Towards a Future Internet

Interrelation between Technological, Social and Economic Trends

Final Report for DG Information Society and Media

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Executive summary

"The explosion in connectivity will redefine the nature of the internet and the fabric of social, cultural, political and economic institutions"

Over the past decade the internet has become a vital part of everyday life for the majority of Europeans and over two billion people across the world. This is likely to expand to seven billion by 2020 as the sophistication in mobile phone technology transforms them into internet access devices. Furthermore, the growth of connectivity of internet-enabled devices, eg the internet of things, will increase this substantially. This explosion in connectivity will redefine the very nature of the internet and, most importantly, the fabric of social, cultural, political and economic institutions globally.

The permeation of the internet in all socio-economic dimensions of our lives has led to an increasing dependency which inevitably breeds deep potential vulnerabilities. These are both technical, eg security and resilience, and legal, eg privacy and trust, which brings into focus the urgency for governance and regulation. On the other hand, it is also true that the internet's bottom-up evolutionary development and relative lack of protection and regulation has made possible the flourishing of innovative applications and unprecedented possibilities, with huge societal and economic repercussions.

The need to better understand these complexities was the starting point for this study, *Towards a Future Internet: Interrelation between Technological, Social and Economic Trends*, which was carried out in 2009/2010 for the European Commission's DG Information Society and Media. The aim was to investigate the links between technological, social and economic trends related to the future internet, explore the future needs of internet users, and outline the principles that should guide its future development.

The study identified four pervasive forces which will impact the future internet. These are:

- Stakeholder conflicts
- Changing infrastructure and socio-technical context
- Governance and regulation
- User focus and inclusion

Together, they point to a key question:

How can we guide the evolution of the internet so that it best serves the needs of society?

"How can we guide the evolution of the internet so that it best serves the needs of society?"

The study addressed this question through several foresight techniques – environmental scanning, an online Delphi survey of experts and scenario analysis – to identify and analyse trends, drivers of change, future needs, technological options and likely socio-economic impacts.

With input from the Delphi results, trend analysis and workshop discussions, we constructed and refined four scenarios of plausible future socio-economic conditions with differing needs:

1. Smooth Trip – the rise of the internet economy as a whole life and work style, a middle road in contrast to more disruptive scenarios.

2. Going Green – internet technologies are used to combat growing environmental challenges.
3. Commercial Big Brother – a heavily commercialised consumer platform.
4. Power to the People – a forum for democracy and freedom, based on free production and exchange of knowledge.

At expert workshops in Brussels, Cambridge, MA (MIT) and Tokyo (Keio University) we used the scenarios to stimulate wide-ranging discussions about the main trends and drivers of future internet needs. Workshop participants felt that Commercial Big Brother was the most likely scenario outcome, but that the scenarios were interconnected and not exclusive – with elements of each likely to appear as the internet develops. Our second-round Delphi survey respondents thought that Smooth Trip was most likely, followed by Commercial Big Brother, Going Green and Power to the People. This last scenario was seen as the most desirable outcome, with Commercial Big Brother least desirable.

Today there are four powerful forces that are shaping the future internet.

"Four forces are shaping the internet: stakeholder conflicts, changing infrastructure and socio-technical context, governance and regulation, and user focus"

One of the strongest forces lies in the tension between the vested interests of the different stakeholders, who see it in terms of "their internet market". These conflicting interests between the players – commercial (network operators, service providers and content providers), governments and end-users – could seriously impede business and technological evolution, and prevent fair competition by limiting openness. As noted in the Tokyo workshop, innovation in internet infrastructure has slowed down since the large commercial players gained sufficient market power, around 2005.

A second force is the shift in the context of the internet.

The internet no longer sits within a straightforward technical context of bits and bytes. Its pervasiveness has expanded its context to include the non-technical global world – social, cultural, political, economic, and commercial. The internet infrastructure itself could radically change, towards approaches motivated by commercial rather than technical reasons.

This context requires that these key dimensions are considered in terms of their inter-relationships and inter-dependencies. This provides the foundation from which future internet requirements can be identified and defined**.**

The third potential shaping force is governance and regulation.

In order for this to become a powerful force in shaping the future internet it must evolve from its current state. Almost every area of public and social policy is touched in some respects by internet policy. Therefore policy makers and regulators need to become more knowledgeable about the internet and its business models, not least to prevent abuse of dominant market power. Open source software suppliers will play an important role in preserving technology neutrality. The preservation of network neutrality instead lies in the hands of regulators, driven by political and social debate, which should be informed by analysis of the socio-economic impacts of the internet. The internet is a global phenomenon which, from a technical standpoint, must be governed globally.

