November 30 Workshop on the Next Generation Internet initiative (NGI)

Brussels, 30.11.2016

Workshop Report by Prof. Petros KAVASSALIS, UAegean

Disclaimer:

The views expressed in this publication are those of the author and do not necessarily reflect the official European Commission's view on the subject.

From the website of the NGI initiative[1]:

"The Internet of the future should be more open, provide better services, more intelligence, greater involvement and participation. It needs to reflect the European social and ethical values: free, open and more interoperable".

1   NGI Workshop purpose

The European Commission is currently launching a multidisciplinary new flagship initiative with the ambition to become a major driving force for the Internet of tomorrow. The Next Generation Internet (NGI) focuses on novel technological breakthroughs, on new architectural solutions and advanced applications and services to support evolving digital business strategies. Above all the NGI needs to reflect the needs of society and foster people's interaction and collaboration. Specific elements and priorities are not yet decided, hence this workshop and open consultation on the initiative. The NGI could exploit new technology breakthroughs and policy domains, e.g. new «edge-based» architectural solutions, innovative forms of data searching like predictive or autonomous search, new «smart services» (incorporating user and location data analytics, AI interpretation,

---

[1] http://ec.europa.eu/futurium/en/node/1460

visualization and real-time monitoring), cross-domain and cross-federation identification, distributed ledger technologies etc. Engaging citizens, researchers, start-ups and SMEs, as well as the industry, will be key in the NGI design; inclusive from the very beginning to further its development. The EC's role is to bind together research, innovation and policy to define and implement a consistent vision of NGI which also addresses European values and priorities. The Internet of the future should improve the workplace and positively influence our lives, promote efficiency, openness and inclusiveness.

This Workshop was organized in Brussels, on November 30, 2016, with the objective to bring together researchers and experts from various domains such as industry, academia and new forms of business (e.g. social entrepreneurship, startups) to share expert insight, to hear different voices and to build a community that stands behind the NGI themes. The issues raised by the participants and the analysis in this report, are classified in terms of: a) possible R&D actions (what should be included in NGI: 10 issues) and, b) procedures or methodology and tools (how to organize NGI operations to foster innovation and agility and increase impact: 12 issues).

2   NGI Workshop Executive Summary: conclusions and key issues raised

The current Internet that has very rapidly grown during the last thirty years, is a clear success. People see this success in terms of the huge transformation and impact the Internet has created across every domain of economic and social life. Yet, part of the Internet's success relates to its bold technological nature, to the adaptability of the TCP/IP protocols, the resilience of its architecture, the end-to-end principle, its openness to new applications. Resilient and robust, Internet has established a *spanning layer* between different applications and the underlying network facilities. That allowed applications to request and obtain network service independent of underlying (physical) network technologies. As a result, applications can work over multiple, different substrates (e.g. network substrates) and these substrates they do not specify the development of new applications, as it

happened with pre-internet national monopoly telecom networks[2]. The decoupling of infrastructure facilities and innovation at the top network layers, explains the **proliferation of Internet applications**, and the wonderful, and continuous, creation of new services for the user.

But Internet's success and unleashing technical performance should not blind us to other concerns on what is actually happening today. Innovation in the current Internet architecture seems to have reached a certain **upper boundary**[3]. Large commercial ISPs, cloud service providers and content providers have gained significant market power. The Internet may essentially remain a distributed system, but its *core,* to use Internet architecture terminology, absorbs most of the activity – perhaps to the detriment of the *edge.* Internet users and citizens feel frustrated because of the rise of **powerful Internet mega-players**, and public opinion openly expresses dissatisfaction with the status quo and irritation. The discussion in the working groups of the Workshop pointed to the dominant market position of these giant Internet corporate interests. According to the opinion of a number of participants, *"Internet is not as pluralistic and research-driven as it once was. Today the top four global Internet players (Amazon Apple, Google and Facebook) have a huge advantage to shape its development"… "Can citizens trust these powerful structures with their data"* to have private for profit corporations take the lead over the Internet evolution? Possible anti-competitive strategies and conflicting interests could seriously impede the technological evolution of the Internet and eventually distort market efficiency by preventing competition and imposing stickiness in prices[4].

