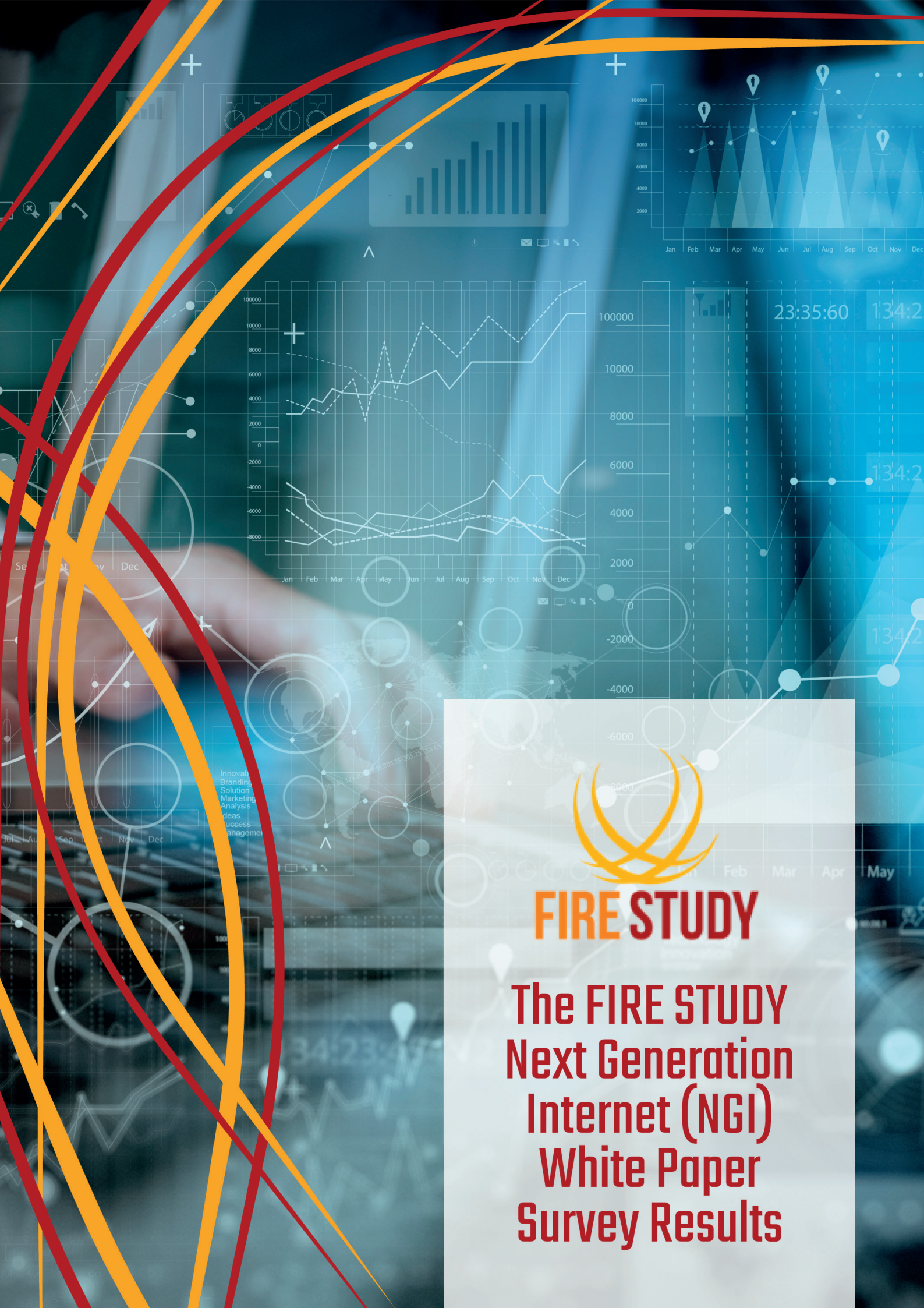

FIRE STUDY

The FIRE STUDY Next Generation Internet (NGI) White Paper Survey Results

Call: SMART 2015/0019
Type of action: TENDER

Inventory of European and National Experimentation Facilities
and Roadmap of the future needs for advanced networking experimentation

The FIRE STUDY Next Generation Internet (NGI) White Paper Survey Results

ABBREVIATIONS

CAPS/CAPSSI	Community Awareness Platforms for Sustainability and Social Innovation
CSA	Coordination and Support Action
EC	European Commission
ENoLL	European Network of Living Labs
FI-PPP	Future Internet Public-Private Partnership Programme
FIRE	Future Internet Research and Experimentation
IoT	Internet of Things
KPI	Key Performance Indicator
NGI	Next Generation Internet

Acknowledgements

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Disclaimer

The content of this document is merely informative and does not represent any formal statement from individuals and/or the European Commission, instead is a public document from contributor editors with visionary perspective and based on years of experience towards Next Generation Internet. The opinions, if any, expressed in this document do not necessarily represent those of the European Commission. The views expressed herein do not commit the European Commission in any way.

1 THE FIRE STUDY NGI WHITE PAPER SURVEY

1.1 Introduction

The FIRE STUDY survey is an initiative that was discussed and agreed upon in September 2016 during the FIRE STUDY Interim review and which was suggested as a concrete approach to gather specific feedback from the FIRE community on the Next Generation Internet Experimentation white paper that was produced and published in Q2 2016. The white paper can be considered as a pioneering position and discussion document within the NGI context that anticipates the role and relevance of experimentation, in various forms and for different research domains, to ground and build the Internet of the future.

1.2 Methodology

In this perspective, the FIRE STUDY survey was structured in a way that would allow participants to provide general input about their NGI-related interests and priorities, but also to provide specific feedback on various specific R&D areas as identified by the NGI Experimentation white paper. The main questions and specific multiple-choice answers can be found online at: https://docs.google.com/forms/d/1zBwbyC5L15Ft5SpOt8lOOJqI8IcqSuX3dxAxPEyBkLU/edit?ts=5825c142 – which is included in Appendix A

Via a dedicated online survey, the FIRE projects' participants were specifically invited to provide feedback about the NGI Experimentation white paper (available for download from the FIRE portal at: https://www.ict-fire.eu/download/1500/) that the STUDY published in June 2016, and in addition to indicate which specific R&D directions and topics related to NGI Experimentation shall be included in the upcoming Work Programme 2018-2020.

