way that control facilities are extremely user friendly, otherwise control won't work in practice we need much better ways of protection than simply the use of passwords which people tend to forget. simplify and concentrate the control of personal data, that may be everywhere. Eg. 1. control / grant/ remove permission / review personal data from one system only, controlling (say) facebook, google, etc 2. make sure personal data of european cititens are stored in servers within the EU With personal and health related data this is essential. Lifestyle self-management needs it. Individual privacy, resisting indiscriminate surveillance How to fend off the real villains on the internet. We see even outside the internet that we are intentionally lured into doing the things that large corporations as e.g. banks and (health) insurers think are benefitting them most. I believe the result of the US presidential elections are a good example of what algorithms that use personal information (examples Facebook, Twitter) can do to influence our choices! Improved cryptography, being prepared to use new techniques in case quantum-computing has their breakthrough. Partial, revocable and time-bound disclosure of personal information The growing tension between privacy through strong cryptography and law enforcement/intelligence in Europe is a strong concern. The awareness at the national and European executive level that

	weakening security and cryptography to favour law enforcement and intelligence operations is a fallacy. Any weakening also benefits malicious actors. Especially in a global Internet, where users have little control over where there data is stored, or what jurisdictions it is transported through makes it a top priority to provide users with the strongest possible cryptographic means to secure their data. On the network side, insight into routing of data will be key to deciding data privacy and confidentiality risks. digital identity management, attributes & entitlements; (homomorphic) encryption; distributed storage; novel approaches to governance Organisational, legal and technical solutions for bringing individuals in control of their data. How to migrate from an API economy to a network economy. Development of a scheme for the platform independent (peer-to-peer) exchange of personal data under the control of the individual. The individual should be at the centre of his data; a node in the system. From this node, the individual should be able to access his data, wherever this is stored and he should be enabled to route this data to other parties which are connected to his node. The individual decides with whom to share what kind of data, under which terms and conditions, how often, for how long and in which form (aggregated; anonymously; under pseudonym). existence of dark web, how to prevent sharing personal information for criminal use, how to prevent the Internet from being a medium for crime related issues The necessity to enforce the Data Protection Regulation; Strengthening competences of independent bodies protecting data privacy; Education of the citizens when it comes to their knowledge about data protection; Simple and effective process of objecting usage of one's personal data; The software (including cloud machines) should be moved to places where data resides and not the other way around. The full control over personal data should be in hands of a particular human person and centralized for particular person (a person decides about the place) and the software (made by corporations or governments) can process such personal data by sending verified and certified piece of software to the cloud where personal data resides. The processing of personal data should recorded, subject to audit and a human person (owner of data) can prohibit and stop any further processing. Data-mining algorythms' accountability-, prevent data moving across contexts Privacy, security Privacy and data handling are widely acknowledged to be of paramount importance in the development of the future of the internet. Privacy Security Property of data Acess to data

	Creating private clouds in the home that replace large enterprise clouds. data privacy, data anonymization in cloud The reluctance to disclose personal info could inhibit the users to either express freely or sign up with different identities that disengage them from any responsibility How to legislate this? ensuring efficient oversight on data access and storage; educating users (weakest link may endanger others); enforcing strict privacy legislation also worldwide; data localization challenges Distributed databases; blockchain technologies; empty 'shell' apps and social networks that interact with information in the hands and total control of the user How to facilitate data collection for investigation without losing privacy. Data management and privacy. Fair use and people exclussion Who will manage all those data? Who will control the data managers? What kind of protection will have the users? The security of this data. data ownership, transferability / interoperability, data sharing / access control - Privacy- preserving technologies for personal devices. - Privacy-preserving technologies for the cloud. Gain control of all the relevant data People ownership of their own private data at all times. personal data risks self-consciusness, time management data cooperatives // blockhain based data rights management tools // open data effects Clarification of the conept of "Privacy". We are back in the "Global Village" Education and raising awareness to all citizens about the importance of their privacy and how to stay safe online (Cybersecurity). Topics like: Online Identity, Dangerous Communities, Phishing... WE need to create a strong general consciousness about the importance of these topics. communication privacy, data privacy, privacy-preserving data mining How to enable customization and recommendations brought by data mining, without depending on large hubs of unencrypted personal data How to make sure that everything that different models learn about us from different services and companies are owned by us and can securely be utilized by new services. So re-usability, standards for user model representations as well as secure protocols where maybe the actual user model is not allowed to live on a company's server. Ways to be able to delete a user model from a company. Today they are not only learning our phone number and date of birth but our habits, our health (fitbit), our heart rate our purchases etc. Personal data confidentiality and integrity per se. Ensurance that the device has not been tampered with, secure the data stored by the device, secure communication and protect the device from cyber-

	attacks PET (and their usability), location privacy, identity management and privacy-enhanced access control and authentication Safe data storage, controlled data dissemination with use consent Institutional privacy aspects in relation to personal privacy The business model of the Web today is what I call people farming. The system Silicon Valley has created can best be described as Surveillance Capitalism (Zuboff). solutions for security and data protection, solution for people to know which data is colllected about them, regulations and adaptation of laws Unique electronic ID. Location of data storage, access to the data, laws and regulations, delete data Appetite for free apps with no awareness of how personal data is collected, stored and used The increasing numbers of existing databases that contain data about persons, either openly accessible or purchasable from data brokers, is making it increasingly difficult to protect against de-anonymization through database cross-linking. Approaches to personal data privacy that rely on pseudonimization are therefore rapidly becoming meaningless. At the same time current trends indicate that no business can realistically guarantee that they will not suffer a data breach in the foreseeable future, the only way to safeguard data privacy of users is to minimize data storage in centralized data-stores. Both technologically and in terms of business models we need to develop better methods for service providing that do not rely on personal data transfers from the users into centralized data bases, or that minimize the time that data is kept in centralized sources. An interesting concept to research would be the development of data encoding methods that include time-based self-destruct. user data privacy and personalizaiton, Intersection of Big Data, Personalization and the Internet of Things; Big Data And The Journey To Personalized Medicine governance and transparency The right balance of privacy protection and privacy "sacrifice" for perceived benefits. Where and how is data saved?, Government control over data, SECURITY systems that assure citizens that their data is stored safely (both governmental and corporate) in a manner that they can see (transparency), are able to opt out of corporate data storage, and the rights to edit items that are incorrect or defamatory... Encourage innovation in quantified self for wellbeing, e.g. across the themes of nutrition, older people, younger people, mental health and data capture. Education of citizens on their rights. Making data privacy transparent and easy to understand. more browsers/search engines - keeps everyone honest instead of 'sanitized, political, filtering,

	tracking, and manipulating data access and transfer by who knows who. Protection of privacy for the innocent while making information available to assist in criminal investigation. Protection from exploitation of data by marketing initiatives. Prevention of spam and related unwanted contacts. Agency based modelling of the planet turns all data into personal data, should we regulate development of such modelling?, Discrimination based on personalisation. data provenance and audit trail - traceable record of data composition, origin and use The challenges include (a) the social: what do people mean by 'privacy' and what trade-offs do they want between privacy and accessibility (b) the technical: how can one build privacy-aware apps that do what people want in a transparent and usable way; (c) commercial: how can one construct an internet that does not allow large corporations to suck up and exploit vast amounts of personal data but still benefit from the advantages of sharing data. Interoperability of different personal data solutions Reliable and usable systems for establishing trust. Need to focus more on the use of the data rather than the data itself.
TA 4 Distributed architectures and decentralised data governance Virtual currency & digital ledgers Governance & Policy Data Management/ Ownership Actions to addres infrastructure Performance Legal Scalability & Efficiency Standards & Protocols	Blockchain interoperability and standards, balance between freedom control and security - One essential point is to address the imbalance that exists between the people who create/have rights to data (social networking users...) and the ones that would like to access the data, analyze/exploit it. As we have seen in the creditworthiness field, when users are obliged to share their data to access a service, they will sign/allow access to anything and everything! Therefore, it's not so much about "data control", but about setting up a governance body which has the power to decide which data processing is ethical/legal and which should be banned. - Scalability solutions for DLT - More eco-friend consensus mechanisms (rather than proof-of-work) - Network neutrality proposals for blockchain network layer - Coupling of communication and storage inside the networks, in servers or personal devices (availability of data, security, atomicity of transactions, ….) - Decentralized autonomous organisations based on new ways to handle data and transaction in communities - Performance and energy consumption for DLT - Managing information like reputation in technologies like DLT

	- Social, legal and ethical issues for block chain 2.0 as well as for block chain 3.0 (so-called Distributed and Autonomous Organisations)
	1) see previous answer on "Personal data spaces"; 2)increase availability and knowledge of personal servers 100% made with open hardware
	1. Modular and iterative design to integrate the customer's need into the software lifecycle. 2. Proposal or operation of distributed services type SAAS (horizontal approach). 3. Self-reconfigurable, hyper-agile software. The system must be able to evolve on its own without programmers intervening. Self-adaptive algorithms for evolving contexts. 4. Virtualization as a means to replace the software without impact to the customer or the user. 5. Manage the multitude of languages, the services provided and adapted to each need. Interfacing between languages (vertical and horizontal). 6. Domain Specific Language (DSL), model-based approach, web application development / Script (javascript, python, etc), components and plugins, source availability.
	5G research calls, Cloud Computing calls, HPC
	A key challenge is to keep data only at the user level and allow on-demand access by third parties. Such a system would disrupt the current business model of the internet actors, but I think for the best.
	A wide range of research and innovation actions addressing cloud innovation, IoT innovation, Big Data innovation, and open software and hardware systems.
	Accountability; Redemption; ability to make mistakes and experiment; fraud modelling
	all information related to a person must be seamlessly under her/his control explicit authorization to use/access personal data must always given at ANY time it happens all user credentials should remain on the user´s equipment.
	an open european distributed ledger technology platform with smartcontracts
	authorization and identification of publishing devices to DLT balancing data security and safety with enforcing privacy legislation and related human rights, as well as data access control and oversight
	Balancing sender and receiver rights – The network will do its best to serve the interests of the sender AND the receiver. – The network serves only wanted traffic to the receiver (assuming that the receiver is battery powered)