[2] D. Clark, 1988, The Design Philosophy of the DARPA Internet Protocols, available at
http://ccr.sigcomm.org/archive/1995/jan95/ccr-9501-clark.pdf
P. Kavassalis et al, 2002, Sustaining a Vertically Disintegrated Network through a Bearer Service Market, available at
https://dspace.mit.edu/bitstream/handle/1721.1/1538/sus.bear.pdf?sequence=2
[3] Oxford Internet Institute, 2010, Tokyo Workshop for a Future Internet, available at
http://www.internetfutures.eu/wp-content/uploads/2010/04/tokyo-workshop-report.pdf

[4] SMART project, 2010, Towards a Future Internet (Final Report), available at
http://cordis.europa.eu/fp7/ict/fire/docs/tafi-final-report_en.pdf

The opposition to technological determinism and market concentration takes frequently the form of a plea for a human-centric vision of the Internet evolution. Workshop participants, in fact, value *openness* and *inclusiveness* as the foundation principles for a future Internet**.** They consider **NGI as an opportunity for a return to a certain equilibrium** between the big Providers (at the Internet core) and the vast activity of local networks of users, business networks, markets and communities, locked-out of the premises of the big Providers (mostly locating at the periphery of the network). Hence, they welcome and embrace innovation that can work for **a more decentralized governance** of the Next Generation Internet. It is normal. The vision for a NGI, and the research that should implement that vision, needs to draw on a wider perspective than the simple exploration of *beyond-the-frontier* network and computing technologies.

Very fortunately, several emerging but powerful technological trajectories in the computer and communications sectors, are leading in the same direction, **towards an "upgrade" of the *Internet edge*[5]**. With decreasing information processing and transmission costs, and increasing abundance of smart devices, IoT networks, cyber-physical infrastructures and large business and community networks, activity and diversity at the edge of the Internet will probably increase unboundedly, potentially, with a consequent increase in users' choices. Clouds, for example, are vertically integrated and of limited quantity in the Internet of today, but this may be different in the NGI. The state of Massachusetts in the US, for example, develops an *Open Cloud project* to provide a local cloud marketplace where unprivileged service providers can compete with offers at all layers of a cloud market (including hardware)[6]. In parallel, smaller geographically distributed clouds proliferate at the edge of the Internet. They have been called *cloudlets or*

---

[5] European Commission, 2016, 2nd Interim Report for the Next Generation Internet Consultation 2016, available at https://ec.europa.eu/futurium/en/content/2nd-interim-report-next-generation-internet-consultation-2016
[6] R. Fonseca and O. Krieger, 2015, Towards a Network Marketplace in a Cloud, available at https://www.flux.utah.edu/beyond-internet-workshops/sdi/Fonseca,Rodrigo-Towards_a_Network_Marketplace_in_a_Cloud.pdf

fogs. They essentially provide powerful, "low latency", processing, storage and communication capabilities to mobile devices and applications[7] For more decentralized internet architectures the question is obvious: what are key technology and related policy issues, for the NGI initiative, to efficiently support this **"move to the edge"?**

At a different level, service innovation forces this same issue, on innovation at the Internet edge. **New smart services** will incorporate personal, environmental and user location data analytics, Machine Learning and AI interpretation, visualization and real-time activity monitoring. Smart services provide instant action rules to service operators and customer experience management guided by the collaboration of humans with software systems[8]. As **data become increasingly essential in the service operation**, NGI applications need to ensure **decentralized data governance**[9]. This can mean offering comprehensive native encryption together with multi-party computation to process data without accessing the raw data directly. The option to incorporate new cognitive capabilities in NGI services assigns to users more control over their data. NGI policies can create this suitable framework for "smart services" and efficient decentralized data governance.

Innovation at the edge and decentralized data governance are examples of key NGI priorities that can answer the questions above that were raised by a number of workshop participants during the workshop. As reported in the section below, participants identified a number of specific issues related to the evolution of the NGI vision **(what R& D topics)**. For each issue, some options for action are given (partially based on the

[7] E. Borcoci, 2016, Fog Computing, Mobile Edge Computing, Cloudlets - which one?, SoftNet 2016 Conference, Rome, available at
https://www.iaria.org/conferences2016/filesICSNC16/Softnet2016_Tutorial_Fog-MEC-Cloudlets-E.Borcoci-v1.1.pdf
[8] NSF Steering Group Final Report, 2016, Looking Beyond the Internet, available at
https://lookingbeyondtheinternetblog.files.wordpress.com/2016/03/looking-beyond-the-internet-final-report.pdf
[9] K. Wende and B. Otto, 2010, A Contingency Approach To Data Governance, available at
http://mitiq.mit.edu/iciq/PDF/A%20CONTINGENCY%20APPROACH%20TO%20DATA%20GOVERNANCE.pdf

participant's input and partly by interpreting their reference as links to major emerging technology trends), as well as linked to the NGI values cited above.