The fourth factor is the future user of the internet.

"A user focus demands a shift from technology driven design to user-needs driven design"

This demands a shift from technology driven design to user-needs driven design, based on technical and socio-cultural requirements. This requires an emphasis on the whole human interface environment which goes beyond the interface of a device and defines the internet's 'reach'. The user interface environment includes user motivations, the degree of digital literacy, forms of signalling (eg touch screen, eye movement, keyboard, etc) and cultural factors such as multi-lingualism. This will also be key for the internet to be diverse and inclusive. If the internet is viewed as a socially facilitating infrastructure, then ensuring internet design enables digital participation for all is of fundamental importance. Inclusion will be determined not so much by physical access to the internet but by

"Access to knowledge enabled by online collaborative tools has been a key element favouring free exchange of information and innovation"

whether the interface and usage technologies work for or against inclusion, eg for older people, for the less well-educated, or those in poverty. Equally important, the majority of users in the next generation internet will come from the developing world. Their need for low-cost, multi-lingual, resilient technologies and the use of different cultural models in communications and interfacing will set the main agenda items in needs analysis, and generally require far more flexibility in structures.

In this respect, the "democratization" of access to knowledge which has been enabled by online collaborative tools (wikis, blogs, P2P, etc) has been a key element favouring free exchange of information between people, public debate and innovation. The analysis and the preservation of this open and inclusive character of the current internet should be central to any prospects for future developments.

The study research focused on identifying and analysing future needs for the internet. This led to the definition of ten paired principles to guide its future development. Thus, the study proposes that the internet should be:

1. Available & Accessible
2. Diverse & Inclusive
3. Scalable & Sustainable
4. Open & Shareable
5. Green & Affordable
6. Reliable & Resilient
7. Safe & Secure
8. Private & Trustworthy
9. Appealing & Usable
10. Adaptable & Customizable

"Technology-driven developments guided by commercial interests may hamper the basic principles of the internet"

The mapping of the ten paired principles to functionality indicates that future internet research needs to have a wider remit than just for networks. There are two layers of functional requirements: one directly relating to the future social and psychological needs and demands of the human being connected to the internet; and the other as a direct response to future political-economic and global needs.

Our consideration of an agenda for future internet research led us to conclude the importance of a multidisciplinary approach, which should be based on a better understanding of the underlying "internet science". Future research will require a convergence of hitherto separate subjects increasingly including non technological areas – such as sociological design, psycho-economics for decision making, design influenced by cognitive factors and comprehension analysis. Moving towards an internet at the meeting point of human-centred aspects and technological complexities is the challenge. In the absence of such a holistic understanding, there is a growing risk that technology-driven developments guided by short-term commercial interests may irreversibly hamper some of the basic principles of the internet (eg end-to-end, openness, etc), which have allowed it to flourish and become an engine for innovation and free exchange of ideas.

In conclusion, we view the internet as a societal artefact, a form of a very large socio-technical structure, whose design has to be human-oriented, holistic and user-centric.

Chapter 1. Just the beginning of the internet age

1.1. Why study the future of the internet?

In a few decades the internet has evolved from a specialized network for transmission of data between research labs to become the basis for global trade and culture. While visionaries proclaimed the coming of the digital age for decades, no-one anticipated the breathtaking speed with which applications such as email, information search, e-commerce, social networking and user-created content became mainstream.

It is unique that a technology has become such a vital, and even intimate, part of human existence so rapidly. Dependence on the internet as a daily tool has tremendous social and economic impact. The internet has already become the anchor of our economies, from financial markets and health services to energy and transport, and yet the potential remains for the internet to radically transform the traditional ways that these sectors function. The internet is now the platform for innovation, the basis of new global businesses and is extending or transforming existing market segments.