	– alternatively a receiver may wish to receive everything that was sent. – Receiver may have an agent in the network. – It makes sense to delegate all security processing for baery powered devices to a network based agent. Cooperative Security – Initially for a network slice – Trust domains, sharing of security incident and pattern information – Automated sandboxing of malicious nodes – Although there is no definition of “malicious”, in practice good heuristics exist, let us use them to their full potential! – Cooperative security follows the one-for-all-all-for-one principle within a trust domain – A use case: all critical services of Information society could be in a slice with cooperative security -> DDoSing would be tackled.
	Billions of sensing and and acting devices are already out there. Smartphones can be seen as the largest sensor network on the planet. Orchestrating the devices for collecting (even realtime) data will be a main research concern in the future. We have so many devices out there, but no-one really thinks about architectures to use them and to adapt to changing or recognising failures in theses devices while being integrated in a recognition process.
	Blockchains Blockchains for data provenance and usage information. Avoiding vendor lock-in to cloud systems Business models to support the various players (data providers, service providers, cloud providers, ...) in such a distributed ecosystem Approaches to fuse data from multiple sources, where each source has different access restrictions Algorithms to ensure data quality, and improve it where necessary Technology to make all data and services discoverable and usable in a straightforward way Blockchains, Big data, Open data

	Broadening BlockChain Use challenges in this are mostly political Challenges: Blockchains and distributed ledger technologies need further research and pilots in various domains. There is quite a number of trials in the financial sector but more is needed to put these technologies in use. Also domains e.g. contract handling or energy sector have already been touched upon but need further research. Cloud computing, noSQL data bases collective action platforms, seamless means of participation, Combining DLT ad P2P technologies to provide effective support for communities Creation of strong open protocols for the exchange of data. Critical challenges to be addressed in this area are the reinforcement/introduction of last-generation information cryptoprotocols (such as the blockchain technology) to ensure decentralized data storage and anonymity; the scalability of this blockchains technology; the reinforcement of privacy-protecting digital identity management and cryptographic security. data recovery, data security, Governance and Audit of Information Systems Data, algorithms, and our technology must be owned by individuals, not corporations. Decentralised approaches to coordinate discovery and identification under control of end-users. Management of data ownership. Decentralised architectures have been quite successful for personal data sharing and other scenarios. The introduction of blockchain technology brought up new possibilities in relation to data provenance and data alteration. Still, the full potential of such technology is to be understood and exploited by opening it up to novel domains beyond the ones that have been mainly driving its development (i.e. cryptocurrency and digital contracts). Also, policies and business models are challenged by technologies such as blockchain and distributed ledger, and will need to adapt or be re-thought. As proven by several recent digital businesses, policies are often too late compared to the evolution of technology, and trying to apply “prohibitions” (mostly to protect traditional market players) won't work. NGI should explore the 1) adoption of decentralized architectures in novel scenarios, and 2) creation of novel Internet business models based on adoption of decentralised data governance. Decentralised data storage and use for self-organisation and personal control. eID and blockchain (DLT). eDemocracy Defining open standards which are not manipulated by corporations and definitions of standards are made available for free.

	deregulated access to high speed high quality connectivity on demand (IP TV applications)
	Devloping a diverse enough infrastructure of the internet is important for cyber attacks and a single point of failure
	digital identity management, attributes & entitlements; (homomorphic) encryption; distributed storage; novel approaches to governance
	dispersed computing ; resilience of system; low cost high performance systems; power efficient and green distributed systems
	Distributed architectures and communication systems; Distributed algorithms for ensuring correctness of distributed systems; Distributed trust (e.g., blockchains, etc.); Flexible information distribution and content delivery
	Distributed architectures of the future need to comprehend emerging developments including hardware-enabled accelerators (e.g. Silicon photonics, FPGAs, crypto-accelerators), and disaggregated hardware architectures e.g Rack Scale Design. For practical reasons they need to be as autonomous as possible: self-managing, self-optimising, self-healing.
	Distributed data store and processing for real-time big data. To address the problem of where data should be processed for smart cities. To protect the data by itself, like in information-centric networking. Novel architectures that merge blockchains, P2P and future Internet. To develop new hardware for distributed big data processing.
	Distributed databases; blockchain technologies
	DLT have the opportunity to completely redefine how network architectures are built - it can redefine the way in which protocols operate as well
	eg. financial world
	Energy efficiency of distributed technologies, especially blockchain.
	EU scientist have to logically Cooperate, but preserve as well their scientific/cultural/ creative independence
	Failures, Faults, Errors
	fed4FIRE
	From my perspective Tech Area 4 is a natural complement to Tech Area 1 and 3, which may provide (sub-)technologies for enhanced security, resilience, transport mechanisms and desirable transparency or privacy for the design of e.g. Personal or Corporate Data Spaces. This is extremely important, but is is also important not to develop specific Distributed Ledger

	Technologies for their own sake, but rather in close cooperation with relevant practical applications of the technologies. Fromalization of DLT technology, DLT channels for micropayments, DLT based P2P netoworks Fund European R&D on Blockchain (500 M€ over next 2-3 yearsà as well as VC Funding (Same amount, same time frame) Genuine attribution (identity) and transparency Give citizens ways of tracking their own data and choosing what to share to who under what context. governance // human in the loop // governance of distributed systems is critical How do we make digitalized money common? Todays money is old fashio. Bitcoins have will be the new How to communicate to traditional companies that blockchain is radically different from their traditional business, and when they try to assert centralised control over "blockchain" it's not a blockchain any more How to enable large-scale cooperation in collaborative communities, harnessing the potentials of the blockchain? And how to reach an appropriate calibration between technical/algorithmic governance and human governance, to boost large-scale cooperation? How to establish new norms while phasing out old practices; processes of progressive change to apply already available technical solutions If nobody is in control, who is responsible when it goes wrong? Each technology has risks and benefits. We should explain the risks better to the users. We should also make sure that what is created is not used first by people who are trying to do unlawful things. We make things more and more complex over the basic Internet but nobody seems to care on how to sustain the growth in traffic. Who is paying for the infrastructure? Why should the network providers continue to upgrade their network if they cannot make people pay for what they really use? Industry 4.0 interdisciplinarity and transdisciplinarity, decision-making, ethics, ownership, complexity, usability, techno-optimism, locality, the importance of face-to-face contact to build trust, conviviality Internet is by nature a decentralized, distributed system. This is a key attribute for the success for the Internet. Open standards and open source (software/hardware) are building blocks that can be used in their appropriate roles. This does not mean that everything should be for free thought. Interoperability, formats, metadata, protocols, acces to public (cheap) cloud computing, Issues of scalability of this architecture towards large data management. Currently most data is about

	limited data scopes, this should be challenged via an adapted architecture. Can be design "safe" URI schemas to use in digital ledger technology referring to larger data storage, including how to secure these by design. It is a big challenge to create businesses based on all kind of data now available. Especially thinking _big_ data, security & privacy issues, efficiency and openness. How to make small data business (applications / services) such that it would be as easy as making e.g. applications for Android phone market at the moment.
	It should have mechanisms for identification and authentication of data sources, entities and for usage authorisation through comprehensive and complete access and usage policies with secure policy enforcement. The delegation chain shall always start at the data origins, its source or its owner.
	Legal issues. legislation to ensure database operators have sufficient up to date expertise, and diligence, to prevent hacking. Financial penalties, and loss of Data Management license, for breach of data store by unauthorized parties.
	Linux, Open Office
	Managing trust, ensuring scalability.
	Necessity of providing complete and coherent regulation on digital currencies e.g. Bitcoin; Social influence of peer-to-peer technology on internet users; Rethinking attitude towards cybersecurity; Influence of peer-to-peer lending money on SMEs financing and SMEs business model; new decentralised algos with more mature operational support functions (revocation, refund, trace, etc)
	New Forms of Organisation; Skills; Business models; Interoperability; Cybersecurity; Dispute management; Supply Chain Management. For example, develop and apply innovative data protection and information security techniques to build trust and create strategic partnerships necessary to achieve significant cost reductions in industry supply chains. Allow access to data to be controlled by membership and role, content, context, time, place and need all within a clear governance structure of trust.
	open innovation for the digital society; open hardware; open software; decentralised storage and management of data
	Originally, Internet was supposed to be decentralized, but the extreme centralization induced by the domination of Cloud Computing and centralized data storage has distorted this promise. Moreover, end-users data are often handled by large companies, which assume power over their data. New forms of distributed systems such as initial blockchain or more recently Ethereum has made a proof of concept that large decentralized organisations may create trusted ledger/contracts in support of transactions without central authority. These technologies make emerging a lot of new research subjects mixing theoretical modélisations in distributed systems, proved algorithm, economics. These theoretical approaches must also be experiments on distributed platforms dedicated to this purpose.

	Partial, revocable and time-bound disclosure of personal information
	peer production and services and network governance Personally controlled digital entity representing a real, commercial, or fictitious person, that cannot be copied
	Privacy, security Privacy, Security & Open source
	privilege life skills to co-design infrastructures platforms and devices include people's experience in designing
	Real impact and financial revolution
	Real time application. Local computation. Fog computing. Reinstall one of the first principles of the internet: decentralisation as a pillar to guarantee resilience: against natural damages, cyber attacks but against tentatives of control made by states or large actors of the internet and, more generally, of the economy.
	Resiliency, Traceability, Ensuring a web of trust among peers, Growing an Open Hardware ecosystem
	scalability of blockchains, privacy-protecting digital identity management, cryptographic security, governance of blockchains, regulatory aspects, development of use cases
	Scale, replication, distribution, fast, dynamic, secure information acces through flatter architectures.
	secure authenticated mesh networking with transparent perfect forward secrecy
	Security. Storage. Speed.
	Secutiy issues Self-organised management that reports to end users
	services and network governance and peer production
	Shared Resource and Industrial data repository
	should be more human - social, easy, immersive, emotional.
	Software development frameworks for IoT systems, New Internet Protocols, Global computing
	Sustainability and energy efficiency. All blockchain protocols suffer from a fundamental defect: to guarantee stability, each participant is incentivized to invest as much computing power into the chain as they can muster, competing against all other participants. Once blockchains in their current design go mainstream, they are doomed to become a dominant factor in global warming and resource exhaustion. New designs are needed. This is yet another reason why European research in cryptology must receive additional funds!
	The accessibility of personal data from distributed sources under the control of the individual is key. In this way organisations and applications can have access to data from an original source with permission of the individual. This could be described as 'personal data virtualisation': people don't need to own the data about them, but they can have access to it and share it with parties they trust.