The survey was open between November 15th and December 22nd 2016 and was advertised via the FIRE communication channels. 23 participants responded to the survey, representing Academia / Research institutes (~35%), Business / Industry (~30%) and Technology providers (~30%). The FIRE STUDY was successful to collect valuable information from 67% of the (ex.) FIRE projects, which, after the DG CONNECT's re-organization in July 2016, are now spread across several EC Units. All 23 respondents answered to the multi-choice questions and between 13 and 17 participants to the free-form questions.

1.3 The FIRE STUDY Survey vs. the NGI Consultation 2016 results

The Next Generation Internet Unit launched, basically in parallel to the FIRE STUDY initiative, a broader, but more generic survey that aimed at embracing researchers and innovators all aross Europe and beyond that can contribute to shape the foundation of the overall NGI initiative and boost the identification of new players and new R&D priorities.

This open consultation process (https://ec.europa.eu/eusurvey/runner/NGI) was open until the 9th January 2017 and included the following main core questions:

- *How to protect Personal Data Spaces in the Next Generation Internet?*
- *What Software Defined Technologies will be essential to create the Internet of the Future?*
- *What new forms of interactions should the Next Generation Internet enable?*
- *Should the Internet of the future be built on distributed architecture and decentralised data governance?*
- *What networking solutions will replace the Internet Protocol in the future?*
- *What should the Next Generation Internet look like?*

The final report of the NGI Open Consultation was published on 6th of March 2017 on the FUTURIUM web pages and can be found online at: https://ec.europa.eu/futurium/en/content/final-report-next-generation-internet-consultation.

The main identified values in the NGI Open Consultation were as follows:

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

Personal Data Spaces was seen a very important technology area for the all top ranked values above followed by Artificial Intelligence. Distributed Architectures and decentralised data governance technology areas were the next biggest for the *Internet should ensure diversity, pluralism and a right to choose* and Software defined technologies for the *Internet should avoid the concentration of data in a few proprietary platforms*. Other identified technology areas included *Discovery and identification tools*, *New forms of interactions and immersive environments*, *Networking solutions beyond IP*, and *Security* in general.

It is important to note that the FIRE STUDY survey results, which have been elaborated and reported in more detail in the remaining of this document, are pointing into the same direction(s) as indicated by the Final Report of the Next Generation Internet Consultation 2016 (see the table below), despite the fact that the time-scale explicitly referred by the STUDY Survey and by the NGI Consultation are different, i.e., the NGI consultation extends the time horizon until 2030, while within the FIRE STUDY survey we focused on 2018-2020.

The main highlights that emerged out of the two parallel excercises are summarised in the table below:

FIRE STUDY Survey	**Next Generation Internet Consultation 2016**
Trust, Security & Privacy are of central concern especially when considering highly interconnected networks scenarios.	Citizens' sovereignty over their own data and protect privacy is the top concern.
Top-priority technology areas include: IoT, 5G; SDN/NFV, Big Data, Edge Computing.	Priority technology areas: Personal Data Spaces (i.e., trust, security and privacy issues), Artificial Intelligence, and Distributed architectures.
New network protocols and architectures need to be developed that reduce the limitations of the current TCP-IP protocols.	Personal data spaces: infrastructure - creating the protocols and systems that allow data to be secure whilst still allowing innovation to occur.
Multi-actor protocol/system design principles and methodologies for cooperating machines and people were ranked on top in the NGI Collective Human Experience policy recommendation.	In Artificial Intelligence the key challenges are in ethics and privacy, and human-machine-relations, which boil down to understand how to create an Internet for Humans where increased autonomy is given to devices, robots and machines.

1.4 The FIRE STUDY Survey major outcomes – a summary overview

1. **The priority service / technology drivers for the evolution of experimentation-driven efforts for a Next Generation Internet are:**
    - **IoT is considered by far the key technology driver** (selected by almost 80% of respondents), **followed by 5G** (selected by almost 40% of the survey participants), **Trust, Security and Privacy, Big Data and Edge Computing** (selected by about 30% of the respondents).
2. **The three biggest elements to impact to European ecosystem experimentation are:**
    - **Interoperability and Open standards** is clearly the most relevant factor for the respondents selected by almost the 80% of participants to the survey. **International collaboration** and **SMEs competitiveness** follow as very relevant impact factors for more than 50% of the respondents.
3. **The biggest roles in the NGI experimentation were identified as follows:**
    - **Intelligent Spaces. Interoperability management considering the large array of "standards" that are emerging in the IoT space** will be crucial (for more than 50% of the respondents). This is a very central issue that many reserachers and innovators are focusing on; see for instance several efforts within the AIOI, IoT Forum and ETSI groups. This is followed by 1) **engagement of larger numbers of users/communities and** 2) addressing increasingly important **security, anonymity and privacy** issues for about 30-35% of survey's participants.
    - **Cooperative Autonomous Machines.** A **paradigm shift will occur within the Industrial Internet of Things domains towards Edge Computing**, in which programmable, **autonomous IoT end-devices can communicate with each other and continue to operate without connectivity**. The degree of autonomy delegated to virtual (either software or hardware) components is an aspect central to many Artificial Intelligence frameworks and debates nowadays. This directly relates to NGI consultation outcomes. Notice that answers to the survey indicate that among the suggested R&D challenges in this domain, almost all are considered as equally relevant, a part from aspects related to machines operating in natural open and uncertain environments and active security design, monitoring and mitigation aspects that seem to have less relevance to the audience.
    - **Collective Human Experience. Experimenters' participatory involvement in collective awareness / intelligence production** is the core challenge for over 50% of survey participants. This is of particular relevance to a number of R&D efforts that are putting human participation and social innovation as key challenges for realizing the Digital Society vision. This is followed by aspects related to **decentralised and distributed social networks, wikis, sensors, blochains value networks** (were considered over 40% of respondents) as central to a number of R&D efforts (see in particular the CAPS initiative and projects – www.capssi.eu).
    - **Key Networking Technologies. Convergence of new 5G scenarios with new IoT capabilities and technologies** will be at the core of future R&D communication networks efforts (selected by over 50% of respondents). This will also entail a more in-depth understanding and analysis of how software defined technologies can provide effective solutions to manage and operate the infrastructure of the networks of the future. This requires focus on a number of technology challenges related to **slicing of network topologies**, **end-to-end integrated radio-network-application/service experimentation**, **NFV/VNF applications**, etc.

