Digital Innovation Networks

Exploring how digitisation and Internet connectivity influence networks of innovation for the Next Generation Internet

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The progressive digitisation and Internet connectivity of people, products and processes is a transformational and powerful trend in societal and industrial systems. But how does digitisation and connectivity influence networks of innovation? How do such networks shape the way knowledge is created, who creates it and where as well as how it is shared? How will new products and services emerge as a consequence? This report addresses these questions through the concept of Digital Innovation Networks, defined as multi-disciplinary and multi-sector networks of people, technologies and organisations aiming to advance Internet technology and innovation processes to address key socio-economic challenges and opportunities. The goal is to understand factors necessary to establish Digital Innovation Networks as foundational structures delivering advanced technologies and social and economic solutions within the Next Generation Internet.

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Authors:

Michael Boniface, Steve Taylor, IT Innovation Centre, mjb@it-innovation.soton.ac.uk

Monique Calisti, Martel Innovate, monique.calisti@martel-innovate.com

Contributors

Jonathon Cave (Senior Fellow in Economics, University of Warwick and Economist Member of the Regulatory Policy Committee, UK)

Noshir Contractor (Professor of Behavioural Sciences, Northwestern University, US)

Lars-Gunnar Mattsson (Professor of Business Administration, Stockholm School of Economics, SE)

Dimitra Simeonidou (Professor of High Performance Networks, University of Bristol, UK)

Dirk Trossen (Senior Principal Scientist, InterDigital Europe Ltd, UK)

Sally Wyatt (Professor of Digital Cultures, Maastricht University, UK)

Gillian Youngs (Professor of Creative and Digital Economy, University of Westminster, UK)

Background

The progressive digitisation and Internet connectivity of people, products and processes is a transformational and powerful trend in nowadays societal and industrial systems. Digital connectivity increases speed, reach and distribution of control to new types of links across previously unconnected physical and virtual objects. Digitisation fosters generativity through increasing digital convergence, and

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expanding knowledge and resource heterogeneity, creating pathways for changing the meaning of existing products and consumer experiences. How will connectivity evolve? How should connectivity be 'nudged' in a way that identifies and implements positive changes, while discouraging or mitigating damaging ones? There is potential for increased 'isolation' for those people and entities lagging behind general levels of connectivity, but this does not mean that those with faster networks are automatically and symmetrically ahead of the pack. The asymmetry and potential for growing 'divides' are important risk factors as they may slow the development of innovation, or increase the strain on policies and instrumentalities called upon to rectify them. In addition, the redistribution and reallocation of information, computing power, knowledge, costs and benefits, may not lead to a situation either placing risks (e.g. innovation and security risks) on those best able to bear them, or offering the best chances of useful negotiability of relevant roles and responsibilities.

Although exploring digitisation and connectivity from a technology perspective is pivotal, organisational structures and processes supporting product and service innovation, evolution and use are also critical parts of the picture. The traditional view of companies creating innovation artefacts diffused through levels of market adoption. This is being replaced by networks of innovation (often emergent) that deliver innovation through non-linear processes which dynamically integrate or split different ideas, tools, or actors; and where there is no single innovator.

Europe must remain at the forefront of the Next Generation Internet (NGI) in a world where competitive economies are increasingly dependent on innovative application of information and communication technologies and where there are rapid changes in society and culture [1]. The digitisation of experimentation and innovation processes is now driving the evolution of the Internet. Europe's public investment policy must foster the creation of vibrant digital innovation networks supported by innovation platforms addressing the challenges of networks of innovators and highly heterogeneous knowledge, as well as engaging designers, users, technology providers, private and public institutions and the civil society as a whole in finding solutions, activating business markets, and most importantly addressing pressing societal and sustainability challenges.

The task leads to key questions of how digitisation and connectivity influence networks of innovation, how they shape the way knowledge is created and shared, and how new products and services will emerge as a consequence. These questions have been investigated through the concept of Digital Innovation Networks, defined as multi-disciplinary and multi-sector networks of people, technologies and enterprises, aiming to advance Internet technology and innovation processes to address key socio-economic challenges and opportunities.

