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REPORT

Trends in connectivity technologies and their socioeconomic impacts

Final report of the study: Policy Options for the Ubiquitous Internet Society

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Executive summary

This report was commissioned by DG INFSO as part of its preparations for the successor programme to i2010 – its current policy framework. It contains the results of the study of the socio-economic impacts of the 'Ubiquitous Internet Society' and its possible policy implications. The study contained a number of distinct but connected analytical steps; stringing together technologies that are supporting the trends towards a more connected world. These are linked to potential future socio-economic impacts and changing business models; as well as their likely policy consequences; in order to recommend a well argued set of actions within a consistent policy framework. This Executive Summary helps to support the reader in navigating between the various analytical steps of the report.

Connectivity Tech Trends

This study set out to review technology trends that relate to the notion of an emerging ubiquitous Internet Society – renamed in this study as 'Internet of X'. The trends or actually trend clusters that are identified in this study are:

- Development of a *Common communications infrastructure* – which can be accessed through different devices and technologies, removing sources of exclusion and discrimination, allowing the supporting technologies to 'draw in' new people and uses and put them in greater touch with one another. Technologies that are directly associated with this trend are: increasing bandwidth; increasing processing power and performance; Increasing electrical power and performance. Related technological development: the increase of internet capacity.
- Evolution towards *Computing as a ubiquitous utility* - putting computing on the same footing as water, power and telecommunications[1] and demonstrates the degree to which 'merely quantitative' advances on processing, storage, etc. develop qualitative transforming power precisely by being interconnected through the network. In addition, access to utility computing creates new demands for connectivity and reduces digital divides associated with differences in access to computing and storage. The mobilisation of shared computing resources seems likely to undermine the asymmetric 'client-server' form of connectivity in the same way that combined heat and power CHP) plants injected a stronger peer-to-peer aspect into energy connectivity. Technologies that are directly associated with this trend are: increasing

[1] Note that these are all regarded as utilities in the sense of universal service policy, but differ in the way they are regulated and the extent to which they may ultimately be regarded as suitable for competitive provision.

digital storage capability and decreasing cost per byte; faster computation; evolving computer architect; grid computing; cloud computing; everything as a service. Related technological developments are: open source software; more internet capacity.

- *The convergence of humans and computers - making* the 'ends' of the network smarter (e.g. through enhanced decision support), changing the need for active traffic monitoring and management in the network itself and producing new geometries of power and control. On the other hand, the electronic enhancement of human experience (e.g. via new input and output interfaces, etc.) creates a potential need for social connection – in the same way as advances in stand-alone platform-based computer games laid the foundations for today's on-line gaming and associated social networks. Technologies that are directly associated with this trend are: increased deployment of nanotech; cognitive computing; cybernetics, specifically cybernetic organisms; immersive virtual environments; decreasing size and increasing capability of embedded sensors. Related technological developments are: cheaper, faster and smaller RFID technology; more tools for personal identification and authentication; immersive virtual reality environments.
- The emergence of *the Intelligent Web:* - describing the deployment of existing technologies providing 'intelligence' to the protocols, structures and internal functions of the Internet itself, rebalances responsibilities and contributions of different stakeholders to overall socioeconomic impacts and creates a powerful 'pull' factor for further technological, economic, financial and social innovation. Technologies that are directly associated with this trend are: convergence of applications; more, easier and better creating & sharing tools; Web 3.0 tools. Related technological developments are: localisation of applications; decreasing size and increasing capability of sensors.

These are discussed in detail as to their nature, supporting technologies, key uncertainties, and likely governance aspects impacting the speed and trajectory of their development. Together they point at a future where people, objects and machines are more connected and context and location aware. This is a future where information flows automatically and can be used, exchanged, and accessed, from anywhere at any time with a great number of devices and interfaces. ICT's will disappear in objects, structures and even people. Moreover as ICT adapts to humans and becomes more intelligent and self-organising, people may become more like machines in the way they connect, behave, organise, and work.