4. **Topics which are expected to create the biggest impact in the NGI Collective Human Experience are:**
   - **Multi-actor protocol/system design principles and methodologies** for cooperating machines and people – for more than 50% respondents.
   - **Networking protocols robust to and adaptable to variations** of outcomes and with transparent constraints – for more than 50% respondents.
   - Very relevant are also technology drivers that facilitate the emergence of new business models that may also operate under a collaborative economy based model – for about 35% of respondents.
5. **Policy recommendations for the NGI experimentation**
   - Over 50% of survey participants selected the **Multidisciplinatory approach** as the main policy recommendation for the NGI experimentation: The interconnectivity of Next Generation Internet Experimentation systems will require a multidisciplinary approach to a number of challenges to be faced when realizing the all-and-always connected vision. Bringing together people, data, devices in a variety of deployment scenarios will require end-to-end experimentation to be driven by combining expertise from different **technology domains** (e.g. wireless networks, optical networks, cloud computing, IoT, data science) in relation to specific **vertical sector needs** (healthcare, creative media, smart transport, marine industry, etc.) **and horizontal disciplines push factors** (e.g. psychology, law, sociology, arts, economics).
   - **Quantifiably Large and Dynamic Ecosystems**, **Next Generation Internet Technology and Investment Education**, **and Efficient and Usable Federations** were next recommended equally by 35% of the respondents.
6. **Highlights of the Next Generation Internet (NGI) experimentation vision statements**

   Beside the policy recommendations a one-sentence vision statements of the Next Generation Internet (NGI) experimentation were asked in the survey. Some highlighted results as follows:
   - KPI of the NGI should be a high volume of NGI innovations validated in beta with real users in close-to-market environments with living lab structures.
   - Make information access fit the human users' needs.
   - Holistic connectivity and distributed intelligence.

Other vision statements are listed in the Appendix A, in which all survey questions and answers are presented, including graphical illustrations.

1.5 Recommendations for the Horizon 2020 Work programme 2018-2020

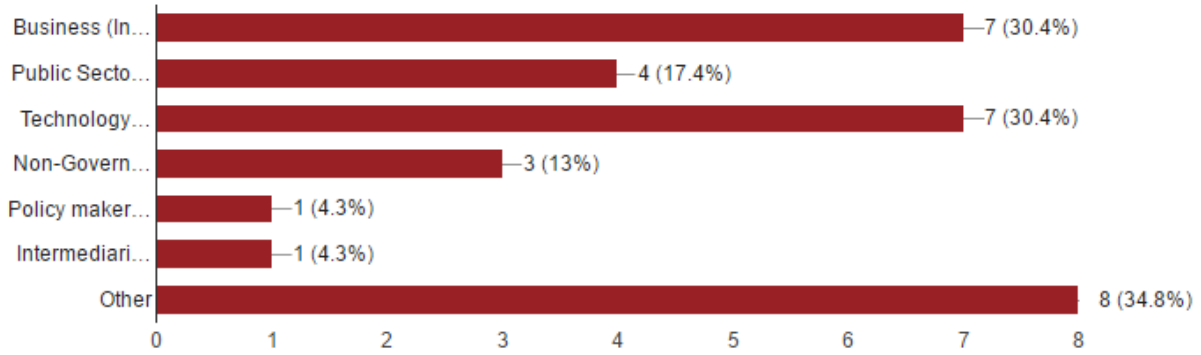
- Focus should be on **end-to-end systems design** (with few larger infrastructures including international dimension) based on **open global standards** and standardised interfaces/APIs, where **5G/6G network** is extended towards **edge computing** and even **autonomous connection** mechanisms **between edges** w/o connection to core network.
- **New protocols** need to be developed to go beyond current TCP/IP limitations: an **end-to-end architecture**, including optical networks, needs to support **IoT**, **media** and **new innovative services** over fixed and mobile networks (**multi-actor protocol/system design** principles and methodologies for cooperating machines and people).

- End-to-end network and protocol validation and interoperability tests should include **real life experimental environments** in an early phase of development, and include activities to provide **fast feedback** and to **improve** the **quality of models and simulations**.
- In order to attract **more experimenters** to test new networks/protocols, and enable prototyping for rapid innovations, **Open Calls** should continue with and w/o funding mechanisms to create interest for **innovative SMEs**, **Startups** and **business verticals** (e.g. eHealth, Automotive, Media, etc.). In this way, **academic** and **industrial** players would **work closer** already in the beginning of new technology development life-cycles, the **academia view** would be **part of future standards**, and **business aspects** and **business models** would be **better taken into account**.
- **End-to-end experimentation** integrating radio – network – application/services through co-design in early phases should foster **multidisciplinary research, development and innovation**.
- **Multi-actor protocol/system design principles and methodologies for cooperating machines and people** should be investigated as key to understand the challenges and implications related to the NGI Collective Human Experience (ethics, security, privacy concerns).
- New research and experimentation areas should include a pan **European blockchain**, including **robotic devices**, and the establishment of **mixed experimentation environments** with large numbers of **heterogeneous devices** with **IoT programmability**, and **Large Scale Streams**.
- **Decentralised and distributed social networks, wikis, sensors, blockchain value networks** where a **heterogeneous mix of humans, autonomous, manual and remotely operated machine**s will co-exist and interact must be investigated. This very much relates to understanding also a number of trust, security and privacy issues we are going to increasingly have to deal with within Next Generation Internet scenarios.
- Specifically relevant to experimentation, but not only, **engagement of large numbers of users and communities of users** for co-creation, awareness and design constraints should be enforced so as to ensure innovative services, applications and technologies to be more easily understood, accepted and adopted.
- **Impact factors** that should be accounted for include **interoperability, open standards, SMEs competitiveness** and **internationalisation aspects**. Appropriate incentives and mechanisms facilitating impact along these pathways shall be set in place.