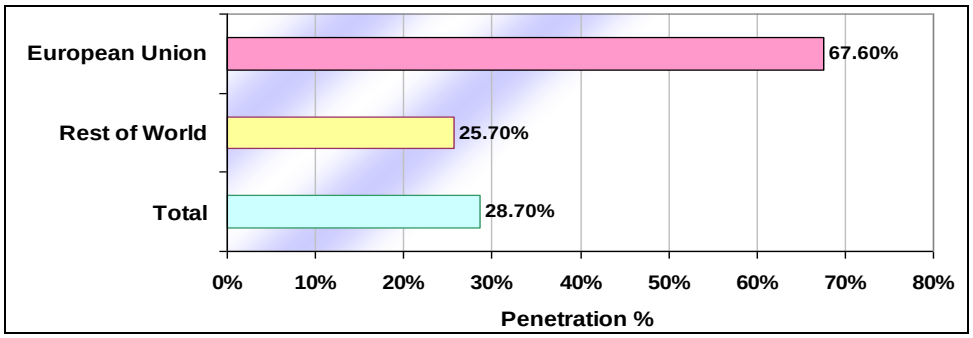
"More than a quarter of the world's population now use the internet"

The internet continues to evolve, most recently through the participative web or "Web 2.0". The astonishing rise of Facebook offers a glimpse of the potential of the internet to transform the way we entertain and govern ourselves, the way we do business – the way we live our lives. Critically, educational performance is found to be correlated with home access to, and use of computers, but increasingly that equates to internet access (FreshMinds, 2009).

More than a quarter of the world's population now use the internet either at work or in their social lives (see Figure 1.1). It plays a particularly significant part in European life with more than two-thirds of the population of the European Union using the internet. EU citizens make up 7.3% of the global population but 17.2 % of the world's internet users (Internet World Stats).

Not surprisingly, rapid growth has been accompanied by growing pains and many policy challenges have arisen. Issues concerned with security, privacy, intellectual property rights, mobility and social inclusion are at the top of the political agenda. Ensuring that all citizens are able to participate in the digital economy has become a key concern for EU policy, as emphasized in the European Commission's Digital Agenda.

Figure 1.1 Internet penetration in the EU, 2010



Source: Internet World Stats

"It is crucial that the internet's future is not seen simply as a technical issue but rather as a multidisciplinary matter"

Naturally we can expect advances in the internet's underlying technology, to enable the vision of pervasive communication, with computing, to bridge the gap between the physical and virtual worlds, by including mobile, wireless and sensor networks. Some of these more basic technology advances will present challenges to the current generation of internet engineering and its core principles.

Given the internet's now fundamental nature, any radical or even apparently trivial technological changes in its architecture could have unexpected consequences at the economic and social level, and even possibly carry some ethical concerns. Social, technological, economic, environmental and political issues are increasingly entwined and, consequently, it is crucial that the internet's future is not seen simply as a technical issue but rather as a multidisciplinary matter. The objectives of this study, therefore, were to investigate the interrelations between technological, social and economic trends related to the future internet, explore the future needs of internet users, and outline the principles that should guide its future development.

Of course, this begs a fundamental question – can the internet be designed or redesigned? The response to these challenges so far has been typically transitional (eg GENI, FIRE) pending more fundamental Clean-Slate solutions. The study's State of the Art report, on the history and current status of the internet, shows how its essential principles, like openness, emerged from the ideals of the few to become the consensual norm. Competition, too, has also shaped its development. Fundamental redesign of the internet may be impossible, unnecessary or, according to some, even a threat. Nevertheless, outlining some guiding principles for the evolution of the internet so that it best meets the needs of European citizens would seem to be both valuable and a realistic objective of this study.

"This begs a fundamental question – can the internet be designed or redesigned?"

The study tackled these questions by means of several foresight techniques – environmental scanning, an online Delphi survey and scenario analysis – to identify and analyse trends, drivers of change, future needs, technological options and likely socio-economic impacts. This report summarizes the study's main findings, with supporting material in Appendix and on the Towards a Future Internet website.

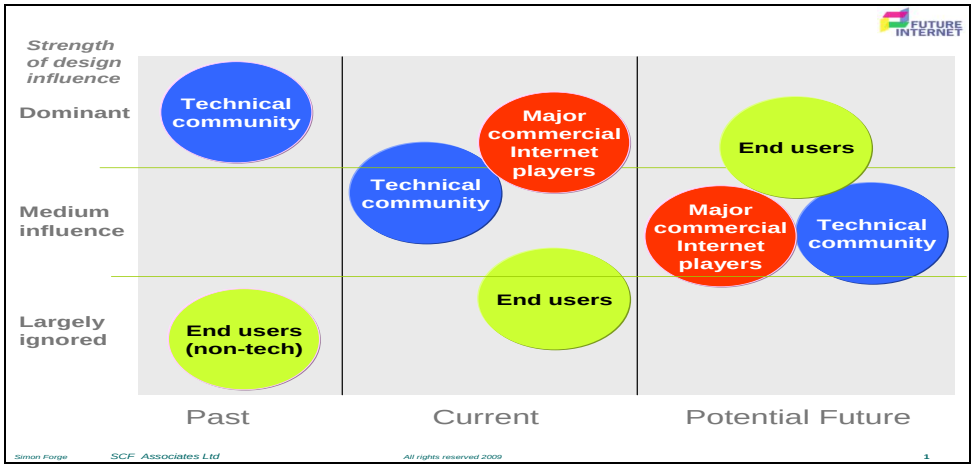
1.2. Why a needs analysis?