Workshop participants were adamant to challenge the current EC rules and procedures for R&D selection, evaluation and funding. They want a reform of the process and ask the EC to develop new and better models for NGI that are: a) more adequate for small organizations, b) flexible enough to keep pace with the accelerated technology path and the increasing organizational diversity related to NGI activities. These requests are given below in the methodology and tools section **(how to: procedure)**.

2.1   NGI November 30 Workshop Material (actions and R&D topics)

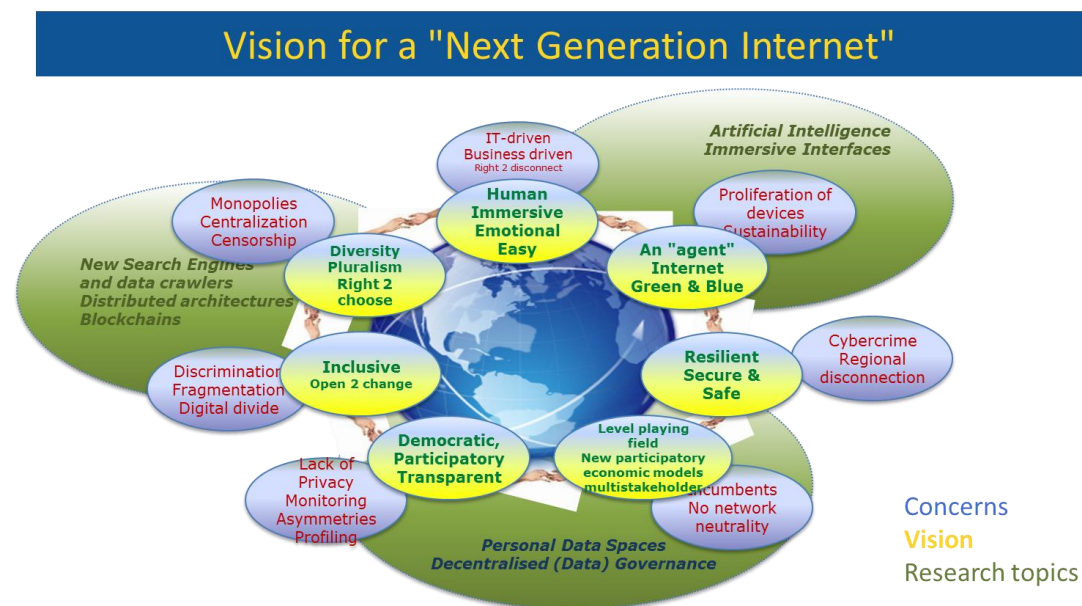The vision map below was presented at the Workshop prior to the breakout sessions:

Figure 1: NGI Vision Map

Based on this vision and the introductory comments by EU officials, each individual participant met in a small group to make his or her own

observations and to propose a number of themes that they felt should be included in the NGI vision. This section:

a. Provides **a list of Issues raised** (issues #1-10)
b. Explains their **relationship with the NGI Values** (or high level design principles)
c. Proposes possible «issue-driven» **Key Actions (R&D topics)** to be considered as part of the NGI research agenda.

The identified R&D topics (Possible NGI actions) are categorized as **potential NGI Research Areas**.
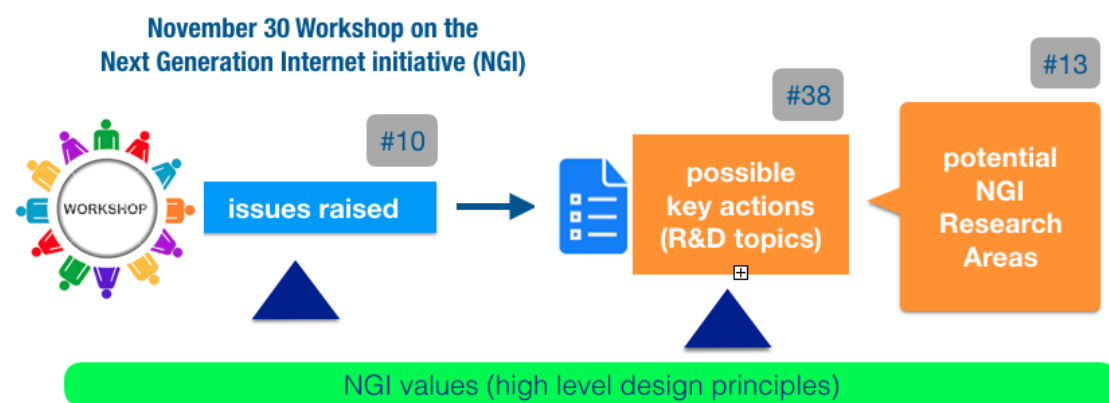

Figure 2: NGI R&D topics - Report methodology

Issue#1: The NGI should be seen as an open and co-operative worldwide platform, in contrast to a "European-only" Internet.