	Essential in this system is the control by the individual, which is expressed by means of 'declarations of permission'. Blockchain technology offers some interesting possibilities for these declarations of permission, which can aid the transparency of the process. The issues related to distributed structures, whatever they may be, remain difficult to grast and trust. The reason is that we are so accustomed to pyramidal structures with clear chains of command. Yet, as Yochai Benkler aptly argued in his well-known book, The Wealth of Networks, these modes of social organizations can unleash unexpectedly extraordinary results. The free software movement is a very good example of this: Linux is everywhere, except on the desktop. Learning how to grow such networks, and make them reach their objective will require studying such networks from an interdisciplinary perspective where hard sciences, including mathematics, and social sciences must collaborate. The Object Management Group (OMG) has long promoted distributed technologies, alongside with a few others in the field of hardware and software. By and large, the needed technologies are known, but the Internet architecture must evolve to improve latencies and security due to distribution. Private clouds need better firewalls or gateway controls, whilst block chains, and peer-to-peer technologies have already shown their weaknesses as well as the legal challenges they cause. A simpler and probably more efficient way is to evolve the basic IP packet structure, so that the individual packets can carry tagged header information giving control to the data owners or service providers. This enables decentralized data governance, yet allows to migrate the existing routing infrastructure. These challenges and issues have all been identified by the Internet Architecture Board (IAB). The transition from proprietary databases to a decentralised model	

	The vision of CSG/M, includes Metaloger Labs that enable the results of every aspect of human behaviour to be a living part of managed existence, becoming a universal eco-system of human purpose There appears to be a fair amount of research going on in this area. Based on my understanding from recent conference talks, a key issue for various bloackchains type technologies appears to be computational cost. A single bitcoin transaction apparently costs around $5 worth of electricity consumption for the require computations. This area is useless unless Europe enforces effective anti-trust laws that are implemented on the spot. Work on local alternatives for Uber and AirBnB. It's not all that hard. But at the same time also dismantle the Cloud. Be serious about decentralized infrastructure. This is not an empty phrase. Close the data centres. That would be a start. We cannot have it both ways. This area is not about good intentions. EU policy should not be a joke, in that sense there is lots to learn from the Chinese: defend European companies and markets. Do something. trust in the people, avoiding surveillance, copy-left use and control of such technologies players | public aspects of blockchains verification and authentication on an open public ledger very related to technology area #3. I would add - Data fusion (related to governance) - Distributed data storage and data analysis architecture - Distributed VM infrastructure - Virtualized end-to-end systems (how to build a totally isolated network of objects and machine located at different location) - Real-time distributed analytics (Map-reduce on different machines in real-time) virtual currencies, mobile wallets, blockchain enabled authentication
TA 5 Software defined technologies Strategy & Approach Technology Governance	- Predictive load balancing techniques in fully distributed, decentralised ICT systems - Development of PAAS to orovide highly scalable infrastructure - All elements of the Internet are now “software defined” (software-defined anything, network, computing, storage, etc.): global consistent views and models to more formally address cross-cutting concerns like security, resilience, optimisation, energy efficiency

Interoperability & Open Standards Robustness & Performance Ethics, IP & Law Traffic Enginnering Standardisation	- Machine learning for the control of all software defined functions both at a local level (short control loop) and global level (autonomic systems) - Computer-aided audit and optimisation of software with regards to security, availability, resource consumption, etc. - Managing the higher degree of business flexibility provided by software-defined technologies - Machine-readable, extensible, future-proof standards to describe distributed resource capabilities and (potentially distributed) workload needs. - Autonomous, distributed, hyper-scale optimisation techniques for workload placement
	"stickiness" of applications in the mobile environment **1. Modular and iterative design to integrate the customer's need into the software lifecycle. 2. Proposal or operation of distributed services type SAAS (horizontal approach). 3. Self-reconfigurable, hyper-agile software. The system must be able to evolve on its own without programmers intervening. Self-adaptive algorithms for evolving contexts. 4. Virtualization as a means to replace the software without impact to the customer or the user. 5. Manage the multitude of languages, the services provided and adapted to each need. Interfacing between languages (vertical and horizontal). 6. Domain Specific Language (DSL), model-based approach, web application development / Script (javascript, python, etc), components and plugins, source availability.
	100% programmable transmission equipment, e.g. telecom masts and sender/transmitters in cars, devices A wide range of research and innovation focused on software defined networks and software defined physical transmission. SDN networks require novel traffic engineering solutions that can exploit the global network view, network status, and flow patterns/characteristics in order to achieve better traffic control and management. State-of-the-art in traffic engineering for SDN with attention to four cores including flow management, fault tolerance, topology update, and traffic analysis. Challenging issues for SDN traffic engineering solutions need to be addressed.
	All components of NGI are “software defined”, from the basic components and resources (network functions, computing and storage nodes, devices) to all the applications and services including the high level management functions. It enables evolutivity and openness but requires additional models to

	address consistently cross-cutting properties like security, resilience, optimization, energy efficiency, etc… The software-defined technologies, along with availability of data from all levels, will introduce new levels of autonomic behaviours, smarter decision making and more efficient tools for network, system and service design and development. The software nature of NGI enables more flexibity and variability in the value chains and will introduce new actors, especially disruptive ones (such as technology startups); it will have impact on the nature and number of business models and on the way regulations are enforced (privacy, cybersecurity, ...). Architecture-oblivious SDN, User-friendly SDN service definition, Conflict resolution Automatic management, provisioning and deployment. avoid tecno-regulation made by algorithm, open source of code for transparency, certification of the code Balance of sharing technologies and protecting commercial/innovation privacy. Co-developments with major players useful, but pushes out small enterprises and over-centralises the technology. Building bridge between actual world and software would be challenging. Software needs to evolve to understand and react based on context and circumstances. BYOD technology,QR codes, digital watermarking and barcodes, IOT API management and security. Choice between proprietary and Open source software community-based decision making and incentivisation, privacy, market mechanisms Considering the software is everywhere, this is just the continuation of an existing trend. Control and visibility over who controls what. (Comment: "Software defined ..." is not a useful identifier for this area) Control of virtualisation converged control of of converged (network/compute/storage) ICT core multi-processor capcity increase, big data algorithms Current systems are 'programmed' at a very low level, opening many opportunities for error. High level descriptions of what is intended to be the case (including invariants that should always be true) need to be compiled to (or at least compared with) the low-level software configurations. This needs to be automatic and fast to enable the full potential of software-defined technologies to be realised. A further challenge is to properly manage the performance consequences of network virtualisation; simply locating a function where the computational resources are cheapest may not deliver the best outcome. data analysis and making sense of data for everyone data and device security

	dependability, trustworthiness, certification; is the software doing would it should, no more, no less (think about the Diesel-gate scandals); new technology is needed to check whether what is delivered is what we want. How do we now that internet equipment (routers) from some manufacturers, be it Cisco or Huawei, do what they need to do, but nothing more (hence, no filtering, spying, backdoors, etc.)
	Determining the priorities when it comes to the queue of requests/demans; Protecting personal data in this aspect;
	Development of applications for smart cities, FoF and healthcare based on FIWARE platform.
	development speed & training of developers
	Die Herrausforderung wird sein, Systeme zu schaffen, welche es erlauben, digitale Jobs die für ein in der EU angesiedeltes Unternehmen, in dritt Staaten erbracht werden, trotzdem eine Wertschöpfung für Europa zu bringen.
	Ensuring interoperability, avoiding vendor locking and proprietary protocols and platforms.
	ensuring network stability and efficient contingency plans; data access control & oversight
	Ensuring security and satisfactory performance of the software-defined technologies
	Especially in network technology (SDN/NFV), a key challenge will be to ensure that vendors really comply with open standards and to ensure interoperability to a high degree. Without this, there will never be a viable ecosystem and what I have seen to date gives me little hope that vendors are working towards this. We risk spending a lot of time developing custom integration software to deal with the peculiarities of vendors, while such an ecosystem can only come to full fruition if there is true standardisation. There is not yet an "IBM PC" of SDN or NFV that can serve as a template for a large industrial base to produce compatible and competing products.
	every node as a server, hyper singularity, connected but not embedded
	Flexibility is the key. So software will become the backbone of allmost all products. Flexibility refers to system designs that can adapt when external changes occur. In the context of engineering one can define flexibility as the ability of a system to respond to potential internal or external changes affecting its value delivery, in a timely and cost-effective manner. Thus, flexibility for an engineering system is the ease with which the system can respond to uncertainty in a manner to sustain or increase its value delivery. This can be achieved with software engineering methodologies.
	Flexible and dynamic scheduling. interoperability, standards
	friendly SW operating system fast low-consumption HW

	From a technical point of view it will be critical to address: • Operating Systems/Platform capable of facing a growing “complexity” (from managing close boxes to orchestrating a sheer number of s/w processes); • Security by design; • Control and orchestration technologies and platforms able to fully automate network provisioning and configuration processes, providing customers control over their services and supporting complete lifecycle operation. It is also important that new wholesale products coming from virtualization (i.e. Network as a Service) could be freely commercialized without regulatory constraints. Future Internet will be software defined to the fullest extent, allowing the tuning of the network for various application domains via "network slicing" and addressing the current security and management issues of the Internet. Flexible management and deployment: replacement of one node at a time, adding Modes, Apps, Slices, Network Functions to nodes. Separation of Apps from the network: layer independence – Ease of changing underlying network – Opposed to simplistic end2end principle – All new protocols must be NAT friendly – Forced by ubiquitous NATting Ease of experimentation – Network wide (including mobile network) wide experimental systems and Apps should be easy to	

	deploy without disturbing other systems and Apps – An experiment may include network func)ons that are unknown in normal Internet – For example we may use network slicing
	**Future-proof, extensible, machine-readable standards and protocols need to be defined to support the introduction of arbitrary resources to a system, exposing all capabilities (including previously unknown functionality). To support potentially hyper-scale deployments, the complete life-cycle should be supported to minimise (if not remove) human interaction, and optimise performance and efficiency throughout the lifetime of the hardware or software. Hyperscale autonomous management and optimisation of software defined technologies needs to be realised. Technology, provider, and workload requirements and constraints all need to be described appropriately, and accommodated autonomously.
	Getting politicians to set out proposals as algorithms, satisfying GDPR which blocks automated decision making based on evidence and artificial intelligence where companies do not know the current state of their system, let alone can explain it to users and regulators.
	How to cope with the complexity and at the same time manage trust and security. How to use software-defined technologies to improve quality of service/experience
	human control available in a smart robotic society based on traceability and clear definition of responsibility
	I have indicated in other Topics my personal understanding in this RTD & I challenge, without strict Rules and endeavors' specifications
	important to control activities and business
	Improved reliability of highly dynamic software defined systems Increasing competitiveness of SMEs; Developing capabilities for Open Source and APIs; Optimising Life Cycle Management Increasing he speed and accuracy of software-defined technologies to meet needs.
	Integration of new technologies in existing business models and behavioral patterns
	Inter-domain SDN remains challenging. Initiative so far aim at defining a unified substrate, while the