The importance of studying the future of the internet, then, is self evident. What is needed, however, is not so much a prediction of the future but, rather, a better understanding of the future needs of different groups of users in society – citizens, public organizations, and businesses. A needs analysis, therefore, is a critical factor in helping us to shape the evolution of the internet.

Since its beginning, a specialized technical community has overseen the internet's development. In the early days this may well have been the crucial advantage that catalysed future success. Then, data networking was largely proprietary so having a robust technical-academic-military community assured rejection of the lock-in of any commercial network architecture, enabling an open space for development. The internet technical community was equally victorious against the limited data architectures of the telecommunications industries, with their focus on metered transport for and by the incumbent national operators. These incumbents initially saw the internet as a threat, not an opportunity. Today the commercial internet players have a stronger influence, especially in the key open standards setting committees. Providers of search engines and portals for social networking see commercial goals in internet design and its key principles. They also often align with the major carriers. And while some analysts fear new corporate gatekeepers are stifling innovation (Zittrain, 2008), nevertheless, there is potential for a strengthened role for the end-user and user-led design in the future, as illustrated in Figure 1.2.

"As the internet has now grown up, a needs analysis for and by the ordinary user is crucial"

Figure 1.2 Who influences the evolution of the internet?



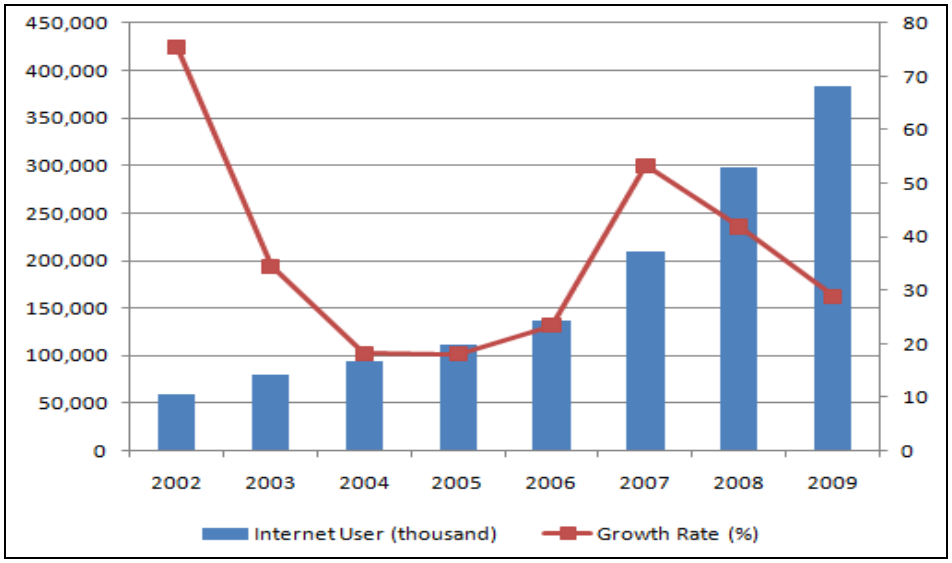
1.3. A European view within a global context

"Any future internet must be highly conscious of the needs of its global user-base"

The European Union naturally wants to ensure that the future internet best serves the interest of European citizens and businesses. The Bled Declaration, a call for concerted European action to redesign the internet, is testament to the EU's desire to meet societal and commercial ambitions. Nevertheless, the EU's future internet sits within a global context, and internet culture and technology are both local and global by their very nature. So any future internet must be predicated on the needs of its global user-base and of the international relations the internet will now engender. Originally US-centric in governance and culture, in the future the internet will be increasingly determined by global interests.

The real number of internet users in the world is difficult to calculate although Internet World Stats estimated about two billion in June 2010. The number and demography of internet users is rapidly changing, with the main growth being in the developing world. In March 2010, the Chinese Network Information Centre (CNNIC) announced that more than 400 million people in China were using the internet. Despite a history of the USA dominating its use, technologies, applications and content, the number of Chinese internet users now exceeds the total population of the USA (see Figure 2.4).