Scenarios

These trends in themselves cannot be directly equated with certain future socio-economic impacts, as their deployment depends on the interaction among these trends and between these and governance and market factors. To gauge the possible future deployment and contexts for generating impacts three possible future worlds were built; representing distinct combinations of public vs. private governance, open vs. closed technologies and competitive vs. collusive markets. These dimensions were selected after careful review of literature and interviews with key experts in the field of ICTs and their role and interaction with society and the economy. The following scenarios were developed.

Scattered World (closed, private, competition); reflect a future of cutthroat monopolistic competition, unrestrained by active and effective antitrust and other regulation. It remains

highly globalised, but the highly variable business and legal climates in different countries and sectors mean that network externalities, which might otherwise result in a 'tipping equilibrium' dominance by a few firms and/or technologies, never achieve global critical mass. By and large, individual users are able to find services and other offerings that meet their needs, though these are primarily mediated by market rather than collaborative societal forces. To meet the need for non-monetised communication and sharing, 'open-source' user communities thrive on the public and commercially-provided networks, but competition among platform providers ensures that these remain largely uncaptured by commercial entities. Government cooperation remains at a fairly low level of essential law enforcement and trade coordination, because national economic interests remain largely competitive and because active competition effectively forces firms to bundle solutions to societal problems (such as privacy and security) where it is feasible and cost-effective to do so. The fragmentation of competition and low levels of vertical and horizontal integration have as a counterpart low levels of inclusion and worrying levels of inequality.

Connected World (open, public, collaboration) paints a future where companies collaborate both domestically and internationally, facilitated by governments who take a cooperative lead in setting rules to optimise global public value creation. This public (-spirited) lead strongly reinforces open technologies so that firms have to compete (and make their money) on the merits of what they provide rather than the ability to exclude rivals. Indeed, interoperability and low entry barriers lead to a high degree of customization in individual applications; allowing customers and other civil society stakeholders considerable latitude to develop and satisfy diverse preferences. This interoperability is thus a powerful public good, and governments are particularly vigilant against the risk of foreclosure by 'bottleneck' firms or proprietary standards, using antitrust regulation, support for open standards and targeted public procurement to ensure a sustainably level playing field with high quality of service and reasonable prices. A potential limiting factor is that the speed of innovation – including the adaptability of policy to technological and market developments - is slowed by the natural pace of government initiatives (from negotiated rule changes to publicly-funded research and procurement). This world is very inclusive, including excellent technologies to assist those that need assistance to participate.

Borderless World (open, private, competition) depicts a world in which systems connect. It is basically a world where global standards emerged from a shake-out of less favoured standards, and are self-enforcing by virtue of strong customer and user preferences for products that connect to the enormous global investment represented by the Internet. High competition leads to low prices and high speed in terms of "time to market". Consumers have to rely on brands and social networks in order to be sure their choice is right: there is a clear private sector dominance in the way this world is run, and the focus is on profit rather than a broader concept of public value.

The scenarios are used in two ways:

1. As input to the formal impact modelling, using the International Futures Model (IFs): the scenarios correspond to specific parameter values, assumptions and outcome measures of particular interest

2. As a means to engage experts in a workshop context to discuss future policies: for this purpose the scenarios that were used for modelling impact will be further enriched with details, supporting data, and 'vignettes' of life stories in the year 2020

Each of the scenarios has been modelled using the International Futures model (IFs) to generate a range of socio-economic impacts. The outcomes were validated and complemented by a review of literature. These insights were applied to assess the effects on business models operating in the dawning ubiquitous Internet society.