	most promising approach is negotiation. Control architecture to be revised. Since the SDN movement is based on the separation of Control and Data plane, the way control functions are distributed need to be revised. Centralising, as most commonly suggested is not a solution. Switching from a push control plane model to a pull control plane model. The NGI will be so big that having a push based control plane (push control information to all control entities) like today's Internet will just not work. What is needed i a pull based control plane (control information requested on demand when needed), but this model has been not extensively studied in the context of Internet. Involvement of end users It is a current topic, it is relevant but it is already there. It is crucial to invent and develop interoperability protocols and mechanisms enabling to cohabit SDN and legacy network management technologies. Another challenge is about added delay between control and data planes that may influence the performance of network management and control processes. This constraint should be considered while designing SDN controller and switch as well as southbound and northbound API. Communication overhead between controllers and switches has to be reduced using learning approach. With the SD perspective, the network operator has a better monitoring of the network state and easier control of network resources. The current shortest path routing in IP networks can be replaced with more opportunistic solutions. In the context of 5G wireless networks, there will be further densification of antennas and users (including non-human devices) and the SD approach can help to cluster and allocate/reallocate resources in wireless networks more efficiently and rapidly It is not a research topic, but a strategy that requires work to be done. The challenge is getting funding for engineering work, not for R&I. It's importatn that open APIs allow impact on fast and standarized initiatives Language technologies will be critical for these challenges. It will be necessary to work on linguistic (not statistical) methodologies and techniques to analyze languages. It is necessary to work on lexical semantics and terminology, to create ingenious dictionaries useful for human and machine users. Legal issues. Localisation or adaptation of software from source to target languages is still an issue. Different surveys demonstrate the one global trend that 75%+ of respondents prefer to use software with UI in their mother tongue rather than excellent English. Fast and a high quality of online translation is still a challenge for majority of services. Low cost and low price of IoT devices and accommodation of their functionality in the current available spectra, as well as, security of operation will be a major issue. low cost software defined radios, spectrum re-use	

	Master these technologies
	Methodologies and tools for system analysis and design facilitating early validation of solutions by end-users
	mobile apps
	Model driven engineering
	net neutrality, anonymity
	not needed - leave application development to market
	open architecture and governance
	Open software
	Open source , open data platforms
	Open source, open standards
	OpenLabs and existing uses of user-driven software routing needs to capture more of the content of
	Predicting aka modelling all relevant End-to-End QoS changes prior altering the resource orchestration
	Privacy, Security, Open source & stability
	privilege life skills to co-design infrastructures platforms and devices include people's experience in designing
	Programmable devices ; updating technologies in the field ; resilience of Software defined technologies
	protecting the (knowledge of) system programmers
	Reduce software and increase hardware
	Regulation of software and legislation on software misbehaviour
	SDN has been being regarded as the building block for 5G and, overall, flexible networking control. Assisted by other technologies, such as cloud and NFV, it has the potential to shape how networks are integrated and made available to a wide range of audiences. It is, however, just the tip of the true potential, allowing us to imagine all the potential breakthroughs that can be realized through that paradigm.
	SDx are a de-facto standard in the management of large data centers and networks. Technologies like OpenStack, OpenDayLight are becoming the dominant solution in the private cloud market and are also adopted by several public cloud providers. Still, their actual application is quite limited. They are entering now the network function market, but other areas remain mostly unexplored, e.g. broadcasting, manufacturing industries. A key challenge is to move the adoption space of SDx from the business to the prosumer and consumer markets. One the one side, the complexity of such technologies is too high to be mastered by small companies and end-users, on the other, the application area of such technology is limited to data centers and their networks. NGI should support the extension of SDx adoption a wider plethora of infrastructures beyond cloud and networks and foster SDx adoption toward prosumer & consumer market, supporting their adoption in “personal infrastructures” (e.g, smart home).

	Security and Privacy first, then performance and efficiency Security concerns as well as open interfaces to avoid vendor lock-in. should be a real agent of change towards sustainability. software architecture, network architecture analysis Software based technologies will be most relevant where hardware has not yet the flexibility it should have: some functions in communication networks, in home boxes, and many more. In order to reach the point where software based technologies can take over some of the functions of hardware elements, there is still a long way to go to achieve in software specification, validation and testing, the equivalent resilience levels in hardware for real time processing functionality. The efforts must therefore go first into software specification standards for real time systems far beyond UML, in formal verification, and in testing. Software defined cloud services, and the standardization thereof that would enable the federation of cloud services from different providers Software defined network should be available on any network device, even at home. Software Defined Networking (SDN) is the latest revolution in networking innovations, which makes the whole Internet more flexible and efficient to use.There are two other ICT paradigms - IoT and cloud computing - that challenge the SDN solutions in the future. IoT revolution will bring billions of electronic devices on the Internet that create a lot of challenges to the networks including complexity and security. SDN has the capability to provide the appropriate tools and solutions concerning these challenges for the IoT sector. Cloud computing is one of the most powerful and efficient tool for businesses, however, its full potential cannot be realised if loaded with conventional networking hardware. Therefore, SDN technology - together with Network Function Virtualization (NFV) - is also very important for cloud services. In order to come up to expectations of SDN a lot of research efforts need to be done in both areas in the future.	

	software defined networking, Software defined networks, Software defined infrastructures, Software functions chaining Software defined technologies are in place for years. Currently we can conduct firmware update or update programmable logic device including field-programmable gate array (FPGA). The key challenge is in making sure that updates to software residing in hardware will be consistent with safety and security of an operating system (OS). So Safety and Security -- as always. Composability of technologies requires verification tools which can prove consistency of the system after an update. Software defined technologies are still innovating in the cloud solutions, but if i take the overall situation are the most solutions not secure enough Software defined wireless networks can play critically important role in realizing, for instance, Internet of Vehicles -platform. The centralized architectures however may not be able to meet the level of dynamism in the environment and corresponding "timely" requirements. Although hybrid architecture with partly offline algorithms form a good part of SoA. However, virtualization and reconfiguration overheads can eventually form bottlenecks for an environment as dynamic as in IoVs -scenario. Standardization of protocols for SDN, multiplatform libraries for controllers, configuration of differente abstraction levels, software for heterogeneous networks Such systems will need to be complemented by intelligent systems capable of feeding in the necessary boundary conditions upon which they operate. the complexity gives hidden firmware, non-transparent SDN functionality - so it should be OPEN SDTechnologies the consumer has to accept these ununderstandable products The evolution towards the integration of life and computational sciences will mark the essential meaning of this, i.e. human behaviour designs the future of all our world (and potentially the cosmos, even) The Internet itself, as it evolved from ARPAnet, and its Vax-based IMP's, demonstrated the full power of software defined technologies. The trend is unmistakable. It has been going on for a long time. I cannot say more about this. The robustness of the Internet came from its relative simplicity. All the attempts at making it more complex are dangerous in that they may affect its robustness. I believe that SDT make the Internet more vulnerable. The software quality and error-free code must be ensured. Double check and fault tolerance shall be provided where certain high-availability requirements applied. To release the true potential of software-controlled infra-structures, far beyond OpenFlow. To create a novel control plane totally software-controlled. training, economy, making sure employees and school leavers have the right skills to work and improve in this area

	Transparency, Open-source access. Security. Storage. Speed. user interface, needs to be an easy and simple access point but the back end would be running complex processes. Users want a program to be able to do everything, but they don't like being confused by it, most don't understand how complex data actually is. virtualisation Virtualized end-to-end systems (how to build a totally isolated network of objects and machine located at different location) embedded internets We need to think about the ethics of algorithms that made decisions that affect people's lives, e.g. credit ratings What if the computer is down ? Within the evolution towards software-defined technologies, some challenges are community-based decision making and incentives, privacy, market mechanisms, replication and duplication
TA 6 Networking solutions beyond IP Philosophical Backward compatibility Updating/ replacing IP Infrastructure Performance & Quality Security & Privacy Independence Access challenge Network Management	- API development and usage - 0 latency wireless and wireline networks with decentralized architecture and "intelligence" - IP address management, dynamics, security - Again, this is linked to the ongoing research on a decentralized web. The EU should support developers that are looking at solutions to these challenges but that propose open source solutions with no motivation through personal gain (as opposed to solutions from ISPs or other parties which have a vested interest to propose a solution over another) - Embedded security in the communication protocols - New way to address naming and routing in federation of edge networks - Content centric networking to optimize the tradeoffs between storage and communications - Keeping backward compatibility and designing an optimal migration path "The internet of the future should be able to overcome these limitations" 5G, Cross cutting priorities, EU International cooperations A key challenge will be to take back control as academics and innovators, from the large (US) companies that currently dominate the Internet. While it is worthwhile that technologies like SPDY and QUIC are finding their way into the public domain and standardisation bodies such as the IETF, I find it extremely worrying that these technologies are in essence developed under a veil of secrecy and then

	"dropped" on the Internet through the use of market share by companies like Google. This presents the global Internet with a "fait accompli" which is hard to reverse and frames future developments in the sense that the starting point is already defined by the technology they drop into the public domain as if they were pearls before swine. A lot of research has been done already, for example in relation to the Recursive INternet Architecture (RINA). The challenges now are how to get this technology deployed in the face of vast inertia and vested interests. Innovation is required in the formulation of regulation and purchasing policies so that these new solutions are not excluded.
	Ability to deliver to the home and to remote areas, and not just to businesses and urban centres; need to avoid marginalisation of rural and disadvantaged areas.
	access for all
	access to high speed high quality connectivity on demand (IP TV applications)
	all sdn like and virtual architecture.
	Are the "limitations" and "Problems" of TCP/IP actually deliberate design features? What do we lose by "solving" them. Does that enhance humanity or diminish it? avoiding designs which are too tailored to present needs, avoiding designs derived by ideology (e.g., network neutrality), looking for a new generation of general concepts, capable of serving the user needs for the next 50 years
	beyond 5G
	Clean slate architectures, landing IPv6 in real deployments, making IPv6 networks securre and resilient
	Compatibility of new protocols with existing ones can be a prohibitive challenge. Internet2 would need to be developed from scratch and offered in a very specific area of application -- like telecommunication and extreme privacy protection with general public safety and security in mind.
	contool of data transfer by IOT and security To what extent the Cloud technology may be safe
	Current and future ICT use cases include 4K videos on various devices, massive IoT, drone control, connected cars and VR/AR. Most of the data traffic on the Internet now is multimedia and streaming video, which will be increased tremendously in the future after 5G services being deployed. The current Internet technology based on the infrastructure using TCP/IP protocol suit will not be capable of managing the future applications and the huge amount amount of traffic. Therefore, we need new, advanced network protocols that meet the emerging applications and services in the 21st century. The stability of the current Internet mainly provided by TCP that is responsible for the transfer of data packets and the congestion control on the networks. One of the main research challenges of the NGI is to have a new high-speed TCP protocol that is capable of serving applications from IoT to real time video, and 5G networks.
	DDoS is something to be solved with better network protocols.
	decentralised architectures
	development of alternative mechanisms and networks
	Development of alternative mechanisms and networks