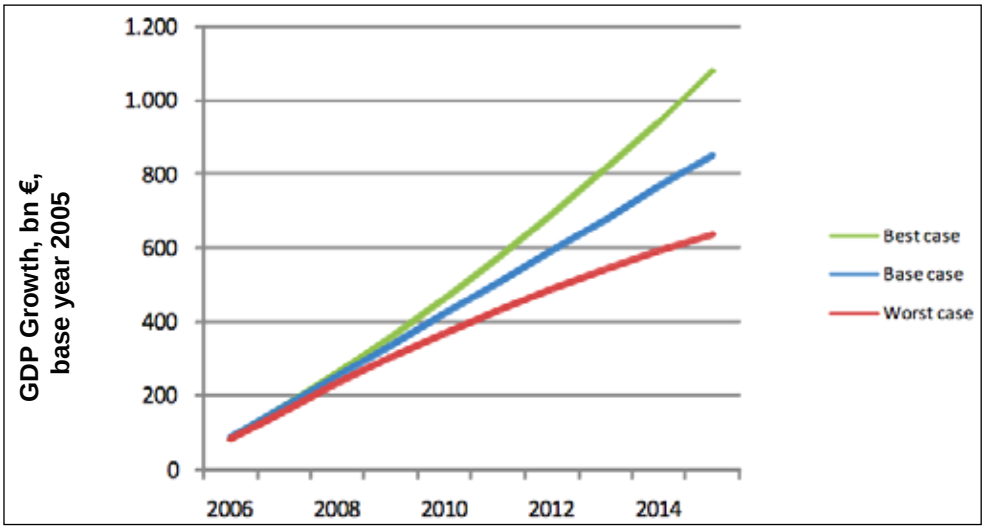
Figure 1.3 Number and growth rate of Chinese internet users



Source: China Internet Network Information Center

What is the global impact of such growth? The essence of networks is to reduce the impact of geography and political, social, organizational, psychological and security barriers (Hiltz and Turoff, 1978). A popular hope is that greater access to wealth and freedom will ensue (Benkler, 2006). The causal impact of internet infrastructure on economic development is becoming clear. For instance, a recent study for the European Commission showed that the impact of broadband on national economies depends on the level of broadband development – in the most advanced European countries, broadband-related gross value added (GVA) growth was almost double that of countries with less-developed broadband. In its base case scenario with a constant adoption rate until 2015 equal to the European average over the period 2004–2006, broadband development contributes to the creation of more than one million jobs in Europe with a broadband-related growth of economic activity of €849 billion between 2006 and 2015 (see Figure 1.4).

Figure 1.4 Broadband-related GDP growth (EU27) 2006-2015 (cumulative)



Source: MICUS, 2008

However, changes in numbers of users and their demography will also cause serious problems for the existing internet architecture and governance. A first issue is the walls being built around many national internets for political, social, and security purposes. China's Golden Shield is a key example. Some Middle Eastern countries and most authoritarian governments are emulating such access walls. Moreover, some democratic governments, such as Australia, are considering the use of access control and filtering technologies to halt inappropriate content such as child pornography. But the definition of political, social and security acceptability varies from country to country. So even if the physical digital divide is bridged, new kinds of digital divide can be expected in a future internet world.

"New kinds of digital divide can be expected in a future internet world"

A second issue is the concern that an explosive expansion in internet and ICT use could drive up energy consumption and contribute to climate change. Both broadband access and mobile networking need servers that run 24 hours a day. ICT products and services consume some 7.8% of EU electricity and may grow to 10.5 % by 2020 (European Commission, 2009). The global population is still growing and, more importantly, the number of internet users is growing more rapidly. Experts in our Delphi Survey were unanimous that the internet would assume even more importance in most people's lives over the coming decades. Connecting the "other billions" in Asia and Africa is laudable but the scalability of the internet architecture and its energy demands is unquestionably a challenge. Telecommuting, teleconferencing, smart grids and metering, etc might mitigate

growing energy use but could be outweighed by the rebound effect or the Jevons Paradox, whereby greater efficiency leads to higher consumption.

Finally, threats to cyber security are growing. With swarms of PCs captured by botnet software, miscreants can initiate large-scale online attacks from a remote hidden location. There is also a risk that cyber wars might break out between states via "non- formalized state actors" employing cheap technologies to attack. Will security forces be able to locate the real perpetrator in time, from among the myriads of potential attacking computers distributed across the world? How can we maintain the robustness of critical infrastructure while preserving hard won democratic freedoms?