EC is to establish international collaboration links with US (NSF, DARPA), Australia, Japan, Korea, China, and explore co-operation with other countries as well, and link to Internet Governance bodies. The objective is:

o To better understand and define NGI values in a global context
o To frame these developments in the context of a Global Governance

*NGI Research Area: NGI socio-economics and policy

NGI values: Internet Global Governance, Transparency, Non-Discriminatory Access for all

---

Issue#2: NGI needs to bring together a large, multidisciplinary, stakeholder community.

Internet developments, both technically and commercially, are currently driven by a few global incumbents (Amazon, Apple Google and Facebook). Some of them, cloud and content providers, may "have passed a certain scale", beyond the necessary economies of scale[10]. A more balanced open governance model would be possible. It needs to keep intact the features of the Internet that made it a success, especially the possibility that everyone can enter the business to add a new innovative service. The model must ensure level playing field conditions. Efficiency plus the fairness principle: possibility to equally compete with other providers in the market. The essential elements of this model should be devised, but priority should be given to: a) the promotion of geographically distributed clouds and cloudlets at the edge, b) the infusion of loosely-coupled software components and programmable hardware[11] at both the multi-domain core NGI and the edge (protocol independent components), the c) the interconnection (within *end-to-end service slices*[12]) between the different clouds and between the core and the edge, etc.

Possible NGI actions (R&D topics which can help establishing such a more level playground are):

o Distributed Cloud and Fog/Edge computing-networking

---

[10] O. Krieger, 2016, A Marketplace-driven Direction for SDI: Towards an "Open Cloud Exchange!", available at https://www.flux.utah.edu/beyond-internet-workshops/sdi/slides-krieger-moc.pdf
[11] M. Canini, 2016, Directions for a Software-Defined Next Generation Internet, available at https://ec.europa.eu/futurium/en/content/directions-software-defined-next-generation-internet
[12] A slice is a set of network resources which fits the service attributes and requirements of customer services (it is already included in 5G network designs). See in particular: H. Zhang, 2016, Future Network: End-to-End Slicing and Hop-On (a Slice), available at https://arxiv.org/abs/1608.06676

- o Software-Defined Infrastructures (SDI) and eXchanges (SDXes)
- o Integrated (multidisciplinary) approach for system building (system prototyping, deployment, testbed operation "in one")

*NGI Research areas: edge-NGI, Programmable Network Components

NGI values: Diversity, Decentralized Governance, Resilience, Openness

---

Issue#3: NGI should have the capacity of detecting network failures and measuring network availability.

The Internet of today works efficiently in practice; it may function flawlessly but, strangely enough, it has never been endowed with global, native, feedback mechanisms. As a result, when a communication request cannot be achieved, the network lacks the capacity to deal with such a failure, i.e. to formally recognize the problem, inform the constituents and repair it[13]. NGI needs to provide a remedy to this shortcoming, originating from the early days of the Internet. It should provide reliable mechanisms to: a) detect eventual failures and organically fix them and, b) consistently measure and evaluate network availability[14]. The gains will be to improve network manageability in the Control Plane and Data Processing Plane[15].

Possible NGI actions:

- o Decentralized Network Control
- o Network availability and Measurement
- o Cognition in the network
- o NGI Control Plane
- o NGI Data Processing Plane

---

[13] D. Clark et al, 2003, A Knowledge Plane for the Internet, available at https://groups.csail.mit.edu/ana/Publications/PubPDFs/A%20knowlege%20plane%20for%20the%20internet.pdf
[14] D. Clark and K. Claffy, 2016, Conceiving Availability, available at http://www.nets-fia.net/Meetings/Fall15/Availability-fia-ddc.pptx
[15] A. Feldmann, 2016, The Next Generation Internet, available at https://ec.europa.eu/futurium/en/content/next-generation-internet

*NGI Research Area: Decentralized Network Control and Measurement

NGI values: Improved Network Availability, Redundancy

Issue#4: NGI needs to build an interdisciplinary Internet of humans. A significant part of NGI will be about considerably enhancing applications and user services, and endowing social and learning networks with mixed reality.