APPENDIX A – THE NGI WHITE PAPER SURVEY RESPONSES

General questions

1. WHICH STAKEHOLDER(S) DO YOU REPRESENT? (23 responses)

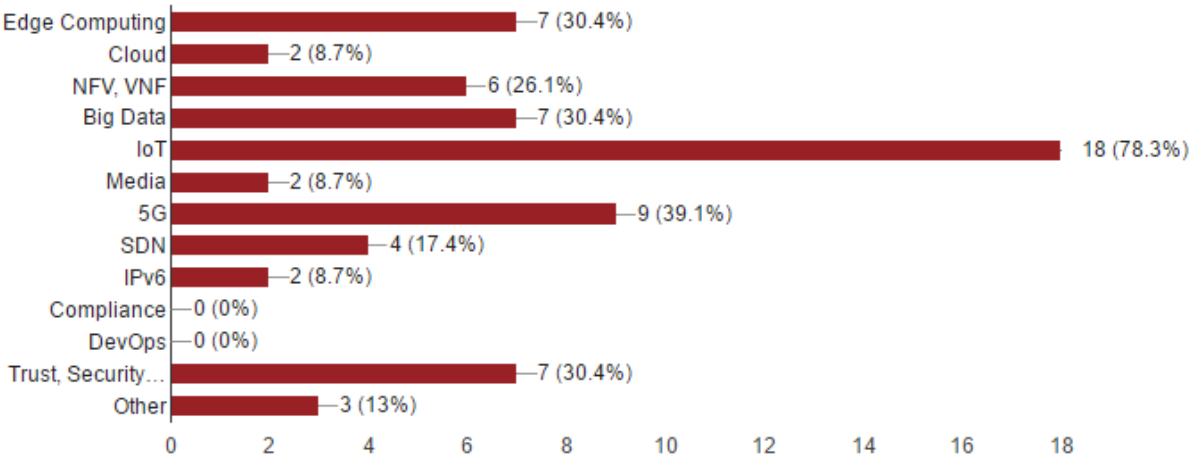


Value	Count
Business (Industry, SMEs, etc.)	7
Public Sector (Government, Local authority)	4
Technology providers (Testbed providers, Infrastructure providers, Service providers, Tools providers, etc.)	7
Non-Government Organisation (5G PPP, AIOTI, ETP, IoT Forum, BDVA, GENI, EIT Digital, ENoLL, Open Source projects, etc.)	3
Policy makers (EC, National authorities, Standard organizations (ETSI, ITU, IETF, etc.), etc.	1
Intermediaries and Enablers (Investors, Incubators)	1
Other (Universities, Academia, Research Institutes, NRENs)	8

Questions about the Next Generation Internet (NGI) Experimentation white paper

2. WHAT ARE THE KEY SERVICE / TECHNOLOGY DRIVERS FOR THE EVOLUTION OF EXPERIMENTATION-DRIVEN EFFORTS FOR A NEXT GENERATION INTERNET?

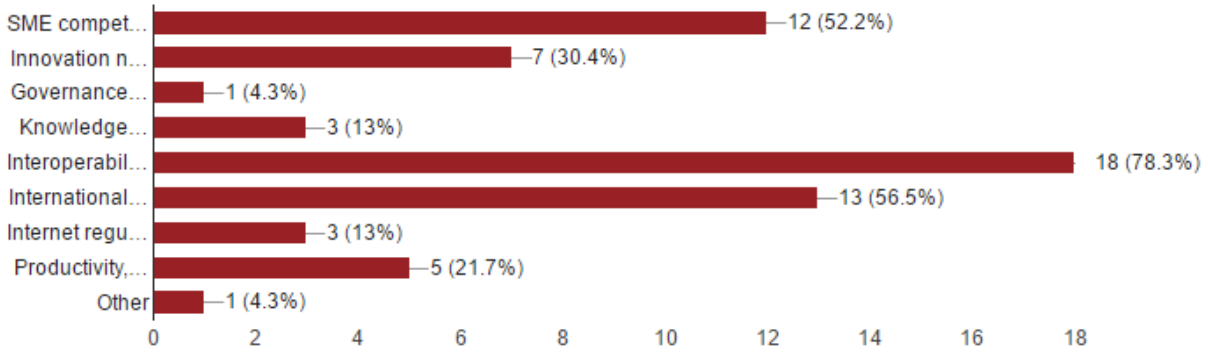
Select max three (3) most important! (23 responses)



Value	Count
Edge Computing	7
Cloud	2
NFV, VNF	6
Big Data	7
IoT	**18**
Media	2
5G	9
SDN	4
IPv6	2
Compliance	0
DevOps	0
Trust, Security and Privacy	7
Other	3

3. WHICH ELEMENTS HAVE THE BIGGEST IMPACT TO EUROPEAN ECOSYSTEM EXPERIMENTATION?

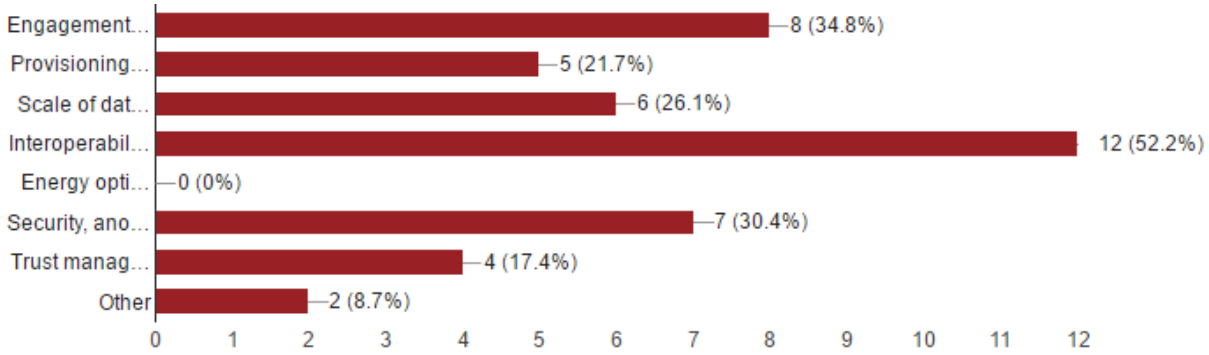
Select max three (3) most important! (23 responses)