	Devolution of IP allocation through flexible and safe channels disruption tolerant mesh networking should be reconsidered. Both DARPA and a Swedish University have studied protocols beyond TCP/IP, to my knowledge. yet when I personally asked France Telecom research what their 'beyond TCP/IP' plans were in 2014, they had no answer. distributed governance, politics Ensure net neutrality of new protocols ensuring interoperability and deployable standards between key players and new entrants; ensuring net neutrality; avoiding walled gardens or the potential of their growth Generalising rapidly IPv6 appears obvious. This standard has been around for over twenty years, and we are presently lacking addresses with IPv4. Finding the socio-economic pathways to this much needed transition is crucial and all efforts in this domain should be increased by an order of magnitude at least. Generic research on the topic - FIRE and related initiative has proven to be a wrong approachs High throughput, low latency and secure communications are key. Challenges remain at infrastructure and architectural levels rather than access networks/devices. The frozen architectures of Internet routers must be challenged. Even with the progress in microelectronics, and with their growing software heterogeneity, the actual routers should be replaced by programmable optical routers and subsequently by quantum computing routers. Other challenges are those encountered by 5G and beyond, where the heritage of spectrum management principles hindered progress towards higher performances. Also, rather than service provider determined QoS, the architectures should evolve to user specified and controlled quality of service, with the service providers offering certified capabilities. New architectures can also have a positive impact on functions, as they push them towards new challenges. Finally network access tariffs should be swapped into individual tariffs; as in reverse auctions. How to develop that tools that will control the rate of transmission of information from A to B I think backwards compatibility will be important with older standards as long as people use these other standards within their networks	

	ICN
	implementation of ipv6
	In previous topics I have clearly defined my personal opinion as an active professional RTD/ICT Engineer not an Academic Research & Development profession
	Industry 4.0
	interconnection, gate keepers
	interoperability with legacy protocols
	IP is an obsolete protocol that a lot of old people push. WE need to scrap IP and think from scratch.
	IP mobility, geographical routing
	IPv6
	long distance transmission and network coverage blackspots. mobile phone companies promise better coverage for things like 4G but the geography of certain countries still causes problems with signal strength. Improving how information is transferred will be dependent on the quality of the infrastructure available to send it through.
	Low latency (a multifaceted problem)
	Making Information-Centric Networking ready, secure, and proficient for practical use. Seamless transition from current IP-based protocols to post-IP protocol world.
	Many challenges on current architectures will not be changed by evolutionary approaches. More deep change is required. We approaching the end of unique stack with TCP/IP. What we need to do is to create meta-architectures that enable Internet evolution. No one wants to lose the gains we have achieved with the Internet, neither the investments done, but we need to seriously think about how to decouple policy making from underlying technologies (IP, DNS, WhoIS, etc). Global interoperability is not an excuse to make the Internet obsolete. We need to keep the Internet working and evolving, but we also need to replace Internet technologies when they become obsolete. Not facing this problem can feed competing solutions to the Internet that does not preserve its fantastic achievements. We as a society should starting developing this new meta-arch where TCP/IP and novel Internet proposal can inhabit, such as RINA, XIA, NDN, GIN, NovaGenesis, IDCom.
	Maximising Interoperability, Privacy, Security and Resilience; IoT applications in Smart City environments, e.g. intelligent mobility.
	Naming, Resilience, Applications, Management network architecture analysis, Telecommunications

	Network infrastructure needs to be self-managing, self-optimising, self-healing. Different classes of data being transported need to be handled and managed and secured and metered appropriately. Any constraints on data in transport should be accommodated automatically.	
	New Internet Stack (embedding of application layers into lower levels) New IoT "light" protocols Next Generation of IP, non-packet-based network protocols	
	Open source, open standards	
	Otical networking, with routing capabilities below the IP level, lambda switching, etc. Cloud-based networking solutions.	
	pointer (url, uri) IP-packets, internet in clouds. Appart from this, Internet should be regarded as a protocol that enables the exploitation of the underlying telecom infrastructure. Making IP more complex hinders that. Instead, SDN and other layer 2 technologies allow the engineering of advanced networks	
	privacy, security Privacy, Security & Infrastructure design	
	Prototyping and trialling of technologies more suited to the 21st century than IP. Selection of appropriate technology and planning migration from IP, maybe starting with 5G RAN. Adapting applications so that they can use the new levels of service to provide a better user experience.	
	QoS request & fulfilment based billing; next generation ATM (VNF & network slicing); QoS maintaining flow transfer mechanisms (cognitive scheduling engines); time-deterministic IP-packet delivery (synchronous data transport); ...	
	radio-frequency identification (RFID), near-field communication. Realtime protocols	
	reinvent and redesign from scratch all communication protocols	
	related to area 5: The Internet is a largely distributed software system! Apply SE methods for designing a new software architecture for the Internet core which can adopt to the ever changing demands of ever new (and yet unknown) applications and to adopt to ever new capabilities of the transport networks. Software is the key! Research and Innovation addressing new technology innovations in the balance between intelligence in the core versus in the edges; network neutrality and the end-to-end principle; the integration of network, computer and services infrastructures; trust and security by design; or the use of open source and open standards.	

	Security against pervasive surveillance is the key technical challenge. The key operational challenge is getting any form of adoption going. Security. Storage. Speed. Blockchain. Open-source access. Securiy is an add on to current internet protocol. It has to be build in the protocol. Separation of control plane and data plane – Data plane = packet transport + forwarding functions – Multiple transport technologies are supported – Forwarding functions may e.g. translate between transport technologies, filter unwanted/irregular looking traffic, choose between alternative paths etc. M2M traffic should be clearly separated from H2H traffic (via slicing) – different security and privacy requirements The base design of the Internet was developed with a specific set of requirements which made sense at that time. However, today, we have evolved that base design to fulfill a much larger set of requirements, and are demanding more. This is the true outcome of making the Internet a fundamental aspect of our everyday lives. As such, original IP mechanisms such as location-dependent identification, or the need to have patches done over the base design for added features (i.e, security, mobility) have started to create an overall complex operational model for the whole internet. New architectures have been being proposed, which allow information to be inter exchanged through more "natural" mechanisms, such as requesting information via its name, as is the case of Information Centric Networking. Europe has started quite well with this aspect, with projects such as PURSUIT in FP7, but is recently falling behind of US-based initiatives such as CCNx and NDN. The current infrastruct and moving from the existing infrastructure to the new one The current Internet is based on protocols that were not designed with wireless in mind while most of the access is now wireless. There are issues of Quality of Experience (this is different from QoS), of fairness, of different types of traffic requiring different metrics, of network neutrality, of applications polluting the Internet with too many updates or data pushes. The users do not know what their favorite applications consume in terms of data. We need to measure pollution and give green label to applications that are good citizens in terms of generated traffic. The future should be a sum of different tecnologies: IPv6 + Fog computing + Software Defined Network	

	The limitations of TCP/IP, especially regarding efficiency and latency, have been known since years. Different approaches have already been proposed to replace TCP/IP with different solutions. Some of these solutions are more disruptive and re-design many parts of the network stack, others are more conservative and rely on existing network stack protocols (e.g. UDP). In this sense the challenge is not so much in developing something that works better that TCP/IP, but in dealing with its legacy. Most of today's applications and services are based on TCP/IP and moving to something different has a cost. Finding a solution that will minimize such a cost and allow backward compatibility or coexistence is an interesting challenge for NGI. Next Generation Internet should foster the development of solutions that one side solve the limitations (e.g. efficiency and latency) of TCP/IP and on the other side limits the cost of the migration to the new solution.
	The movement from the technologies of data to the living technologies of life will forge new paradigms beyond 'data' alone, i.e. social and behavioural enacgtments
	This is of key importance. The technology needs to be changed in order to enable the achievement of many other dimensions (some listed above) in the future of internet.
	This is probably the most important part of the overall puzzle upon which the Internet's very existence and advancement will heavily rely on in the future. The great discrepancy in infrastructure between north and south Europe is still years apart! Any further advancements of supporting sophisticated services must first ensure that every home in every corner of the continent has equal opportunity to make use of these services and at affordable costs
	This is the foundational block for rest of the topics discussed above. Several innovative applications can be built over more user centric networking technology.
	transfer from IPv4 to IPv6
	Unified management of across all digital infrastructures
	Until the client-server paradigm will not be overcome, the performances of internet will always be lower than the best achievable. This would require a whole new hardware infrastructure, but nowadays the server paradigm is outdated.
	What is missing in today Internet architecture is a TE/QoS layer. IP is great but rigid. That is why a lot of overlay technologies are rising in both 5G and Datacenter context. As such, flexible overlay has to be researched, coupled with the SDN technology. A promising technology making its way in both 5G discussion and datacenter is LISP (Locator/Identifier Separation Protocol). It all to increase the scalability of the internet architecture, it is based on a pull control plane, fully separated from de data plane. Challenges in this technology remains the support for multiple types of encapsulation and a more scalable and secure control plane.
TA 7 Artificial Intelligence	- machine learning - data analytics