Economic impacts

The economic impacts were mainly assessed in the context of the three scenarios as modelled in the International Futures model. A number of scenario dependent impacts were identified as well as a few more general expected impacts of the emerging Internet of X. General findings of likely future impacts are:

- Economic growth (at least in Europe) becomes increasingly capital-efficient. At the same time investment in the BRICs (Brazil, Russia, India, China) continues to outpace GDP growth, indicating that their real potential for economic dominance lies beyond 2025 and thus that Europe faces a long-term challenge in maintaining its strong position
- Multifactor Productivity (MFP) growth is held back by knowledge capital, meaning in rough terms that it attracts more payment than it deserves, possibly due to persistent market power in the control of intellectual property rights. Free access to ideas can reverse this as it makes visible the potential return to their shared exploitation. In addition, physical capital continues to retard multifactor productivity growth at the global level, although this is easing as new technologies reduce the deadweight loss of 'bottleneck' proprietary infrastructures. Finally, to fully asses productivity growth in the Internet of X, productivity gains in peer-based, open-source and other unpaid production also need to be accounted for, which is usually overlooked due to a focus on purely monetised returns.
- Growth of inequality within as well as between nations: will initially decrease in open and business driven economies. But as market power consolidates and prices rise, the poorest nations and individuals again begin to fall behind. Also, while governments in general are becoming less powerful (asymmetries of power among nations are weakening), the technological power of the leading countries is increasing. The situation of poorer nations can be partially ameliorated by a combination of stronger public sector engagement and greater openness (of technology and economic activity), which tend to promote a more sustainable and equitable society with long term decreasing inequality. As a result, interpersonal inequality increases in two out of three scenarios (Connected and Scattered Worlds).
- Greater connectivity and globalisation of financial and other markets tend to change economic dynamics. With strong public sector regulation (or effective self-regulation) this may promote short-run stability, but increase the chances of sudden (global) shocks in the medium term. Without effective regulation, complex short and medium term dynamics can produce sudden shifts in the availability of capital which in turn increases the volatility of expectations formation. This can produce either a sudden shift of capital to new technologies, business models or goods and services or a collective reluctance to abandon the status quo in favour of risky alternatives. Whether excess volatility or excess inertia

prevails depends strongly on recent history, making random shocks more persistent than they were before. In addition we note that GDP per capita understates the true social cost of the connectivity failure, given the likely higher rates of unemployment,

- With regard to economic policy, the combination of large shifts, global impacts, the availability of a wealth of real-time information and the possibility of using technology to implement sophisticated regulatory strategies can create an imperative for more active and continuous intervention. This can produce a fallacy of control; the growing *complexity* of the economy may render such actions less effective than hoped, generate a greater range of unforeseen consequences and possibly even contribute to economic instability (if authorities are too reactive) or inertia (if they become too risk-averse and therefore unwilling to stake political capital on policy changes whose consequences cannot be perfectly foreseen).

Social Impacts

Social impacts of the Internet of X were first reviewed within the (modified) framework set by another study funded by DG INFSO on the social impacts of ICT, and then applied to the scenarios and technology trends. Some social impacts like rationalisation, inequality, knowledge society index and connectivity were also modelled within the IFs to generate outcomes for Europe, Japan, Korea, America and the BRICs. In general one may conclude that technology does not determine social change. In fact it's the other way around. However in some areas behaviour is changing, or at least is changing at a faster pace, due to ICT and connectivity. There may be many overt and subliminal socio-economic impacts which over time affect values, governance structures and business models. Some of these impacts are:

- Rationality, intuition and beliefs (religious or other) are being rebalanced at the individual as well and the societal level. Professional instruments and networks provide some individuals with disproportionate influence, whilst also disenfranchising people who cannot use the tools or who feel overwhelmed.
- As with the economy, in the social sphere the growing complexity of interaction, the abundance of data (if not necessarily information) and the increasing salience of social policy may lead either to excess inertia or excess volatility. A reluctance to engage with complex changes can lead to gradual erosion of control,
- Bonding, bridging, and linking social ties are all relevant. Weak ties matter as much as – and for some purposes more than –strong ones. A world that encourages the formation and use of many weak ties may be more innovative – and more risky - than one that facilitates strong - and therefore less numerous and diverse -ties. More intermediation is expected to manage information streams and wide networks of social ties. Intermediaries may also get 'bottleneck' power because people cannot or will not bypass them, which may cause inefficiencies.
- Tech trends are likely to further blur the distinction between private and professional spheres, especially in combination with the emergence of a large group of "prosumers" (individuals acting both as producers and consumers, or migrating between the two roles as technologies and service offerings mature).