Value	Count
SME competitiveness	12
Innovation networks	7
Governance processes and tools	1
Knowledge processes and tools	3
Interoperability and open standards	**18**
International collaboration	13
Internet regulation and governance	3
Productivity, based on experimental platforms	5
Other	1

4. WHICH INTELLIGENT SPACES CHALLENGES WOULD PLAY THE BIGGEST ROLE IN THE NGI EXPERIMENTATION?

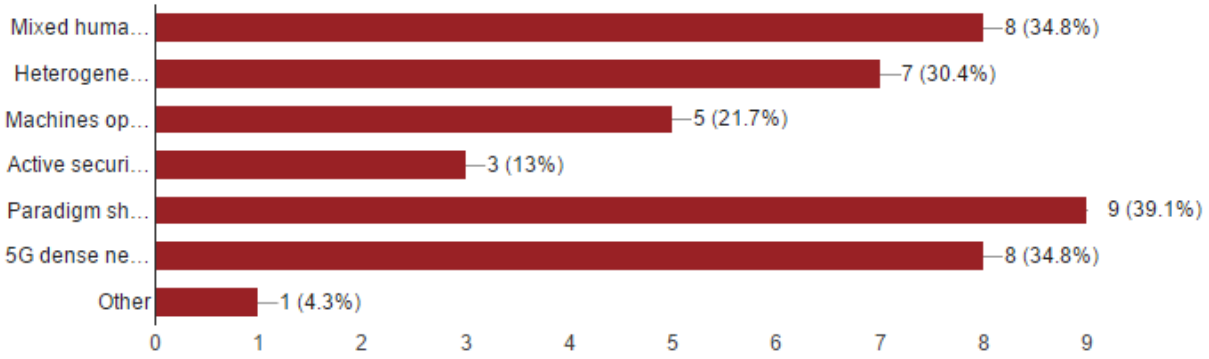
Select max two (2) most important! (23 responses)



Value	Count
Engagement of large **number of users/communities for co-creation, awareness and design constraints** to improve user acceptability.	8
Provisioning of large numbers of cooperative devices.	5
Scale of data management associated with the scale of devices.	6
Interoperability management considering the large array of "standards" that are emerging in the IoT space.	**12**
Energy optimisation for low-powered chips, aligned with intelligence for smart devices and spaces.	0
Security, anonymity and privacy because at intelligent spaces the amount of data that is produced is large and most of the time associated to users, by location, usage and ownership.	7
Trust management mechanisms and methodologies for ensuring safe human acceptance/participation.	4
Other	2

5. WHICH COOPERATIVE AUTONOMOUS MACHINES CHALLENGES WOULD PLAY THE BIGGEST ROLE IN THE NGI EXPERIMENTATION?

Select max two (2) most important!(23 responses)

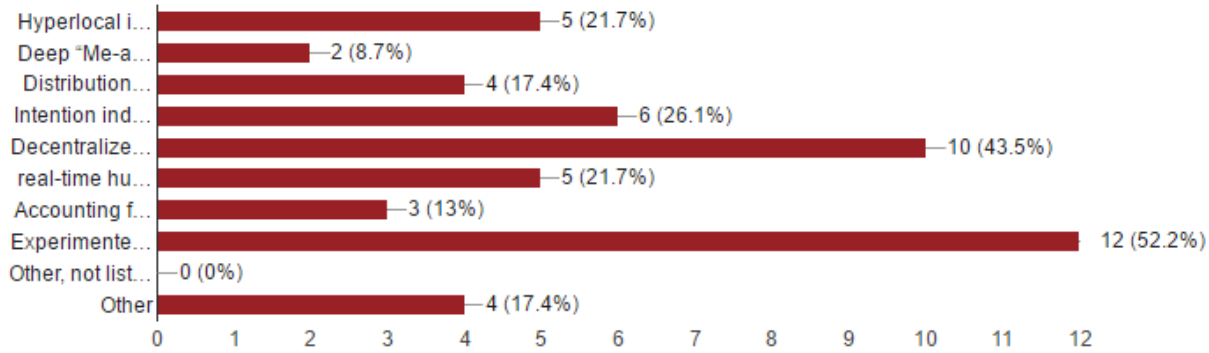


Value	Count
Mixed human-robot environments (e.g., ITS environment where driverless vehicles can coexist with vehicles having human drivers).	8

Value	Count
Heterogeneous mix of autonomous, manual and remotely operated machines.	7
Machines operating in natural open and uncertain environments.	5
Active security design, monitoring and mitigation in relation to emergent threats from deep learning intelligence machines and systemic dependencies.	3
Paradigm shift within the Industrial Internet of Things domains towards Edge Computing, in which programmable, autonomous IoT end-devices can communicate with each other and continue to operate event without connectivity.	**9**
5G dense network infrastructures with Edge computing capabilities that are complemented with new **M2M communications protocols**/networks (i.e. NB-IoT)	8
Other	1

6. WHICH COLLECTIVE HUMAN EXPERIENCE CHALLENGES WOULD PLAY THE BIGGEST ROLE IN THE NGI EXPERIMENTATION?

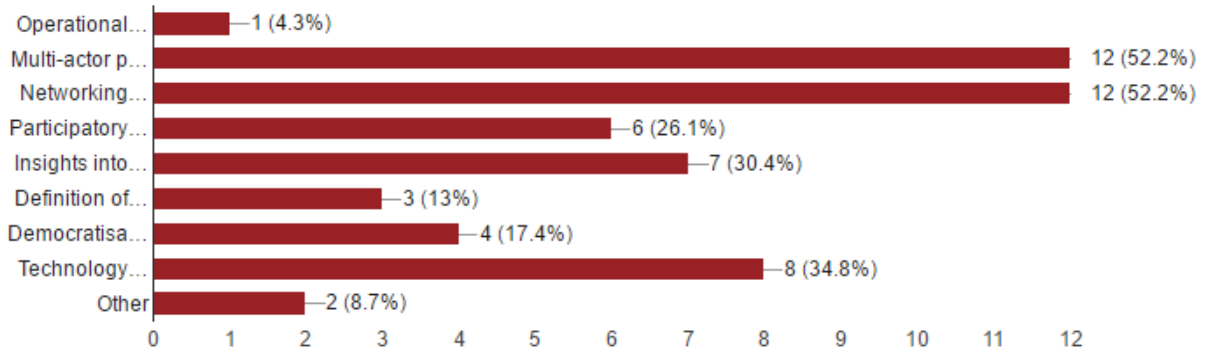
Select max three (3) most important! (23 responses)