NGI tends to increasingly move storage, processing and functionality to the network edge, in combination with the opportunities arisen from the deployment of programmable network components, create the supporting environment for a next generation of user-tailored (personalized) applications and "smart services". They should operate by processing personal, environmental and user location data analytics, conducting AI interpretation and providing visualization, real-time activity monitoring and instant action rules. Such a "smart service" paradigm can provide instant action rules to service operators and customer experience management guided by the collaboration of humans with software systems. Research in this area is of high priority. One key motivation for NGI is also the increasing reliance of humans on cognitive IT systems (as such, it should not be only driven by Machine Learning and Artificial Intelligence developments).

Possible NGI actions:

- o Real time Collaboration
- o Collective data processing and visualization
- o Haptic-Multisensory Interfaces
- o Collaboration of Humans with Cognizable Machines
- o Immersive and Augmented Reality Technologies for edge user networks and communities
- o Real Time Location Systems incorporating ML and cognition

o   Decentralized Data Governance
o   Cognitive IT

*NGI Research Areas: NGI edge-Applications and Services, Technology-mediated Human Networks

NGI values: Human Dimension, Smartness & Easiness

Issue#5: There is an urgent need to solve the privacy and security issues that make the Internet vulnerable and less trustable today.

Data proliferation and cloud-based services will increase the importance of user data and privacy. In parallel, smart devices and IoT networks create new vulnerabilities and challenge the processes of interconnection between systems[16]. Eventually, a radically new security framework is needed to be defined, so to address NGI security challenges and requirements.

Possible NGI actions:

o   Privacy-Enhancing Technologies (PET)
o   User Data Ownership (Personal Data Spaces)
o   New data-encryption technologies – data masking
o   Advanced Network Security (in the presence of wireless and IoT)
o   New concepts of security for Software-Defined-Infrastructures (SaaS, security automation etc.)
o   Detection and Prevention of Bandwidth Depletion Attacks (DOS and DDOS)
o   Cybersecurity
o   Cross-border and cross-domain Access-Control Technologies
o   Trust and Identity Management in Federation

---

[16] B. Schneier, 2016, Testimony at the U.S. House of Representatives Joint Hearing "Understanding the Role of Connected Devices in Recent Cyber Attacks", available at https://www.schneier.com/essays/archives/2016/11/testimony_at_the_us_.html

*NGI Research Areas: NGI Privacy (new paradigm), NGI Security (new paradigm)

NGI values: Non-intrusiveness, Security, Safety

Issue#6: Emerging search needs for mobile/IoT may challenge existing search engines practices and current monopolies.

As mobile continues to grow and IoT is thriving, adding context to search becomes an imperative. NGI should favour research in contextual search and recommendation[17].

Possible NGI actions:

o Advanced contextual search and data aggregation
o Meta-Search Technologies for the IoT, the Online Social Networks, the «Deep Web» and the «Dark Web»
o Contextual recommender systems

*NGI Research Area: Advanced Contextual Search

NGI values: Disrupting Technology-based Monopolies, Transparency, Pluralism

---

Issue#7: NGI should support the digitization of industry (Factory 4.0) and service sectors.

As "smart production" and global supply systems become the norm, NGI should support industry and service to manage complex industrial production processes and service value nets.

Possible NGI actions:

---

[17] M. de Rijke (ed), 2015, ACM Transactions on Information Systems (TOIS) - Special Issue on Contextual Search and Recommendation, available at
http://dl.acm.org/citation.cfm?id=2737806&picked=prox&CFID=702729580&CFTOKEN=12696996

- o Synchronization of Real and Virtual Production Plants
- o End-to-end Quality of Experience (QoE)
- o Robotic Process Automation

*NGI Research Area: NGI for verticals

NGI values: NGI for the economic welfare

Issue#8: NGI should allow for a continuous bottom-up movement to strengthen NGI's "public good" features.

NGI has great potential to drive transparency and efficiency of public information diffusion through the creation of new infrastructures for public services and the promotion of open verification processes.

Possible NGI actions:

- o Promote Distributed Ledger Technologies (DLT) for Transparency and Accountability in Government Records, Regulation (RegTech), Decentralized Data Governance etc.
- o Invest NGI funds only in Open Technologies & Transparent Algorithms

*NGI Research Area: NGI for transparency (Distributed Ledger Technologies etc.)

NGI values: Transparency, NGI for the public good

Issue#9: NGI should have real impact on Digital Divide, Social inclusion, Jobs Creation, Open Democracy, Education and Public Health.