- Tech trends such as Utility Computing and Infrastructure Convergence offer platforms for bottom-up engagement with government and encourage policy making that is more actively driven by citizens and hence more responsive to their (direct) needs. This does not imply less public government, as strong public domain is important for allowing citizens, civil society and business – for better or worse - a platform or 'landing place' for active participation and involvement, without which empowerment through web 2.0 (and 3.0) tools and unlimited access to information will not be effective.
- The centrality of collaborative behaviour is likely to drive demand for soft skills and make them a central focus of education (notwithstanding the continued need for innovative engineering skills which are necessary for developing and managing complex technologies). Human-machine interfaces are likely to become increasingly intuitive, easy and less reliant on user (technical) expertise, as the tech trends such as Human-computer Convergence and the Intelligent Web move complex technical decisions from the end points to the centre of the network..
- Education is likely to become an increasingly critical national as well as personal asset if the job market of the future is as global as the flow of goods and services. Combined with Internet of X possibilities to deliver participative and interactive educational experiences as well as 'mere' curricular content, this may possibly lead to dominance of 'branded' education provided by (commercial) elite institutions and thus increased inequality of access and skills. Other potential impacts include limited access to skilled positions by those with 'second tier' skills and loss of intellectual diversity.
- The European Research Area concept aims both to produce a richer set of research outputs and to increase individual incentives to develop human and social capital. The same approach can be applied to the educational 'strand' of the educational establishment to induce students to benefit from the rich supply of education across Europe through common standards and joint educational programmes. Without such rationalisation there may be over-supply of education without sufficient variation.
- Work and careers will develop (at the higher skill levels, at least) a portfolio character, which will increase the resilience of individual employment to changes in the labour market and internalise much cross-cutting or 'tech transfer' innovation. Large global companies will invest more in attracting than in retaining talent and skills. A by-product will be the emergence of online (public and private) services to enable workers to manage their own training and social security across Europe and possibly globally.

Business model impacts

How business models change depends largely on market structures and governance. Therefore their development is very sensitive to the differences in the scenarios. In contrast strong public governance is likely to use competition law more actively to break up monopolies and undesirable technology lock-ins. A strong market driven dynamic may lead to global monopolies but also possibly to more integrated service offerings. An important distinction that needs to be made in assessing business models is the extent to which they achieve value capture or value creation. From a public policy perspective the second is likely to be the more desirable. Some of the impacts that were identified are the following.

- In general, technology trends that preserve Internet openness are seen to favour net value creation, while those that enhance proprietary restrictions and reward lock-in favour net value capture as a rationale for business model evolution.
- Dominance of global business brings certain benefits of integrated service offerings based on proprietary standards, leading rival firms to favour incompatible products, thus limiting customer mobility. This may threaten diversity and competition due to technological lock-in and rent-seeking behaviour. Such behaviour would seriously impede small innovators' ability to enter markets as the incumbents aim to capture as much value as possible through technology lock-in at the infrastructure and platform levels or through coercing innovators to join existing IPR and interoperability clusters.
- A counter trend may well support many small suppliers of services to the platforms. As the dominant companies seek the speed, creativity and volume of large and diverse populations to develop (e.g. crowdsourcing) and to consume (e.g. the long tail) new formats and applications for their platforms, they are likely to embrace openness.
- Firms whose business models depend critically on the ubiquity, quality and affordability of communication infrastructures will increasingly try to influence the platform market. This will be opposed by platform providers in so-called 'two-sided markets' who will try to exploit the complementarity of content and service providers with end-users and consumers. Increased functional substitutability among infrastructures would reduce this effect and would be likely to make infrastructure service providers abandon business models based on vertical foreclosure for more competitive, utility provision models.
- In principle, utility computing decreases the advantage of large firms and increases the ability of consumers to take control of and exploit their own profiles (including activity records and other personal data). Human-computer convergence will strengthen this trend as it also enables a high degree of customisation. However the effect is likely to be different as Human-computer convergence will almost inevitably complicate customer switching. It does this by enabling the provision of an increasing range of 'niche' services suiting the specific characteristics of clients.
- Innovation is likely to become even more important as the basis for commercial success shifts away from commoditised offerings or as commoditisation and homogenisation are pushed down into the infrastructural layer. Differentiation and divergent innovation will be stronger in the user-facing layers. Innovation is also likely to become more 'democratic', with companies striving to promote endogenous innovation, using the stronger (internal) connectivity of creative individuals, customer feedback
- The services will be increasingly paid by licensing and less by advertising. New technologies and business models allow greater discrimination and differentiation in pricing, quality of service, content and other aspects of valued services. Because these are valued differently by different people, and because their provision triggers joint as well as separate costs (e.g. infrastructure costs or congestion/contention costs), some form of discrimination is necessary for profit maximisation and for efficiency and equity.