Today and increasingly in the future, states function within various networks of interdependence (NIC and EUISS, 2010). Global powers no longer seek territorial expansion. They combine information and communication networks, logistical networks such as maritime and air services, with financial, trading and economic influence networks to persuade and negotiate with others. This transition of hegemony will allow the emergence of plural hubs of actors in global governance. The likely implication, as seen by participants in the study's Tokyo workshop, was that the although the USA may maintain a powerful position, Asian, Latin American, African, Near/Middle East, European and other hubs will emerge. At the level of the international community, the core requirement for the internet will be to connect hubs and other smaller nodes in the world, as political and economic powers will become far more distributed.

1.4. Embracing multiplicity and multidisciplinary thought

Looking forward, the internet is poised to connect an ever-greater number of users, objects and information infrastructures. This means that the policy framework governing its use and development also needs to be adaptable, carefully crafted and co-ordinated across policy domains, borders and multiple stakeholder communities. For these multiple dimensions, the primary axis is the requirements of different categories of users for social, economic and political progress. Of course, political decisions on priorities will vary across jurisdictions but understanding broad user needs, explored in Chapter 2, to formulate guiding principles for the internet's development, outlined in Chapter 3 will surely aid decision making. The technical requirements resulting from these guiding principles are explored in Chapter 4, while implications for policy, regulation and future research are outlined in Chapter 5.

"Design of the future internet will demand a more holistic approach and multidisciplinary thinking."

What is clear is that we can no longer afford for research on the impacts of the internet on society, and *vice versa*, to be addressed in the traditionally fragmented way of the past. Computer science, social sciences and other disciplines all have their own separate approaches but all have a contribution to make to understanding how best to move forward. A more holistic and multidisciplinary approach is needed, as perhaps illustrated by this study, so that we may better understand how to guide the development of the internet so that it best serves the needs of citizens and societies around the world. Moreover, in the absence of such a holistic understanding, there is a growing risk that technology-driven developments guided by short-term commercial interests may irreversibly hamper some of the basic principles of the internet (eg end-to-end, openness, etc), which have allowed its flourishing and its key role as an engine of innovation and democracy.

Chapter 2. Analysing needs: different scenarios, multiple perspectives

2.1. Research findings from the Delphi survey

An online Delphi survey of hundreds of internet experts in Europe and across the world was a key element in our study. It was conducted among experts drawn as far as possible from different countries and backgrounds and with a more socio-economic emphasis than technical. Results from the first round emphasized that the internet would become vital for the majority of people in five to ten years, as shown in Figure 2.1. Most respondents believe that it will become indispensable for finding and maintaining employment, and employment related services, as well as becoming the prime source of news, entertainment and a channel for socio-political expression within 5 to 10 years. From the survey, up to 50% of a person's day will be directly influenced by the internet as it permeates most aspects of our lives, as by 2020 the internet is expected to also support all basic voice and data communications. It will thus represent the principal social interactive conduit for a majority across the globe, with an increasingly significant influence on our daily life and lifestyles.