Privacy & Ethics Autonomy Human/ Machine relation Fair & Accountable AI Trust Open AI Communication Divorcing from Internet Giants Tech Challenges	- meta data - extracting intelligence from big data - AI has one major limitation: since it develops on the basis of data that is being fed to it, it is only as "good" or "accurate" as the information it feeds on. So the danger is that AI will simply "consolidate" reality as it stands today. To give an example, had AI emerged in the 16th century, it may have concluded that Monarchies were the "natural" form of government and that kings should hold all the power because people were too stupid to govern themselves. AI is an "imitator" of something that exists, it has no way to imagine alternatives. It is therefore essential that AI is used where it is most beneficial like replacing or helping humans in jobs which are physically straining. Or assist humans in tasks that require little creativity but mass processing of data (like accounting, identify patterns to help prevent/cure certain diseases or identifying relevant legal articles in a case). - Data analytics and machine learning for autonomous behaviours in the networks and in the applications - Multi-level cooperation between “smart systems” to synchronize on heuristics and policies - Pattern recognition at large scale for security, optimisation, adaptation of large scale systems - Apply artificial intelligence to software engineering and computing services, by means of new mechanisms for distributing computation according to a set of given criteria as well as simplifying the programming of complex systems. "Sharpening" should be "sharpen". This questionnaire has not been sufficiently edited. The most important question with regard to AI is how it affects human employment. If extremely efficient and powerful machines end up taking most of the possible activities for human beings, how will the latter manage to maintain a viable economic role. Pushing AI without thinking about this question is like driving at night with headlights. Very dangerous! • The main strategic challenge is filling the gap in research and innovation activities on Artificial Intelligence (AI) between Europe and US and Asia (e.g. China, Japan, Korea), where there are several initiatives and emerging start-ups. •Technical Challenges: • Potential adoption for automating operations, taming the “complexity” of future internet; • Potential adoption for Security (e.g. prevention of cyber-attacks); • Impact on daily life applications (e.g. from personal assistants, to avatars, social robots, but also

	Industry 4.0, Smart Cities, synthetic media, jobs automation, etc.).
	A critical challenge is achieving more reliable and more human-like communication in natural language.
	again algorithms need to be designed so they are not biased - or controls need to be put in place to ensure that this is limited
	AI applied to computer security
	AI -based systems for common citiznens use (expert systems), global expert systems for EU societies, encouraging people to enhance the rule bases, knowledge bases
	AI can exist without the internet and vice versa. Could be important to link AI to DDoS protection etc.
	AI is at the hearth of IoT, Artificial intelligence can be sued to make sense of IoT data
	AI techniques have been applied to a number of fields since couple of decades up until now, when machines acquire autonomously knowledge from the environment and decide how to behave accordingly with different degrees of autonomy. A number of initiatives that provide AI solutions made it to the market and self-driving cars, for instance, are to enter soon the public transport reality. Rather than pure technical challenges, what still remains open is how to deal with the ethical issues coming from the mass adoption of AI solutions where autonomic features give increased power to machines. Whether morality can be programmed or not remains debatable, but for sure one of the core challenges to address is how and up to which level we can delegate to machines decisions that shall be affected by intentions, rights, past actions and other morally relevant factors. NGI should foster the realization of “open” AI solutions to ensure ethical issues derived by AI mass adoption can be addressed.
	algorithms should support, not contain. Avoiding mechanic-algorithmic alienation from the Internet
	Algorithms that can scale and can be operated by more companies than the large Internet companies, which have access to vast computing power and have centralised stores with all the data available for them.
	Algorithms to autonomously manage hyper-scale networks of distributed resources - hardware and software. Solutions should be self-managing, self-optimising, self-healing as new resources are introduced and as issues arise.
	all language technologies (natural language understanding, high quality machine translations) and these have to be developed for all languages (both EU ones and the languages of importance for EU activities (business&trade, cultures, refugees, etc.)
	Artificial conscience.
	Artificial Intelligence for an Ethical Society. Not only should AI behave ethically, there is the much more difficult question of how to use AI technologies in order to further a democratic and ethical society. AI will be abused a lot for spreading misinformation and illicit content - AI technologies will also need to be used to counter such abuse.
	artificial intelligence is the decision level above machine learning. it is a key challenge in making the internet user friendly.
	Autonomous car, voice control

	Autonomous cars will be the major end user of this technology Autonomous vehicles; Automated insight extraction from data; Automated data science
	Bias, interoperability, hci, bots, social bots, IoT, behaviour changing
	Big Data, Cross cutting schemes, CAPS causality and interpretability in complex systems, deep text understanding
	Computer Ethics, Proper usage of full AI potential, impact on employment Confluence of Artificial and Natural (human) intelligence. Cooperation between services, security of personal data. Cooperative working with technology. The continued reduction of employment opportunity (regular jobs) on account of even more increased automation.
	Creating the basis for a long term project. Implementing Asimov's 3 laws in all AI and working from there.
	Data Mining, Data Capture, localisation
	Data ownership Ethical challenges on big data analysis Coordination and limitation of human behaviour/opinion control Methodologies and tools for analysis and design of complex systems data security, international laws
	deep learning, big data analitycs Deep learning, Natural Language Technologies Deep natural language understanding, high quality language technologies for all European languages including machine translation, cross-lingual search, knowledge bases, ontologies, taxonomies, deep learning, marrying symbolic knowledge and symbolic processing with statistical, neural, data-driven approaches, creating and maintaining multilingual knowledge bases, deeply embedding language and knowledge technologies into desktop and mobile operating systems.
	Der durch die AI entstehemde Klassengesellschaft entgegen zu wirken. Dabei meine ich reiche vs arme Länder innerhalb er EU aber auch ausserhalb der EU
	Develop high-performing deep learning algorithms, Ethical AI, privacy
	Developing alternatives to monopolies (Google, Facebook, Amazon...). These monopolies collect most of the data today, and use it to feed giant neural networks that will form AI utilities tomorrow. See Kevin Kelly's article (Wired): http://bit.ly/2g0KWmW Monitoring those monopolies.

	Educating the general public about this issue.
	development of robots, development of security fall backs, sensors and new areas of application
	Doctors robot, umanization of robots.
	efficient placement of "human factor" within the connected processes while avoiding "kafkaesque" outcomes; strict data protection and privacy regulation
	ethic, knowing what the algorithm do, having our TTS and STT technologies
	Ethical and legal aspects should be addressed. Machine learning in general needs a boost.
	Ethical and legal aspects, privacy
	Ethical framework; legal issues related to liability; transparency of algorithms and data use; accountability
	ethics
	Ethics and policies regarding algorithms is The Key Defining Challenge for our century (CO2 will be for next century after us)
	Ethics and privacy vs AI
	ethics, solutionism, privacy
	Event-driven process chain, Machine-Human Interface, Process Mining, biological signal transformation, bio chemistry, Trans human engineering, database engineering, programming languages & development environments, ...
	Exploit AI, while keeping the human in the loop
	Factory Automation to increase productivity; Human - Robot Interaction in Home, e.g. to support Ageing; Security; Ethical Considerations in Decision Making by AI, e.g. autonomous cars in road scenarios; Legal Liability; AI for Health Diagnostics; Impact on society, e.g. employment, education and life long learning.
	**Finding broad application, human interfaces, ethical issues
	Finding ways to keep AIs under control
	Focus should be given on a) multimodal human interaction (for avatars, agents, holograms and robots) with novel techniques for physical conversation (taking into account emotion and human behaviour); b) development of intelligent agents that distill knowledge from open data (web etc.); c) development of algorithms for social media data mining, in order to support topic detection, prediction, user profiling, estimate real-life phenomena etc; d) development of intelligent understanding and prediction algorithms combining heterogeneous information and big data (e.g. combining environmental, mobile, financial data that are interconnected in the Internet of things); e) development of intelligent decision support systems that can guide humans taking into account heterogeneous data including the user context;
	For me, the major research effort should go into personalized models with limited training effort. If you

	see activity recognition as one aspect the internet could be used for, tremendous data and tim eis still needed to fit a model. Mathematical models have to be defined to overcome thi limitation in the boot-up process. Additionally the adaption of the models to the changing human lifestyle has to be rethought to fit models to humans over lifetime.
	foster AI
	Future ICT scales will demand help from machines. Self-driven architectures are required.
	Get larger training corpora for languages other than English. Work on NLP toolkits for languages besides English with open and business-friendly licenses.
	Go beyond deep learning and today's approaches that have a lot of drawbacks. See for example: http://www.theverge.com/2016/10/10/13224930/ai-deep-learning-limitations-drawbacks We need core research here to find approaches that can solve these problems and benefit from the good things that symbolic approaches have. Not until then will we have an approach that will really be AI. Today's deep learning is not very deep and todays AI not very intelligent. Also research on how to best apply AI technologies on language problems (understanding, conversation, translation). For natural language understanding we need an approach that is both broad and deep and that can take into account context and all different sensors.
	helping knowledge workers (like docters f.ex.) to collaborate and to provide access to a "shared knowledge" - to help identify illness causes and best remediation.
	How to enable humans to live and work in a pleasant environment with just the right support.
	How to formulated the results of and AI calculation, so humans understand the calculated reasoning? Who takes the responsability of the medical operation recommended by the AI-doctor?
	How to turn it off? Increased Dependence on AI : consequences & side effects, on brain development, soft and technical skills, relationships
	Huge challenges to make it relevant and useful to end users.
	Human-machine interactions
	I am a great advocate of business intelligence and the methods used today to gather and assess how we shape our services, media, etc. The very behavioral pattern of e.g. people's shopping practices, travel, education, vocational or other parameters, if gathered properly and used intelligently can greatly benefit governments in making wise decisions based on data and information on their individual populations. The most relevant technology here, is to gather qualitative data and make them readily and continuously available decision makers.
	I think ethical challenges are more crucial than technical ones here. How much do we trust a particular

	algorithm (especially when the learning process is not very transparent)? Correspondingly, how much power do we give to artificial intelligence? How do we encode our morality into the algorithms? Do we even have a good idea of our morality? Who gets to decide?
	I think when required, on the internet, an AI system must be able to identify itself to human users so that users can be wary of unexpected behaviour in the early days of AI.
	inclussion and assistive technologies allowing IoT. Privacy concerns
	In-depth understanding of the need for AI, where it is relevant and where it is not, notably with regard to the security of employment, impact on humans and societal cohesion. Understanding the importance of AI, it's usefulness as a tool is of great importance but so to is understanding what the rapid development of AI will mean for people and if there are areas in which it is better not to further develop AI due to security or societal concerns.
	Individual rights to opt in or out
	Intelligent agents, machine learning, soft computing, etc.
	Internet / Google as a Cognitive System, transcending its own "neurons", i.e. all of us...
	Is becoming increasingly essential to drive personalised models using big-data
	It is important to address the ethical issues arising from the use of AI to make decisions, e.g. what a car should do if it cannot avoid an accident.
	It seems that here also is a confusion about Internet the network and Internet services. However, artificial intelligence has opportunities both in the network (management etc) and in the more human connection in applications. it should be well addressed the changes of behaviours as result of AI , not to move away of strong principles and values
	Keep AI transparent and open (source)
	Language technologies will be critical for these challenges. It will be necessary to work on linguistic (not statistical) methodologies and techniques to analyze languages. It is necessary to work on lexical semantics and terminology, to create ingenious dictionaries useful for human and machine users. Language technology Scalable text processing technologies (beyond classic Natural Language Processing approaches) Improved prediction of the information needs of users searching for information on the internet, so as to better satisfy these information needs (Semi-)Automation of knowledge work (automation of work that is currently undertaken by highly qualified humans, such as legal reasoning, patent writing and search, medical diagnosis) language understanding, language generation, translation, multimodality
	Liability for decision making will need to be clearly understood. AI software mediation will also displace human knowledge domains (e.g. law) and change our conventional understanding of rewarding