Policy issues

To identify policies that would deal with future issues, experts were asked to engage in a scenario game. They were asked to identify the key policy issues through a SWOT analysis

of the three scenarios. They were then asked to look back from the future and identify policies that would have dealt with the issues to achieve more desirable outcomes. The feedback from the three groups was processed and reworked into a new scenario. The same group of experts was asked to engage in a role play of citizens/civil society, business and government decision makers to identify the critical issues and remedies from these distinct perspectives. Both exercises together allow identifying issues and policies that are sensitive to stakeholder interest and which are able to perform under deep (future) uncertainty.

The issues that emerged can be categorised under five sub headings: core values and principles; architecture and design; uncertainties; leadership and coordination and policy instruments. The most relevant issues are summarised here:

- *Core values and principles*

A review of the concept of privacy and the means to protect it. Some form of fundamental right to privacy will still exist in 2020; either government driven (data protection frameworks), business driven (self-regulation, privacy at a premium), or citizen driven. A future proof approach is likely to be more risk based and outcome oriented; guided by general privacy principles, including stronger personal liability and redress instruments. Technical measures would be an important part of privacy protection. The user will be in control, permitting revocation and legal control methods, maybe in combination with data stewardship.

The importance of trust. Trust is a multi-stakeholder concept, in which governments (especially in a global context), will no longer be the final arbiter. Hierarchical, top down approaches conflict with the end-to-end principle[2], requiring a more equitable partnership (peering) between actors. Trusted environments will be enabled through transparency, provided through technological solutions and embedded in legal frameworks. In case of trust there is a trade off between open and closed networks, in which (private) Trusted Third Parties (TTP) could be an intermediary.

The central concept of identity – group and individual. Individual and group identities are central to the functioning of society and the behaviour of individuals and collectives. Identity capital ties past circumstance and behaviour to current choice and future consequence and remains the most important intangible asset of the Information Society. The Internet poses a new threat to individual identity, by making it more fragmented and less durable or private or by weakening the constraints that help align individual and group interests. This raises questions on the level of privacy and autonomy individuals will retain, on how they may influence collective action and group reputations and how individuals will form, join and leave groups.

- *Architecture and design*

The benefits of open networks and how to ensure this; including Net Neutrality There is a trade-off between requirement for data protection and the value of using information for innovations in an open network. The world of 2020 is expected to allow for differentiation by quality of service. In light of the Net Neutrality discussion it is thus expected that pure

[2] See footnote 4

indiscriminate openness will give way to a more hybrid situation of fully open networks for basic services and quality of service (QoS) models for premium offerings.