NGI value comes not only from market success but also from the social impact of the deployed actions. Applications in these areas are good laboratories for interdisciplinary research.

Possible NGI actions:

- o Close Coordination with existing Edge-Networks of Users and Communities (for example eIDAS [18] for identity management, e-twinning network for schools[19])
- o Build experimentation ecosystems supported by open experimentation platforms[20]

*NGI Research Areas: NGI User Communities, Experimentation Platforms

NGI values: Social Participation - Openness - NGI for the social welfare

---

Issue#10: The impact of NGI action undertaken by EU should be measurable (accountability).

Possible NGI actions:

- o NGI KPIs (at different levels, project-based – programme-based etc.)
- o NGI Tipping Points and Societal Impact

*NGI Research Area: NGI socio-economics and policy

---

[18] https://ec.europa.eu/futurium/en/eidas-observatory and
https://ec.europa.eu/cefdigital/wiki/display/CEFDIGITAL/eID
[19] https://www.etwinning.net/en/pub/index.htm
[20] See in particular: M. Boniface et al, 2016, Next Generation Internet Experimentation - Drivers
Transforming Next Generation Internet Research and Experimentation, available at
https://ec.europa.eu/futurium/en/content/next-generation-internet-experimentation
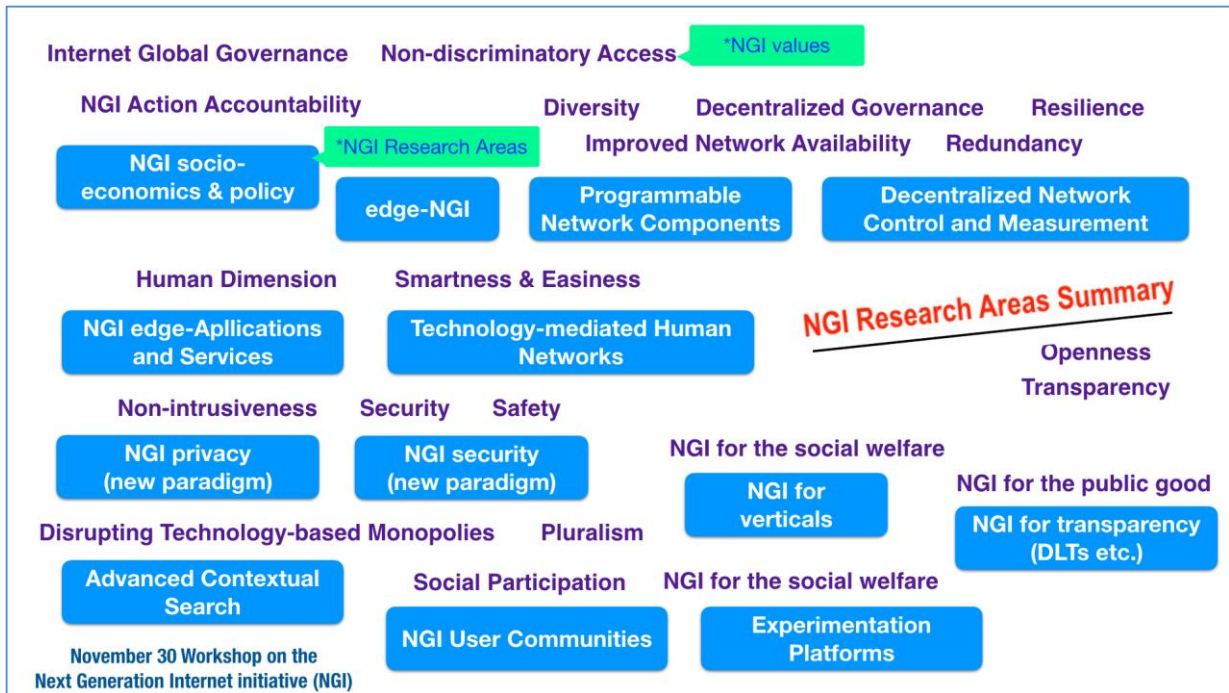
NGI value: NGI Action Accountability

Figure 3: An overview of the NGI values mentioned in the Workshop and potential NGI Research Areas