Value	Count
Hyperlocal infrastructure, service and platform models.	5
Deep "Me-as-a-Service" provisioning, orchestration and choreographies.	2
Distribution of agency in networks, machines and people.	4
Intention independent and transparent networking.	6
Decentralized and distributed **social networks, wikis, sensors, block chains value networks**.	10
Real-time human monitoring and observation sensor data streams.	5
Accounting for the context through changing conditions.	3
Experimenters' participatory involvement in collective awareness / intelligence production.	**12**
Other, not listed above (explain in comment)	0
Other	4

7. WHICH OF THE FOLLOWING TOPICS WOULD HAVE THE BIGGEST IMPACT IN THE NGI COLLECTIVE HUMAN EXPERIENCE?

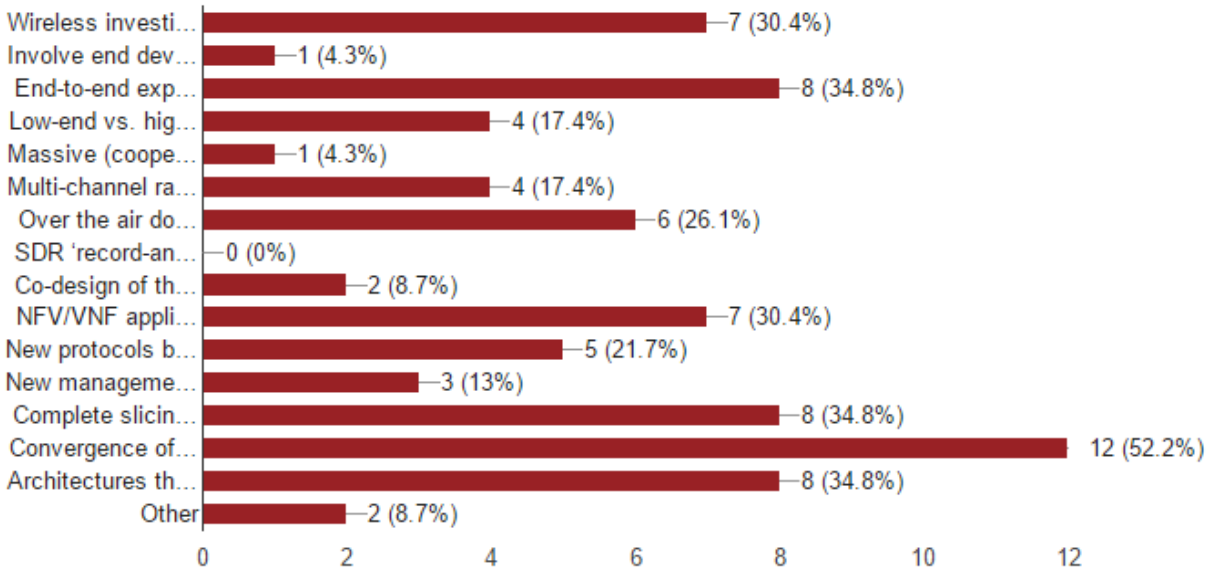
Select max three (3) most important! (23 responses)



Value	Count
Operational models fostering localised ownership and control building on international standards.	1
Multi-actor protocol/system design principles and methodologies for cooperating machines and people.	**12**
Networking protocols robust to and adaptable to variations of outcomes and with transparent constraints.	**12**
Participatory innovation and interaction models supporting collective intelligence production.	6
Insights into the disruption of new value systems supported by emerging technologies such as **block chains.**	7
Definition of new legislation to accommodate the entrance, and reduce barriers, of new technology, service and applications into daily lives of European citizens.	3
Democratisation of the internet across new open and innovative services	4
Technology drivers that facilitate the emergence of new business models that may also operate under a collaborative economy based model. Thus, **citizens and social impact** is considered as a key driver for technology evolution.	8
Other	2

8. WHICH KEY NETWORKING TECHNOLOGIES CHALLENGES WOULD PLAY THE BIGGEST ROLE IN THE NGI EXPERIMENTATION?

Select max four (4) most important! (23 responses)