This report summarises an expert-driven scenario for the future of Digital Innovation Networks. The analysis builds on previous strategic research priorities for Next Generation Internet Experimentation which identified important technological research areas for NGI [2, 3]. This report extends [2, 3] to

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explore factors influencing the process of innovation itself. The work is conducted as part of the FIRE Study Tender [4] which is providing policy recommendations to the European Commission in the area of NGI research and innovation [1].

Methodology

The Digital Innovation Networks study, is part of the FIRE Study Tender, and aimed to subjectively identify pertinent factors related to digital innovation networks and their impacts. The study used the Delphi forecasting methodology based on qualitative (judgement) rather than empirics, in order to overcome the lack of accurate empirical historical data about innovation programmes and to incorporate the possibility of new and disruptive situations. The motivation for Delphi was that it is a consensus building approach, allowing for identification and agreement of a small set of futures that can be used as the basis for road mapping. In addition, Delphi requires anonymity of experts, overcoming the problem of unstructured groups, band-waggoning and halo effect that can negatively affect the outcome of analysis.
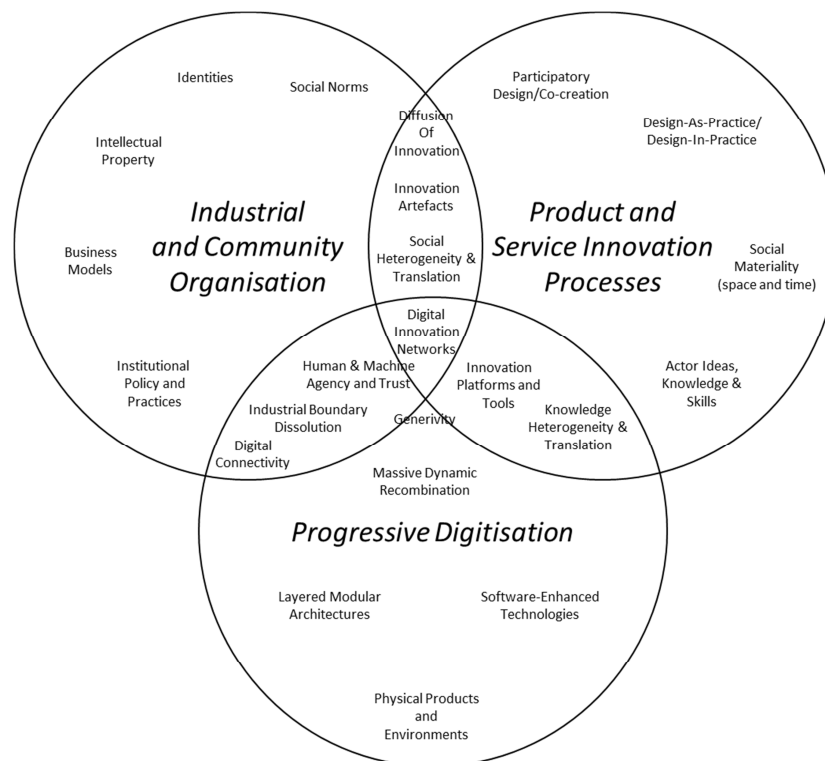
Extant literature provided theoretical discussion and scope for the study design including initial identification of important factors influencing digital innovation networks. Qualified experts were then identified with deep understanding of the issues to participate in group decision making activities rather than population-oriented statistical sampling methods. Three major expertise areas were identified reflecting different aspects of Digital Innovation Networks both from theoretical and practitioners' perspectives as shown in Figure 1:

- Industrial and Community Organisation: experts who understand social, economic, network and industrial organisation theory and structures

- Product and Service Innovation Processes: experts who understand innovation and knowledge processes
- Progressive Digitisation: experts involved in technology research and development

The study was implemented through two iterations with a final experts' workshop that was held at the European Commission to discuss the results with EC representatives of the NGI Unit.