Interoperability, connectivity and the architecture of networks. Most ICT solutions could be IP based or use other open protocols and standards; however this is rarely in the interest of dominant market players. The challenge will be to keep the architecture whole and coherent if you move for a network with more 'intelligence' built in. The report notes the distinction between 'horizontal' (connecting ends without platform) and vertical connections. If horizontal interoperation –is limited, then consumer mobility, competition and 'bottom up' innovations are limited. *Vertical interconnectivity*[3] is concerned with technical, organisational, price, and other barriers. The legal and economic basis for promoting interoperability may differ by kind (technical, organisational, economic, etc). Any assessment of possible interventions for increasing interoperability must start by identifying when interoperability is good and when it is bad, and for whom it is good or bad. But also, who can be regulated or subsidised and how static and dynamic considerations trade off against each other.

Open Standards. Interoperability and open standards - are part of the same issue[4] Open standards apply in one way or another to all tech trends: allowing the 'higher layers' to maximise benefit from the converged infrastructure layer; allowing the 'cloud' to find an optimal architecture; facilitating diversity of innovation in new forms of human experience enhancement, increasing the reach of cybernetic systems and enabling participation; and finally allowing 'smart' elements of infrastructure management to be deployed across a range of interacting systems

The extent to which public good services/controls need to be deployed inside the network. The end-to-end principle either needs to be reconfirmed and strengthened, or reviewed, possibly by putting security and other 'public good' controls in the network. This is beyond the remit of the EC, but it may research practices of ISPs, and the technologies and use of deep package inspections. Also the EC can help broker an EU vision on the risks and benefits and articulate a new concept of controlled openness.

- *Uncertainties*

In 2020 we will need to be able comfortable with uncertainty, to deal with 'Black Swans', disruptive technologies and creative destruction.

Availability of and access to new infrastructures (incentives to invest). It is uncertain who will invest in new generations of infrastructure and what model will prevail. A basic principle *might* be to separate the construction (and operation) of physical infrastructures from the (potentially) competitive provision of services over the infrastructure, possibly involving (partial) state ownership of the infrastructure. Restrictions and inefficiencies of existing infrastructure governance may contribute to the growth of alternative infrastructures and to market segmentation, which may be discriminatory and undermine the infrastructure convergence trend. Facilities-based competition experienced in Europe has led to a misallocation of traffic among these modes (compared to their technological strengths and

[3] This is largely covered by existing frameworks involving 'essential facilities,' critical infrastructures, common carriage or easements;

[4] See also for a discussion on open standards: Undheim 2008

weaknesses) and thus distorted uptake and the development of services and applications in other parts of the value chain.

Competition and the risks of technology lock-ins. The interconnectedness of the Internet of X challenges competition as the sustainable engine of continual improvement. Network externalities favour 'tipping' into monopoly and competition weakens or moves to the extensive margin, with firms striving to produce as much variety as possible. Such variety may stem more from a desire to limit interoperability than a desire to innovate and offer effective choice. Lock-in can be good or bad. Technology, market and societal structures and norms of behaviour can be self-reinforcing even resisting superior alternatives. An early advantage can be sustained by cohesion, allowing time for collective benefits to develop. Policy should take this 'stickiness' or path dependence into account, for example by: consumer protection or other policies that protect users and enable them to escape harmful lock-in.

- *Leadership and coordination*

Horizontal nature of connectivity and the role DG INFSO can play as an expert centre or catalyst inside the EC. Future Internet policy has a cross-cutting nature and connectivity touches on almost every aspect of Information Society development. Therefore connectivity aspects should be taken into account in formulating all EC policies (connectivity awareness). INFSO should inform and support thematic DG's in their understanding of the emerging 'Internet of X' and how this affects their policy areas; also through connectivity-based monitoring tools for impact assessment and policy evaluation.

Need for public leadership in setting the EC agenda and influencing global ICT/Internet policies. The Internet of X will be largely global. Policies and ambitions should reflect this. The EU (still) has an opportunity to influence the value setting of these global phenomena in global fora. Since the financial crisis - rooted in an increasingly connected financial system - connectivity is becoming politically more important. The EC is in a good position to lead, facilitate and mediate the investment in high bandwidth infrastructure and linkages across borders.