2.2 NGI November 30 Workshop: proposed NGI methodology and tools (how to: procedure)

The discussion then pointed to issues related to the process of participation in the NGI initiative actions. Workshop participants have insisted on the need to adapt the conditions for participation in EU R&D projects, especially in the NGI related actions. They have also proposed a number of potential process changes which are reported below, in terms of **Issues** and **Possible Types of Action** (Issues #11-22).
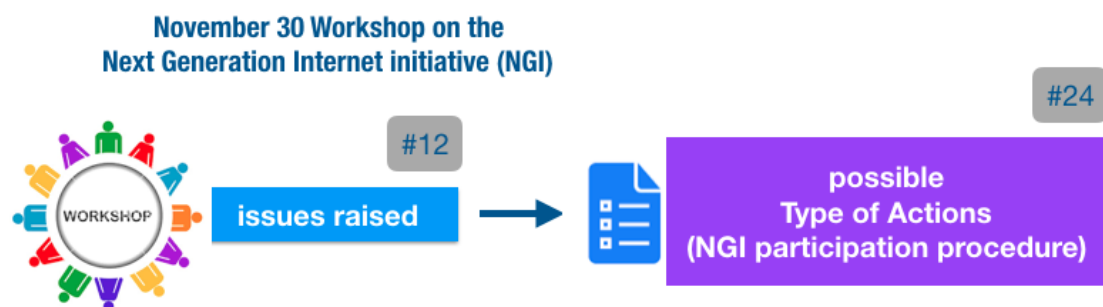

Figure 4: NGI Participation Procedure - Report methodology

Issue#11: The presentation and the selection of projects should be simpler and quicker in the NGI initiative. Academic excellence and merit remains valuable to the initiative. Different scientific fields and communities should participate to build the initiative.

Possible Type of Action:

o Engage multi-disciplinary communities; strive for high scientific value, high-risk research (address the human dimensions of NGI innovation technological, economic and social)
o Define NGI research agenda from bottom-up

Issue#12: NGI calls for proposals should provide more room space for "exotic ideas" beyond the mainstream industry approaches.

Possible Type of Action:

o Adapt the selection process, e.g. to provide to the proposers, in certain cases, the possibility to defend their research proposal against the evaluation committee

Issue#13: NGI projects should embrace only the necessary "programmatic constraints" in such a ways as to not hamper researchers' passion and motivation. Innovation and creativity should be the accountability drivers in the deployment of a NGI project.

Possible Type of Action:

o Allow for frequent but consistent re-arrangements of the research agenda during a NGI project life

Issue#14: NGI should leave some room space for small scale and/or short term projects (which will coexist, and potentially interact, with NGI long term research projects).

Possible Type of Action:

o Apply two different project scale requirements (short term research projects, 1 year maximum and mid-term research projects with 2-2.5 years average duration)
o Make wider use of a submission procedure in two steps (pre-selection on the basis of a short research proposal, submission of full proposal only from those having succeeded in step one)

Issue#15: NGI projects should improve the research/adoption gap

Possible Type of Action:

o Require from the project teams to address the issue of how a project's output can respond to particular use-case scenarios, elaborated by domain experts; or, eventually, to deploy one of the major project technologies into a real life case (by including in the project a specific team with the relevant competence and expertise)

Issue#16: Europe's success in NGI will increasingly depend on innovation timing and public funding flexibility.

Possible Type of Action:

o Require rapid prototypes, recognition of early adopters and validation
o Re-orient part of the available funding towards the most successful research projects («success breeds success»)
o Establish conditions for funding larger projects; use the EU «Innovation Procurement» framework[21] as an additional opportunity for NGI projects delivering outputs that may fit to the procurement needs of EU Member States' public administrations

---

Issue#17: Smaller amounts for prizes and grants should be attributed to individual researchers, cross-border groups of researchers and small companies, including hi-tech start-ups (while decreasing the time frame for these activities to 18-12-6 months). Then if the project is interesting, valuable, successful, fund it even further.

---

[21] https://ec.europa.eu/digital-single-market/en/innovation-procurement

Possible Type of Action:

o Create an NGI fund for rapid financing of prizes, micro-funding (up to 20 K€) and small scale research grants (up to 150-200 K€) – as first steps to go further

Issue#18: NGI should facilitate the involvement of SMEs and create powerful links with the European start-ups ecosystem while focusing on selecting the "right" SMEs and start-ups.

Possible Type of Action:

o Review existing project selection and funding process under the perspective of better serving the need of increased participation from hi-tech SMEs and start-ups
o Simplify application and project management rules (deliverables etc.), so the NGI initiative becomes more attractive to SMEs and start-ups
o Establish collaboration agreements with Large and/or High Profile User Communities
o Stimulate participation of social startups and social entrepreneurs as drivers of the NGI societal concerns
o In order to attract new stakeholders, an additional effort on communication to create awareness among relevant groups is required

Issue#19: NGI should encourage civil society participation.