- **Round one questions and consensus analysis (Dec 2016):** The study asked three general research questions (below) to gain a broad understanding of the experts view on future events in relation to digital innovation networks.
    1. What kinds of physical, industrial/economic, and socio-political infrastructure are necessary for the establishment of viable digital innovation networks in Europe?
    2. What forms of experimentation and innovation practices and technologies have the most potential for implementation in a period of 3 to 5 years for maximal socio-economic benefit?
    3. What practicable solutions are available for challenges in economic policy and managerial strategy regarding viable and beneficial digital innovation networks?
- **Round two questions and consensus analysis (Jan 2017):** The responses of round one were collated, anonymised and summarised, removing any irrelevant material and looking for common viewpoints. The result was distributed to the experts along with a further set of over 100 questions derived from opinions and ideas from round 1. These questions explored deeper aspects of digital innovation networks with the aim of clarifying specific issues and to try and reach agreement.
- **Expert Consensus Workshop with the EC (Feb 2017):** The results of round two collation analysis and findings were reported as a draft set of policy recommendations that were discussed by the experts, the EC and the FIRE Study representatives at an Expert Consensus Workshop on Tuesday 7th February 2017. The focus was on the elements of the surveys that did not have agreement, and the goal was to reach consensus about the future of digital innovation networks and to make recommendations for policy addressing the risks to and opportunities for future work programmes.

Digital Innovation Network Scenario

The consensus view of the panellists is summarised into an expert-driven scenario for Digital Innovation Networks as shown in Figure 2. The scenario clusters panellists' views into three areas:

- *Internet research*: What research needs to be conducted
- *Digital innovation processes*: How the research needs to be structured
- *Societal and economic impacts*: What impact is expected from the research

The societal impacts associated with progressive digitisation are seen as a major justification for public investment. The increasing impact of connectivity and the pervasiveness of the Internet as the means by which the society solves problems requires public intervention. Digital

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literacy, fairness of opportunity and empowering and protecting the public from increased risks are key policy objectives. In addition, progressive digitisation is changing social experience, identity, and cognition of individuals in society, and new ways are needed to transparently observe social

transformation whilst encouraging human responses to an increasingly functional machine-based Internet system. Public services need to engage in innovation processes and socio-political structures need to be established to facilitate this engagement even in the face of austerity.

The economic impact of increasing centralisation of power and the role of incumbents constraining innovation opportunities directly or indirectly through greater levels of machine agency requires a societal response. Greater understanding of the contribution of digitisation to sustainable development and new concepts of public goods and Internet ecosystem services is advocated. The panellists believe that industry is in a state of transformation and that multi-industry networks should be encouraged. A challenge is how to structure NGI interventions considering the prevalence of vertical or horizontal approaches. Vertical structures provide specific top-down solutions that make it easier to obtain funding and measure results. Horizontal structures seek to address underlying socio-economic issues in populations but tend to be abstract and rarely deliver universal solutions due to the complexity of individuals, society and the economy. A more refined approach needs therefore to be considered that avoids polarisation and rapid programmatic shifts between horizontal and vertical structures, and where vertical and horizontal integration is encouraged.
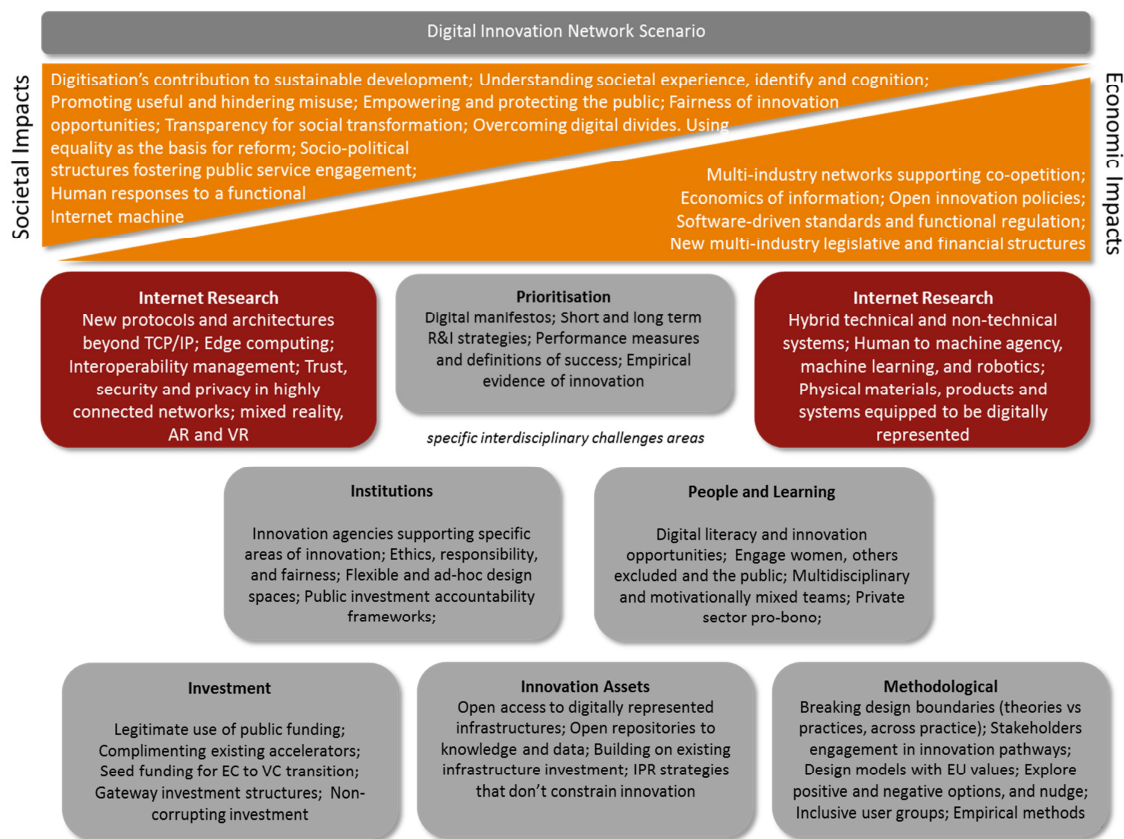