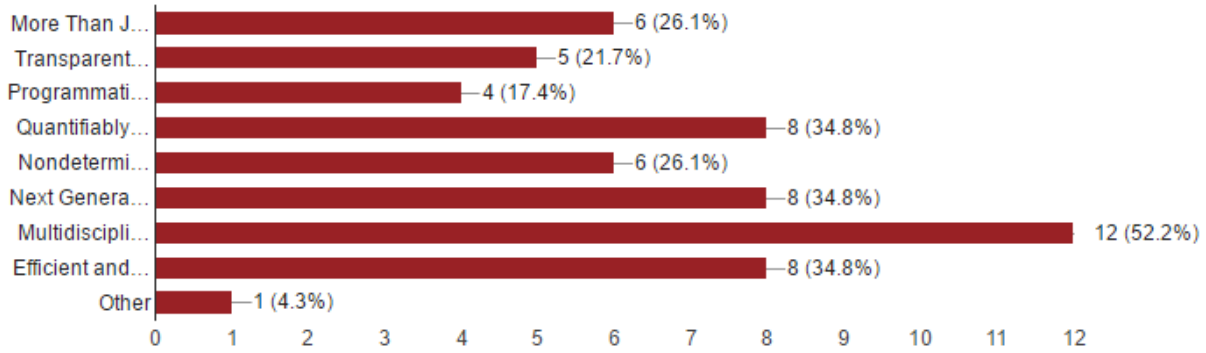


Value	Count
Wireless investigations closer to real world ecosystems providing ways to demonstrate the applicability of experimental evidence to real-life application scenarios and to explore realistic coexistence/interference scenarios.	7
Involve end devices: more flexible, compact, energy efficient radio platforms.	1
End-to-end experimentation integrating radio – network – application/services through co-design in early phases through multi-disciplinary research, development and innovation.	8
Low-end vs. high-end flexible radio platforms considering new high end spectrum bands (e.g. cm and mmWave) in contrast to mobility scenarios with (very) large-scale experimentation standardisation of low-cost SDR.	4
Massive (cooperative) MIMO aiming to reduce complexity & cost, and involve distributed, heterogeneous devices forming virtual antenna arrays.	1
Multi-channel radio supporting multiple virtual Radio Access Technologies (RATs) running simultaneously in a single wireless node, supporting simultaneous operation of new-innovate (RATs) and traditional RATs.	4
Over the air downloading of new RATs, live reprogramming of wireless device & synchronous instantiation of new RATs (adding/updating RATs) on a set of co-located wireless devices.	6
SDR 'record-and-replay' building real world wireless environment (background scenarios), E.g. out of-band transmissions (satellite, TV, aviation, etc.) to instantiate real-life scenario emulating many concurrent systems in real world.	0
Co-design of the wireless access and the optical backhaul and backbone in an integrated manner, researching at the convergence point between optical and wireless networks.	2
NFV/VNF applications over the platforms employed by the testbeds can assist in building modular testbeds.	7
New protocols based on existing technologies (e.g. beyond LTE for cellular communications, WiGig, etc.).	5

Value	Count
New management architectures moving towards the orchestration of functionalities towards the extreme edges of the network to reduce latency, enhance reliability and ensure data sovereignty (Edge Computing).	3
Complete slicing of network-topologies including available frontend and backend services such as EPC to setup separate management domains for various use cases that require partly orthogonal QoS parameters, such as IoT/M2M or CDN networks.	8
Convergence of new 5G scenarios with new IoT capabilities and technologies.	**12**
Architectures that reduce the limitations that TCP-IP have towards the expansion of Internet (i.e. mobility, addressing, etc.).	8
Other	2

9. WHICH FOLLOWING POLICY RECOMMENDATIONS WOULD BE THE MOST IMPORTANT FOR THE NGI EXPERIMENTATION?

Select max three (3) most important! (23 responses)



Value	Count
More Than Just Technology Networks: Successful Internet platforms deliver technology-enhanced ecosystems supporting large-scale efficient interactions between platform users. A technologically advanced platform without users will deliver no impact. Europe must focus on developing where networks of users and technology can coexist in ways that support sustainable growth of real life network and as a consequence drive demand for emerging information and communications network architectures.	6
Transparent and Accelerated Innovation Pathways: Industry and SMEs need clear routes to market for research and innovation activities. Platforms that deliver insight that cannot be adopted within applicable investment cycles are not relevant to business. Europe must establish experimental platforms with clear innovation pathways that deliver commercial opportunities whilst addressing contemporary / legacy constraints, market-driven interoperability / standardisation, and regulation.	5
Programmatic Consideration of Business and Technology Maturity: Large industry and SMEs have different capacity to invest, appetites for risk and rates of return. Europe must design and nurture current initiatives with a business and technical strategy that optimally aligns technology lifecycle phases with appropriate business engagement models for different stakeholders (Industry vs SMEs vs Research).	4
Quantifiably Large and Dynamic Ecosystems must be sufficiently large and interactive to understand performance, acceptance and viability of platform technologies in real-world scenarios. Large-scale is often cited but rarely quantified. Europe must establish measurable	8

Value	Count
criteria and tools for Next Generation Internet ecosystems (e.g. infrastructure, platforms, data, users, etc.) necessary to support research and pre-commercial activities ecosystems (i.e. up to city-scale), and mechanisms to rapidly scale networks towards market entry.	
Nondeterministic Behaviour vs Replicability: Insights gained in one specific physical or virtual situation need to be applied in many global situations to maximise the return on investment. Computer science wants to deliver replicable experimentation however this is looking increasingly unachievable considering that networks are inherently non-deterministic and that open systems and real-life experiments only exacerbate uncertainties. Europe must foster the development of methods and tools supporting investigation into non-deterministic systems incorporating human and machine interaction in open environments that allow for insights to be replicated across the globe.	6
Next Generation Internet Technology and Investment Education: Learning about the potential of NGI technologies and business implications is essential for the next generation of entrepreneurs and SMEs in Europe and beyond. Unless innovators understand the ecosystem and technology potential sufficiently to convince investors (e.g. business units, venture capitalists, consumers, etc.) of the value proposition continuation funding and consequent impact will not be delivered. Europe must support platforms that educate the next generation entrepreneurs and technologists whilst supporting SMEs in the development of NGI business plans and provide ways to test the viability of solutions with potential investors.	8
Multidisciplinary Action: The interconnectedness of Next Generation Internet Experimentation systems means that multidisciplinary teams must work together through common objectives. Europe must support end-to-end experimentation driven by multidisciplinary teams from different technology domains (e.g. wireless networks, optical networks, cloud computing, IoT, data science) in relation to vertical sectors (healthcare, creative media, smart transport, marine industry, etc.) and horizontal social disciplines (e.g. psychology, law, sociology, arts).	**12**
Efficient and Usable Federations: Collaboration is often the most cost effective way to acquire capability, scale or reach necessary to achieve an objective. Yet the benefits of collaboration through federated platforms are limited by the barriers of interoperability, multi-stakeholder control, trust concerns and policy incompatibilities. Europe must support federated **Experimentation-as-a-Service** approaches where there are clear benefits to users of the federation and where techniques lower the barrier to experimentation and cost of maintaining federations through increased interoperability, usability, trustworthiness, and dynamics by contributing to or leading market accepted standardisation efforts.	8
Other	1

Additional questions about the experimentation in the Next Generation Internet

10. PLEASE INDICATE WHERE THE EC SHOULD FOCUS THEIR R&D INVESTMENTS FOR 2018-2020 (=UPCOMING H2020 WORK PROGRAMME 2018-2020)? (17 responses)

IoT

New experimental platforms for emerging areas like **mobile edge computing/fog computing**.