Possible Type of Action:

o Create a NGI Social Forum as a bridge between NGI actions and the organized civil society

o Create decentralized environments intrinsically privacy protecting, to encourage civil society participation

---

Issue#20: NGI vision and values, and a "challenge-driven" approach (not only a technology-driven one) should be explicit parts of the NGI.

Possible Type of Action:

o Include a strong multidisciplinary component in the NGI initiative;
o Establish support activities to process and define the context and the specific objectives of subsequent NGI calls, on the basis of societal concerns gathered though open consultation processes and other inputs[22]

Issue#21: NGI should initiate a culture and a organizational framework for experimentation, a sort of a «NGI playground for researchers" that will enable a rich collaboration environment: "We need an overall framework where we can be creative, we need a sandbox to play and test".

Possible Type of Action:

o Invent new forms of collaboration and common work for the NGI community
o Widely use the EU CO-CREATION model[23]
o Provide experimentation tools and promote good experimentation practices

---

[22] In the model of ICT-41-2017 Call (Horizon 2020 - TOPIC : Next Generation Internet)
[23] http://ec.europa.eu/esf/transnationality/content/three-essential-steps-co-creation
Example: An IoT Co-Creation framework - http://www.slideshare.net/IoT-EPI/value-cocreation-workshop

Issue#22: In a «creative by design» NGI environment, success is important but equally important is to recognize and admit failure, and analyse failure to take lessons

Possible Type of Action:

o Systematically review research results to identify «failures» and create a learning capacity from failures

3   NGI vision: general context and open questions

Need for a NGI policy framework: Economists, political scientists, professionals and the general public, recognize that there is an increasing tendency of the Internet towards industry concentration and lack of transparency. The Next Generation Internet initiative in Europe, and every other similar initiative in the rest of the world, faces the challenge to design a more favorable environment for competition and for innovation. The case for more competition gets stronger recently, especially in the cloud services sector where experts ask for an open cloud interconnection to avoid "customer lock-in" and private and business data aggregation in a few proprietary clouds[24]. The bigger concern however relates to the fear that a de facto restriction is established, as far as the capacity of the public policy to redesign the technology framework or the regulation system of the Internet is concerned[25]. **It is essential and the right time for Europe to define the NGI policy framework that allows for the innovation path that people expect and ask for, so as to increase the impact of all NGI R&D actions**. This is perhaps the most important open question for this initiative.

---

[24] W. Lehr and S. Bauer, 2014, Interconnection in the Clouds, available at
https://www.caida.org/workshops/wie/1412/slides/wie2014_wlehr.pdf
[25] K .Claffy and D. Clark, 2014, Workshop on Internet Economics (WIE2014) Report, available at
https://www.caida.org/publications/papers/2015/wie2014_report/

Promote the formation of strong user communities as NGI edge-nodes: A second, and related, open question arises from the emerging trend for network decentralization[26]. This Report confirms the particular force of the technology trend. A substantial part of network activity is expected to move to the edge, so NGI will naturally form from multiple edges, connected flexibly and securely with other edges and the core. To influence and get benefit from this trend to "move to the edge", **it is a priority to promote the formation of user-community-based edges that will experiment in real conditions (in-vivo) with the software-enabled NGI technologies and leverage smart services opportunities**.

Endorse international collaboration: Finally, the success of the European NGI initiative is conditional to the global impact of the action undertaken in Europe. In this perspective, a collaboration with the research groups involved in US Future Internet related activities, and with other countries, is the rational strategy for increasing focus and impact. **The NGI initiative should design specific actions for policy collaboration, shared technology development and interaction between user-communities, with other initiatives in the world where parts of the global NGI infrastructure are designed and deployed**. NGI requires a strong institutional framework to promote and realize the vision with an advanced international collaboration programme. This work should be addressed with an open entrepreneurial spirit and a flair of innovation.

Workshop Identity	
Opened by EC officials (P. O'Donohue, J. Villasante, P. Fatelnig, L. Anania)	
Keynote Speaker: D. Papadimitriou, Nokia – Bell Labs, Antwerp	EU
Plenary and «work in groups» (Big Industry, Start-ups and SMEs, Civil Society, Research)	
Workshop URL: https://ec.europa.eu/futurium/en/content/first-workshop-next-generation-internet-initiative-brussels	

---

[26] D. Papadimitriou, 2016, Ground breaking path on Internet development, keynote talk in November 30 Workshop on the Next Generation Internet initiative (NGI)