FIGURE 2: EXPERT-DRIVEN DIGITAL INNOVATION NETWORK SCENARIO

Human factors of digital innovation including diverse paths to engagement with innovation processes require expanded and deeper investigation. Increasing digital literacy in a broad sense, beyond the technological, is critical to reduce the digital divide and allow society to seek solutions to its problems. Multi-disciplinary and motivationally mixed (commercial, personal, societal, etc.)

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disciplinary perspectives need to be combined to find solutions that are inclusive and equitable for all involved and more likely to be socially acceptable.

The role of Innovation Agencies is important to act as multi-sector enablers and for oversight in terms of fairness, responsible innovation and ethics. However, although the role of Universities and Research Centres are seen as possible Innovation Agencies, these institutions are not entirely independent and there would need to be appropriate governance frameworks for accountability of investments made that go beyond current EC rules.

Justification for public intervention needs to be clearly articulated in an environment where accelerators and investors are looking earlier into the ideas pipeline. Investors are increasingly competing for ideas and there is no shortage of capital risk funding available for the right ideas. It is important to relate EC funding to capital-risk investment in appropriate ways, for example, the size of public investment made by the EC to individual innovators should be set at a level to provide incentive structures that are not corrupting to private sector entrepreneurship. In addition, new forms of empirical evidence are needed from innovation networks to identify when, how and where aspects of innovation happen and to grow understanding of how this relates to actions of Innovation Agencies seeking to fund it. There needs to be more granular justification for the specific roles of EC investment and more analysis of the impact of previous programmes and the best practices and learning from failure resulting from them.

Europe needs a strongly connected pan-European ecosystem that collectively understands what is needed to build digital innovation networks, and how they can operate to address the major challenges for society as a result of progressive digitisation and the evolution of the Internet. The Digital Innovation Network scenario highlights important factors relating to the future of digital innovation for the NGI but it's just a stepping stone on the way. Engagement must now be broadened to further experts, Internet researchers and innovators. This will be achieved through the Digital Innovation Network Forum in Brussels on 27 June 2017 [5] where technical, socio-economic and innovation topics will be covered leading to further refinements to the research challenges ahead and recommendations for digital innovation network structure and policies for NGI.

References

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