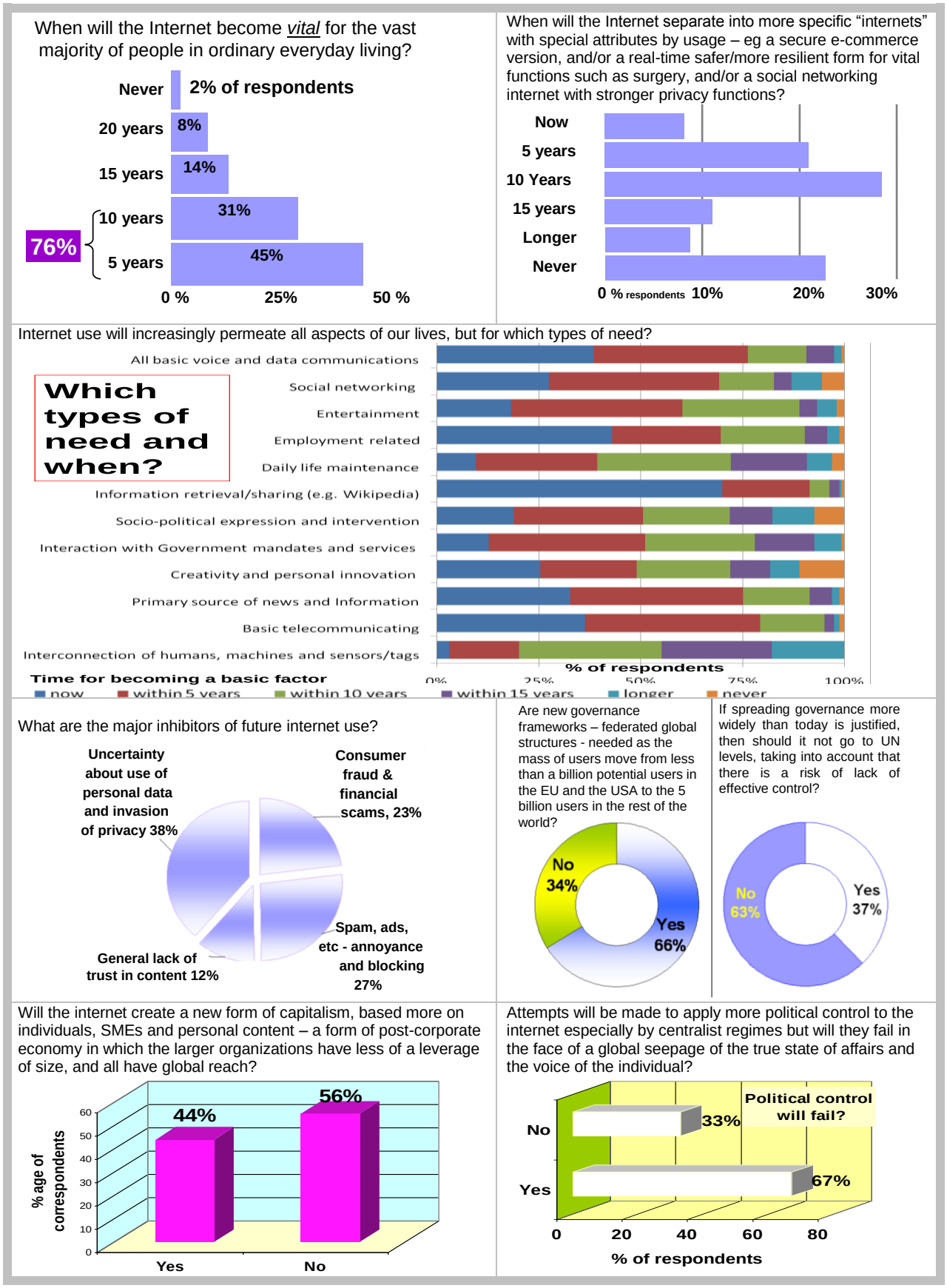
"The internet will be vital for finding employment as much as a conduit for social interaction"

Today most users employ the internet to retrieve or share information and this is expected to expand, especially for social networks, (such as YouTube, Friendster, Facebook, LinkedIn, MySpace, Twitter, etc). However, networks may have to take on new forms, as the survey confirmed a possible strong limit to current social networks – the lack of trust in how personal information is used by services is the highest barrier to internet use – as shown in Figure 2.1 in the set of potential inhibitors to internet expansion. Overall, the findings indicated that social and economic use of the internet will tend to exceed the political usage. Also the majority of government services will use the internet to interact with people. For instance, citizens will be able to access basic information or to engage in simple communications with government agencies. However, detailed advice will still be delivered via face-to-face interactions.

In terms of business usage, there is a general perception that by 2020 the internet will become critical for the vast majority of business functions. Jobs and the economy are more likely to be dependent on the internet by 2020. It will soon be as vital as electricity for most business activities, including operations, sales, management, human resources and finance, expanding on today where it is already crucial for logistics, research and development, marketing and personal relations using the Web. Among its many potential new functions, the *internet of things*, or interconnection of machines, and sensors/tags and humans, is perceived as viable, but beyond 2020, not before.

Respondents expected that politicians and governments will continue to develop their use of the internet to influence politics, where it is already a powerful tool to help campaign groups to coordinate supporters in specific political actions. Political parties will be fundraising, recruiting and interacting with their members through the Web. We may also see more use of online consultations on specific legislation or government polices. However, we may not see the internet being used to organize e-referenda for direct

Figure 2.1 Some selected key findings from Round 1 of the Delphi survey



democracy leading to legislation. Such an ambitious objective may never be achieved unless we improve the security of the internet. On the reverse side, of whether governments will be able to control thinking and censure debate over the internet, the majority of respondents felt that eventually this would fail (see the results charts in Figure 2.1).

"There is optimism on the freedom of the internet from political control by governments"

Perhaps pragmatically, there was little confidence that security and privacy issues would ever be satisfactorily resolved so that the internet becomes a truly safe and secure place to interact socially and to conduct business, and one which is also highly reliable.