More focus on **end-to-end systems design and validation** (not only validation of solutions through models and simulations, but also validation in real life experimental environments). With programmable HW and SW available today, validation can go beyond modelling and simulation even in early specification and design phases. This should not exclude **modelling and simulation activities**, but early feedback from experimental validation can improve the quality of models and simulations, and lead to

more realistic specifications. As such experimentation can drive the standards, rather than just validating the standards.

Internet protocol and architecture supporting IoT, media and new services over mobile network.

Reliable mobile connectivity everywhere with fast access (low latency, fast transfer, protocols that support transport of information, not just data)

Focus on a few **larger infrastructures** (and accompanying research).

Optics, increase the coherency of projects outcome, to better ditill knowledge creation, reducing duration of projects and increasing validation of results

Connected eHealth.

5G and **6G**

Interoperability of technological domains.

1. 5G + IoT standardized interfaces
2. Co-operation of the centralised Cloud with distributed Edge computing

Setting up a pan European blockchain for research and experimentation. Also opening up opportunities for SME players.

Funding for innovative startups and SMEs

Design and deployment of **Full Stack (End2End) Solutions** in the form of Reliable Devices, Sustainable Infrastructures, Interoperable Platforms and Innovative Services.

Large scale open platforms that enables prototyping for rapid innovation. End-to-end systems are utmost importance, considering cross layer interactions and supporting verticals.

IoT, **robotic devices**, establishment of mixed experimentation environments with large numbers of heterogeneous devices, device programmability

IoT, Large Scale Streams, NFV, Edge Computing

11. WHAT NATIONAL/INTERNATIONAL INITIATIVES ARE UNDER WAY IN THE MEMBER STATES WHICH SHOULD BE LINKED TO THE FIRE/NGI COMMUNITIES? (11 responses)

Fed4FIRE

IoT Sweden, iotsverige.se

It is important to explore true international collaboration opportunities, with common proposals, evaluation processes and funding opportunities across continents. Today, it is for example impossible to have a formal collaboration with funding at both sides between US and Europe. **Collaboration between US and Europe** is always based on goodwill, interest and parallel research programmes (that are not always aligned).

GEANT, **NREN**s

Finland: The **5G Test Network Finland** (5GTNF) coordinates and combines the research and technology development activities from the 5G infrastructures built under Tekes' – the Finnish Funding Agency for Innovation – 5thGear programme (http://5gtnf.fi/).

IoT-EPI

AIOTI, **OASC** and **OASC Ireland**, **FIWARE**, **GCTC**

12. WHAT THEORIES, METHODOLOGIES, PROCESSES AND/OR MODELS WOULD YOU RECOMMEND TO CONNECT OUTSTANDING ACADEMIC RESEARCH TO RAPID INNOVATION? (13 responses)

IMEC (formerly iMinds) has several processes and office facilities to assist ICT companies with innovating, both imec spin-offs as well as ICT-companies active in the research domains of IMEC. More info: see http://www.iminds.be/en/business

Participation in standardization as well as industry cooperation.
Turn academic results into demonstrators that can easily be incorporated into prototypes in innovative industries.
Build communities between infrastructure providers and users (researchers), link to international similar communities
Immediate experimental validation of theories, including deep learning/AI experiments
Beta validation of close to market innovations with real users In Living labs.
Be closer to the reality and the development at application and service level.
Agile methodology
Twice per year: Specific one-day innovation workshops: participants shared into smaller groups (4-5 persons). Target to create a patent application by all or by smaller groups.
Filling the gap between the research and the industry. Involving business units in the R&D projects.
All to One Disruptive Modeling, Walt Disney Innovation, Co-creation Design, Fast Prototyping and Design Thinking
Industry currently develop their own closed platforms to prototype their products. Finding incentives to build large scale open platforms are crucial. This requires close coordination with industry, providing what they need but also offloading their workload.
National policies for spinning-off research outcomes - facilitation of research oriented investments

13. HIGHLIGHT YOUR VISION OF THE NEXT GENERATION INTERNET (NGI) EXPERIMENTATION IN ONE SENTENCE. (16 responses)

State-of-the-art experimentation as a service enabling true remote experimentation from anywhere anytime involving anybody.
Providing technology-agnostic solutions for supporting end-to-end differentiated services with deterministic guarantees on top of dynamic heterogeneous (wired/wireless) infrastructures and technologies (requiring the need for network solutions that automatically and transparently reconfigure network settings or reprogram networks/devices to adapt to changing application requirements across heterogeneous infrastructures and technologies).
Large-scale measurements to support protocol and mechanism design.
Make information access fit the human users' needs.
Large, generic and flexible infrastructures for all kinds of NGI research, world wide connected with high bandwidth and lowest layer possible.
The invisible network, ubiquitous, extreme capacity, secure and safe at marginal cost (as it is become a utility like water) where knowledge and its analysis are easily accessible.
KPI of NGI should be a high Volume of NGI innovations validated in beta with real users in close to market environments with living lab structures.
An environment where you can pre-deploy services and devices to validate them.
Multidisciplinary.
Easy access to free tools and to free federated resources.
Next Generation Internet for the Next Generation of Europe (Europe 2.0).
Democratise access to a network of devices (e.g., IoT, mobile nodes, powerful servers) to experiment innovative services and applications.
The collective instrument for defining paths and ways for innovative solutions at the different levels of the Information Technology (IT), Devices, Infrastructures, Platforms, Data and Information, Applications and Users Experience.
Large scale open platforms that support novel cross-layer end-to-end services.
Holistic connectivity & distributed intelligence.
Virtualization of the experimentation facilities to increase performance and scalability.

14. PLEASE LET US KNOW ANY OTHER COMMENTS YOU MIGHT HAVE. (6 responses)

The expertise needed to create and build the networks of the future is multidisciplinary and contains at least computing system, networks and data analytics. However, the network should stay as smile as possible, maintaing most functions at the edge or in users' equipments. Training and knowledge concentration is essential.

FIRE/NGI integration and co-existance will feel better by executing alignment of plans and ideas involving different stakeholders in the form of All-to-One workshop or providing an atmosphere for Walt Disney Innovation activities, surveys provides a good way to identify stakeholders / main people interested on participation but does not necessarily provide the feel of realisation of ideas while co-creation and workshops provides better outcomes. We should plan on using this or one of the proposed methodologies in the next FIRE/NGI FORUM.