- *Instruments*

Multi-stakeholder networks and governance principles. The EC can encourage efficient competition among technologies and discourage inefficiently-high incompatibility, through creation or coordination of multi-stakeholder platforms and networks, and by applying multi-stakeholder governance principle. These would be enabling the adoption of common standards and market wide approaches to public policy concerns. The challenge is to intervene in a way that replaces inflexible 'black-letter' prescriptions with mechanisms that help identify the best approach and engage the efforts of those best-placed to help it.

Technology as a complement of traditional policy tools. The use of technology as a complement of traditional policy tools like regulation may hold promise for ensuring public interests where self-regulations is too weak and regulation cannot be enforced or is too inflexible and slow.

Supporting 'self-correcting' market mechanisms. Policy solutions should seek to exploit and support 'self-correcting' market mechanisms (Quality of Service/Net Neutrality, spectrum trading, etc.), where necessary backed up with the threat of regulation. In the virtual world

of the 'Internet of X' traditional regulation will have limited traction and will be difficult to enforce. Therefore the EC should further analyse how best to structure self-regulation, and mitigate the risks.

Better and more strategic use of procurement. For a number of reasons the huge potential of procurement for creating a technology and innovation pull remains under exploited, with cross-border procurement still only representing 15% of overall public procurement.

Spectrum allocation as powerful ex ante *tool.* Traditional ex ante regulation and ex post control of the wireless domain is increasingly difficult. Spectrum allocation can be a substitute (*ex ante*) policy instrument to support innovation, new technology, and more competition. However the use of auctions has lead to mixed outcomes in balancing different policy objectives (technical, economic, and societal) and much available spectrum is hoarded or left idle. Allocation mechanisms are shifting towards a combination of market-based regulation, societal regulation and 'regulatory withdrawal'. The EU may monitor the effectiveness of these mechanisms and also support policy convergence and standards to support a strong internal market for hardware in Europe.

International comparison of policies: Japan, South Korea, United States, Canada and OECD

Before recommending specific actions based on a theoretical exercise and the outcomes of a scenario game, a review of policy frameworks in the most advanced and connected countries was conducted. This allows assessing and comparing the most recent global policy thinking about how to address the connectivity challenges and the socio-economic impact of the Internet of X.

- The development of a future ICT strategy is still very much work in progress in all countries. With the exception of the OECD, there is no fully developed ICT strategy for the time frame 2010-2020.
- Early thinking about a future ICT strategy seems to revolve in all cases around the idea of a ubiquitous network society. Particular emphasis is given to the positive societal impact associated with such a society – but also potential threats (such as increased internet addiction or concerns of privacy, accountability and freedom of action) are articulated.
- In terms of leadership, ICT strategy development and implementation are ranked highly on the agenda of most countries – as is reflected in the engagement of policymakers at highest political level in these countries.
- Despite agreement on the objectives and ambitions of a future ICT strategy (in the early thinking) there are significant differences between the different countries (and the OECD) about how these are best to be achieved. These differences range from differences in the role of government to differences in further technical development. In particular US and Japan are developing a new networking and distributed systems architecture that is meant to revolutionise computing, while South Korea, Canada and the OECD focus on the upgrade of the existing net architecture (from IPv4 to IPv6).

Recommendations and policy framework

The ultimate objective of this exercise was to identify and recommend policy actions to the European Commission. Through a scenario workshop, in which the virtual hindsight technique was applied, experts were engaged to think of adequate policies to respond to the

future challenges of the Internet of X, enhancing opportunities and mitigating the risks. These and further reflections on the complexity of networks and the challenges raised by connectivity have lead to suggestions for an overarching policy framework for the European Commission and DG INFSO in particular. The framework identifies the vertical – or DG INFSO specific – policy themes, as well as linking areas across the Commission where connectivity plays an important role. Additionally, the framework identifies areas beyond the reach of DG INFSO that are critical for ensuring good and/or bad connectivity. Finally some policy instruments have been suggested.