	employment which will become scarce. liability, responsibility, legal issues, human rights, ethics issues, new high level theory of AI for human project
	Linking Neural Network Technology with Symbolic reasoning : machine learning that does not only abstracts and organises Information (e.g. photos, speech, text translation) but machine learning for reasoning (learning rules, how to apply them, in which order ... for problem solving, for decision taking) Low power, low cost AI hardware and software, i.e. commoditisation of AI algorithms and platform machine learning algorithms & cloud training Machine learning and high-performing deep learning algorithm; artificial and collective intelligence; Internet of Things and its use to enable autonomous, self-organizing systems; Ethical AI and privacy Machine learning tools have potential to bring enhanced prediction to social areas such as law and government, but must confront (exaggerated) fears that explanations to humans are insufficient to make these insights useful and accepted.
	Make machine learning-based decision making more fair, accountable and transparent (FAT). Ensure good generalization capabilities. Create intuitive interfaces between humans and AI systems. Ensure that appropriate mechanisms are in place that prevent AI systems from overriding human judgement without consent. Create new ways of explaining and justifying results of AI systems. Move from supervised learning settings to the problem of unsupervised learning.
	memory capacity, human brains are possibly infinite, computer "brains" are not. To increase the processing power of a computer requires bigger memory and processors, but space is an issue and overheating too -Migration to Neural Networks for the provision of language solutions
	More human like AI assistant.
	Most of human knowledge is expressed in language. We will communicate with AIs via language. Therefore any progress in AI is closely linked to advance in Natural Language Processing (NLP). The bulk of research and innovation happens using English. European citizens not speaking English are excluded of the AI and Data revolution. Their information remains unproccessed.
	My personal ideas & vies have been indicated in previous topics, considering that Innovation has to be FREE
	Natual Language Processing and Ontologies
	Nearly everything can be automated and learnt. Maybe setting some limits?
	Networking is not isolated anymore. having bridges toward IA is crucial. We already have very nice results demonstrating the help of IA in severals networking layers ; from MAC to application.
	One challenge is the learning by imitation (robots). One of the biggest challenges for AI systems, especially Artificial Neural Network type (e.g. Deep Learning) machine learning systems, is audit-ability of the decision processes. Just like the human

	brain that they are inspired by, artificial neural networks are very opaque concerning the actual relationships that they infer from the training data. Efforts for 'rule extraction' have been going on for a long time but remain highly challenging. Nevertheless, for many uses of this technology it will be vital to have reliable ways of interrogating how and why AI systems make their decisions. Closely linked to this is the issue of user agency which I raised for Q2
	*Open domain conversation with an artificial agent, open domain information extraction and structuring, data linking *open source AI depositories and initiatives
	Privacy concerns, Availability of descision logs for end users if a system using AI/machine learning makes descions that will afffect things, without descision logs a person will have no idea why a certain deciscion was reached, on what metrics etc.
	Privacy, Security & controle.
	privilege life skills to co-design infrastructures platforms and devices include people's experience in designing follow a wise approach beyond smartness
	Reliable and trusted machine learning techniques
	Research and Innovation on IoT and AI, Big Data and AI, Future Internet and AI
	Robotics, Drones, Self Governing Devices and gadgets
	Robots an AI will probably become the future regulators of the internet, due to the huge capacities required to do the job.
	Security and privacy concerns Security, privacy
	See earlier comment. I think it is vitally important to be able to know the drive behind the development of these technologies. The "revenue model" underneath it. Most models work in an a-moral way purely focussed on bringing in the largest amount of earning. Especially if performed by a large "anonymous" bodies that is most threatening. Disappointments in this area will reduce acceptance of artificial intelligence (including robots).
	semantic web, contextualisation of data and relationships with a decentralised premise
	should ensure diversity, pluralism and a right to choose.
	smart grids and smart energy control of buildings, processes etc.
	social & ethical impacts, privacy
	Stop thinking about Human-Machine relations with a master/slave model; for AI to evolve it needs autonomy; autonomy means lack of human control; make neural networks share with humans its process of thinking-, keep 'human-in-the-loop'.

	Text intelligence, content analysis, data mining
	text to speech and speech to text in virtual developments
	The absolute control of artificial intelligence
	The advances of deep learning architectures are gradually taking over many different fields of artificial intelligence. However, the increased algorithmic performance comes along with a number of shortcomings: a) these architectures learn by processing huge amount of data without offering a way to take into account explicit knowledge. As a consequence, there is no way to incorporate logic-based inference in the decision making process and thus there is not way to remove the bias that may potentially reside in the data, or to enforce any other logic-based reasoning the may derive from ethical, legal or other "extraordinary" limitations; b) as a result of their deep structure we have very little knowledge of why the algorithms produce and certain outcome. As a results apart from the issues related to trust, we may also envision issues related to malicious manipulation.
	The ease of communication / business with people speaking other languages may change the status of English being the lingua franca The internet is fragmented by language. AI is enabling steps towards the digital single market: Amazon and eBay are translating product listings using software created by European projects. Neural models are rising and it's important to insure Europe's lead in this area.
	The social machine (optimal combination of machine and human reasoning); Ethics and a code of conduct for artificial intelligence; The right to opt out, i.e. methods to access non-individually targeted/processed data; Methods to avoid that AI processes and a "too-intelligent Internet" push users into automatically anticipated opinions and connects them only to like-minded others (to stimulate, instead of avoiding, confrontation with opposing opinions - also in the Internet, e.g. to counter-play post-truth politics)
	There are a lot of risks with this technology (such as the increase of unemployment), enterprises using it must be controlled, because the great amount of information they have give them a great power. This technology is connected with the development of robots; we must be able to have the control of them and they should not be similar to human being
	**There is lots of good research happening in these areas but no top-down coordination to bring together the different disciplines. Internet research in Europe is still marginal and has to struggle against television and film, literature or sociology. It simply has no priority as education elites feel threatened by internet, in particular in France and southern countries but also in Germany and Eastern Europe. Internet is something for engineers. This delegation to the technical class is deadly.
	There should be always appointed a human person (CEO of a company) fully and personally responsible for any side effects and detrimental results of applying technology by an organization. A situation when a CEO of company claims that some detrimental effects are a result of an error in

	software should be excluded. Software is a tool used by someone and it should be clear who that human person is. That person must know what type and scope of responsibility and consequences are behind using particular technology. The person should confirm and sign a document confirming that full responsibility for any errors is on the corporate/governmental user of the technology applied towards other human beings or ogranizations. Responsibility of a person (CEO) in this particular area should be covered with an insurance policy. And the number of policy with coverage details should be made public. This a critical area where recent breakthroughs have started a new phase in its development. An important global challenge, not only in telecommunications, is to extend these success stories to other fields and to other problems (something we are starting to observe already), and thus to contribute to the improvements of the techniques. We expect that distributed machine learning methods will find a number of applications in the networking context. Real-time processing of multiple data streams (IoT, Voice broadcasting, …): Uncover the spatio-temporal dynamics of raw IoT data by cross-correlating streaming data series, and integrating them with historical data or external sources (e.g., open data) Continuous mining of multi-dimensional data: Investigate feature drifts that occur whenever a subset of features becomes (or ceases to be) relevant to the model to be learned, or how extracted patterns on historical data should be incrementally maintained as fresh IoT data arrives. This goes hand to hand with data. What data can be collected, by whom for what? We don't use forecast much in the Internet while other complex systems do , e.g. the electrical grid. How can data and AI improve the Internet sustainability? This is critical. Specifically the serious application fields will develop. Today this field is already driven by large (US) companies and research organisations (specifically in the EU) lag behind. While we seem to lose ground in some areas (e.g., automotive), a very strong emphasis must be laid on commercially not as relevant but societal extremely relevant areas (education, health care, personal development) in order to assure not to lose competition here as well!	

	*This is probably the biggest field for new applications and business model in the future. For the time being, it is difficult to say, what will be the business models and technical possibilities, however, it seems obvious that Europe needs to invest more on skills and education in this field, be it in general IT, programming or data management. The Internet seems to be a source of lot of the data that can be used to “educate” artificial intelligence. AI can then be used to improve such as online services.
	To ensure we don't allow machines to rule over us
	**To make the Real AI, it is essential to go beyond the human brain. But this is like trying travel faster than light.
	To respect privacy and to keep on emotions in a human world.
	transparency of algorithms and I.A. decision taking
	transparency, accountability; bias; control & governance; democratic guarantees
	Updating regulations on labour law; Determining common rules on the subject responsible for AI's actions; Providing regulation on protection of individuals against AI's actions; Cybersecurity challenges (possible usage of AI for criminal actions);
	Use machine intelligence to manage the network layer.
	values & ethics // right to examine algorithms // governance
	Virtual Agents, Cognitive Robotics, Fraud Detection via artificial intelligence, use of artificial intelligence in Health and other disciplines.
	Watson, Deepmind
	Where is the off button? How do we override machine decisions? How do we analyse performance and bias to know what is actually occurring rather than what a machine reports is occurring?

ANNEX 3: THE OTHER TYPES OF RESEARCH PROPOSED

Type of Research
• 10% of exploratory research and 90% of R&D • a combination of long-term and applied research as well as practical innovation / coordination proj. • A TRANSDISCIPLINARY APPROACH, ON THE EDGE OF DIFFERENT DISCIPLINES • All mentioned above plus explicit Interdisciplinary research involving usage domains • Anything that can improve thrustworthyness of what we get from the internet • biomedical - social - psychological • Combination of Theory of Complexity and Cognitive Sciences • Dynamic education • Ethical problems must be adressed as well • Evolution served in small chunks and small steps. • Experimental research: many startups and civil society movements have tested solutions! • Foresight research on future implications, risks, emerging technologies, "wild cards" (surprises). • I call this often 'use-inspired research', it's fundamental, but it comes from concrete applications • I think you should say: system-oriented, experimental, theoretical.... All are needed • ICT and Society • industrial research that embeds academic researchers directly into companies for a few years • It doesn't really have to be interdisciplinary. There are known holes that need to be fixed today. • Long term research with proper experimental parts!!! • long-term research applied research & development of the infrastructure for Europe's digital economy • requirements from vertical areas - e.g. humanistic research • Research using start-ups and changes being fielded now - not just future looking. • set up interdisciplinary teams from different areas (technological, social, artist, medical,....) • Social Sciences and Humanities (SSH) expertise. • social sciences, humanities, arts -- many base technologies are already there or very close • targeted basic research • This should not be called long-term research but fundamental research, which can short- and long-ter • To enable long-term research, whose output can be bring to current and emerging technologies. • User communities

Developer clusters

ANNEX 4: RESEARCH ACTORS RECOMMENDED BY PARTICIPANTS

Key research actors beyond the above
• a mix of the above with particular focus on high-tech start-ups • a mix of the above, together with governmental science services (e.g. the JRC in case of the EC) • academic and industry should address different aspects • All mentioned above plus Autonomous Computer Systems (Artificial Intelligence for research) • Artists and creative people; cultural agents and citizens • Citizens should be involved in a participatory research/design process. • Citizens: The Internet's a critical social infrastructure, society must co-design its next gen! • Civil society (via consultations and participatory activities) • Civil society organisations working directly with the citizens • civil society, activists • cluster initiatives • Comment: academic + industry, but not start-up - research is incompatible with a good start-up. • Corporates • DEFENCE UNION should be excluded until they learn to behave themselves • Emphasis should be made to include social scientists and information scientists. • Engage young people in crowdsourcing, hackathons • Europe must focus on public research and start-up. A lot of money is given (and lost) to Big Companie • Government MUST ensure private companyes dont' create another closed solution • governmental agencies and organizations, policy makers • Historically major ICT innovations have come from Academia. • INFORMAL ACTORS OF THE CORE ECONOMY • Innovation platforms, PPP fasilitators • It should be ONLY academic researchers and members of Open Source tech. Others have vested interests • local communities • local NGOs, "active citizenship" committees... • Long-term and applied research needs to been combined with expert advocates for potential end-users.

- Moral philosophy and the results of increased knowledge and communicability.
- new models for a sustainable growth according changes of paradigms and time required for adaptation
- non-governmental institutions. Ushahidi/Wikipedia/fact-checking websites don't fit categories above

- Young people (high schools?)
- Potential role for national government departments (encryption, data privacy -- e.g. UK's GCHQ)
- real experimentation environment. people, factories, etc. no living labs. real environments.
- regulators, central banks
- Regulatory and socio-psycological as well as socio economic research
- Researchers from outside closed loop bubbles of industry-academic-startups all group thinking
- Small and medium sized enterprises to be more precise
- SMEs that do not necessarily qualify as start-ups, but not even as industries
- Societal organisations, citizen's representatives
- Students
- The mix of academics and industry (could not be entered using radio buttons.)
- The operational internet infrastructure and open source community, together with academia
- think tanks & consultancies
- What is important in Europe is to understand the internet ecology from a cultural perspective.
- Wireless communications
- Women should be involved as much as possible - who buys the most on the internet?

ANNEX 5:

Key research initiatives in your organisation or country
• - FP7 project XIFI, FP7 project FI content 2, H2020 project FI core, H2020 project C3, H2020 project, FI NEXT • 5G as mobile device connectivity (personal devices, objects) will drive innovation and new usages, NESSI • AI and machine learning in Learning Environments at Eliademy.com • Unit JRC.B6; the integration of Public Sector Information with dynamic data streams from novel sources.To this extend our investigations would be a kind of 'usage area' of the NGI. • At digi.me we're leading the ownership of personal data by the individual • At the European Space Agency, we have started making use of the Business intelligence approach to better gauge our users' needs and demands. • Aufklärung in der Bevölkerung über die sozialen und wirtschaftlichen Auswirkungen, wenn man sich gegen die Technologie stellt. • Bigdata analysis of DNS queries to detect paterns of abuse. • CHIST-ERA call 2015 "User-Centric Security, Privacy and Trust in the Internet of Things" • CLARIN • Contact the Start-Ups in Amsterdam • Creating open standards for sharing industrial machine's information • creation of new digital learning environment addressed to the need of adult working adults studying at university • Debates on: security, surveillance and human rights; Digital Ethics; European Internet of Things; Trusted Health Care data; • Development of AR environment able to manage on the job-training • distributed and pervasive machine learning, multi-clouds data mining. • E-Democracy • Einstein Center for Digitalization, Berlin • EPSRC IoT Hub • ERC CIRCUS / H2020 NEXTLEAP • EUROCLOUD • Eurovr • eWine project • FCT; ISEP; UPTEC; GMK; AST • FuturICT 2.0, nervousnet, BlockchainX • Grand Duchy IT pillow and public initiative (DataCenters, Connectivity, BlockChain, FinTech)

- Grid'5000 testbed: http://www.grid5000.fr

  FIT Testbed: https://fit-equipex.fr
- Horizon Digital Economy Research institute:- http://www.horizon.ac.uk/
  Citizen centric approaches to Social Media analysis:- http://casma.wp.horizon.ac.uk/
  UnBias:- http://unbias.wp.horizon.ac.uk/
  Rights of young people online:- http://5rightsframework.com/
  Databox project (http://www.databoxproject.uk/)
- http://www.medmij.nl/wp-content/uploads/2017/01/161228-Consultatiedocument-Hoofdstuk-1-afsprakenstelsel-MedMij-CONCEPT.pdf
  https://www.forumstandaardisatie.nl/sites/bfs/files/proceedings/FS%20161019.9A%20Rapport%20van%20bevindingen%20Qiy%201.3_0.pdf
  https://www.logius.nl/fileadmin/os/Vergaderstukken/FS_151216.6A_Discussiepaper_Regie_op_Gegevens.pdf
  https://www.youtube.com/watch?v=iFu-bGUjDwA

- https://ec.europa.eu/digital-single-market/en/trust-services-and-eid AND https://www.idesg.org/
- MKLab is currently involved in hackAIR (http://www.hackair.eu/), PROFIT (http://projectprofit.eu/), HOMER (http://www.homer-project.eu/), TENSOR (http://www.tensor-project.eu), MULTISENSOR (http://www.multisensorproject.eu/), H2020 KRISTINA (http://kristina-project.eu/en/), SocialSensor (http://socialsensor.eu/)
- ICT @An Early Age. which an E-learning capacity training courses for Teachers working in early child hood education. Champion by society for Promotion of Education and Development (SPED) initiated and Developed by the program Officer.,Lagos Nigeria
- IoT, Cloud Automation, SDN, NFV, Big Data
- local vs global values
- META-NET
- multilingual knowledge processing
- National 5G activities
- Ongoing Foresight projects on the above-mentioned issues.
- Ontology and Terminology and Lexicography
- Open Source-related research by Inria (France)
- mklab.iti.gr Projects; USEMP (http://www.usemp-project.eu/), REVEAL (http://revealproject.eu/), InVID (http://www.invid-project.eu/), WikiRate (http://wikirate.eu/), ChainReact (http://chainreact.org/), hackAIR (http://www.hackair.eu/) and PROFIT (http://projectprofit.eu/).
- P2Pvalue
- Peercraft https://www.bedreid.dk/distributed_business_service_discovery
- Pheme (FP7), Reveal (FP7), InVID (H2020); CommuniData (FFG)
- Prototype implementation of Flexilink technology (which doesn't have the drawbacks of IP and also supports new economic models), see http://www.ninetiles.com/FlexilinkIntro.html and http://www.ninetiles.com/Aubergine.html
- R&D and Development of initital software for privacy protection in a Encryption AtRest-InTransit-InProcessing model has been

conducted by Simplito Computer Science Lab, Simplito sp. z o.o. (s.smyczynski@simplito.com)

- Read the IEEE SDN eNewsletter on Intent-based Networking
- research on sharing economy; research on e-commerce barriers;
- salus cooperative// citizen cooperative of health data in which citizens collectivelly decide conditions upon which the share their data for research according to the nature of solicitant and use // Ideas for Change
- Security of personal data.
- situation in France sucks. ANR is dead. no hope ... or maybe after may 2017.
- Smart Cities' IoT development - currently solving many NGI issues in practice. Finnish local specialities: MyData, Thing2Data
- Smart Service Welt: Industrie 4.0
- Smart specialization programs
- Startup Europe Partnership (SEP) to foster startups-corporates interecation
- studying and applying Internet / Google as a Cognitive System, transcending its own "neurons", i.e. all of us...
- The Alan Turing Institute is the UK's national centre for data science
- The Collaborative Research Centre (CRC) MAKI (Multi-Mechanism-Adaption for the Future Internet) funded by DFG (http://www.maki.tu-darmstadt.de/sfb_maki/ueber_maki/index.en.jsp) at University Darmstadt
- The Commit2Data public-private partnership in the Netherlands (run via NWO).
- The Future Internet Research Group at BME (Hungary) : packet processing, survivable optical networks, Internet routing, and Software Defined Networking (SDN). Also involved in the 5GEx project of the 5G PPP Programme of the EU H2020.
- The Internet of Communities
- The TRANSMEDIA LITERACY / H2020 project is close to these challenges > https://transmedialiteracy.org/
- Internet Governance Forum for communication standards and bring internet connectivity to unconnected communities as a good form of social change
- There is significant long-term research ongoing in industry in relevant fields such as quantum computing, optical computing, silicon accelerators, integrated FPGAs, disaggreggated hardware architectures, energy harvesting.
- Aalto University: Key research initiatives of this community include the Take-5 5G experimental platform, http://take-5g.org, and the Aalto Industrial Internet Campus initiative, http://aiic.aalto.fi.
- TIM participating in relevant European initiatives including:FiveGO, EIT Digital high impact initiative called “European Trusted Cloud Ecosystem” and “My Data Store”
- W3C, META-NET, Cracking the Language Barrier
- We are about to coordinate a new 4MEUR-funding H2020 project ANASTACIA "Advanced Networked Agents for Security and Trust Assessment in CPS/IoT Architectures" which copes with security in CPS/IOT systems
- We are creating a Integration backbone (APInf) for integration of IoT and different types of systems. We are making this integration with REST APIs. It is the most secure and open platform. For more information http://apinf.org
- we are now 'supporting policy' rather than performing research
- We are researching network infrastructure sharing, including new economic models that address some of the constraints mentioned above, and could address problems of state aid for broadband infrastructure.

- We are working on evolved next genreation of Internet protocols (network and transport) that are necessary to deliver pervasive natwork based applications.
- We're working on detailed approaches to more robust protocols, and more general studies of differential privacy and its extensions into game theory mechanisms in a joint Israeli-German center for Cyber Security.
- WiFi communication, Radio and wireless communications, Wireless digital communications
- www.networkcultures.org