Our expert base was pessimistic on finding an easy solution to this key infrastructure problem. Nearly a quarter thought a truly resistant network infrastructure would never be implemented, while almost another quarter could foresee this only after 2025. The consensus was that the internet's vulnerabilities are deeply embedded. In fact, for a significant proportion (25%) of respondents, they are incurable. A not very encouraging general message is that by 2020 the internet will remain vulnerable to critical failures and cyber attacks.

However, according to the Delphi survey, a few of the expectations for 2020 in advances, functionality and human interfaces should be met. First, an EU-wide mobile internet will be everywhere. Second, most citizens will trust online transactions and financial services more, even though the internet will not reach acceptable levels of privacy or crime prevention. Nor will the internet be secure and reliable enough for vital services in which lives could be lost by malware or malfunctioning, eg tele-surgery or air traffic control. Average internet use across the EU will exceed watching broadcast TV (including social networking, playing games, listening to music, watching TV over the internet etc). The survey's majority voted for the internet becoming the main conduit for video by 2020.

Overall, by 2020 considerable changes for users are expected. On the one hand, social exclusion will be reduced with smaller gaps for the age, gender and able/disable divides. But, on the other hand, the geographical divide may or may not be reduced and wealth and education level will remain important causes of the current *digital divide*. Nevertheless, by 2020 internet use is expected to increase from the current 66% to 75% of the EU population. On the other important issues for a "socially-positive" development of the internet, by 2020 lower cost and user-friendliness should be the most significant positive factors, followed closely by some degree of greater trust, security and secure applications, mobile access and open access. Developments such as open standards, network neutrality, multicultural/multilingual interfaces or collaborative tools seem to have lower levels of importance or impact for a "socially-positive" internet.

"Scepticism remains over absolute levels of trust and protection"

Learning and education processes will also be impacted at most levels. Today the internet has penetrated education mainly at the university level (both undergraduate and post-graduate). But by 2020, respondents expect vocational retraining, secondary education and lifelong learning to be deeply influenced by the internet. The impact on primary education remains to be seen. One of the interesting findings of the survey is that the promotion of e-literacy, the improvement of general levels of education and the reduction of poverty and social inequality appear as the most important drivers for the take up of the internet by 2020.

Naturally, future evolution of the internet could also be hampered or slowed by a number of inhibiting factors especially the growing uncertainty over the use of personal data and privacy concerns. Furthermore, between 10-20% of the population are expected to categorically refuse to use the internet, considering it an unnecessary imposition.

Overall, a future internet is expected to be more user-friendly, offering ever more wide-ranging, refined and spontaneous ways to interact. For example, image recognition and gesture detection (with machine vision) or multi-sense technologies might become widely available. By 2020, some segments of the user population may be able to test advanced prototype versions of natural language understanding for all the EU languages (with

interactive voice) or useful intelligence-interpretation interpolation. The internet may also become more 'intelligent' and responsive to users' requirements with greater use of semantics, for example. New sociological and psychological behaviours as a result of internet usage and penetration in society are expected. Internet cultures will tend to be more creative as the internet is already forming a new *digital adjunct* to some segments of society with increased social interactions.

The internet will also play an important role in global issues. For this reason, there will be many attempts to apply more political control to the internet (globally and nationally). Current global and economic conditions will accelerate internet usage so new actors will enter in response to its commercial potential while all actors will try to shape the internet and its operation in their favour. Respondents held conflicting views on whether the internet will ever contribute to a new form of capitalism, based more on individuals, SMEs and personal content – a form of post-corporate economy. Similarly, there was no consensus on whether the internet may or may not challenge the global balance in trade and power by 2020. What is clear is that governance structures will be needed for the internet and that it will be politically difficult for internet governance to be controlled by international actors, such as the United Nations.

With regards to the pace of evolution of the internet, revolutionary changes by 2020 are not clearly expected. The idea of having multiple "internets" with special attributes by usage (eg a secure e-commerce version, and/or a real-time safer/more resilient form for vital functions such as surgery, and/or a social networking internet with privacy functions) does not seem to convince around a quarter of respondents as ever happening while the majority think it would be another 10 years at least. An alternative, apparently less conflictive possible situation for 2020 is an internet with tiers of value and privacy/security. Would this reduce or increase exclusion or the digital divide between those with premium services and those with standard ones?

Payment models for internet services are also expected to evolve from subscription and advertising by 2020, as new business models appear for "monetization" although their nature is quite unclear. Equally feasible may be the *internet of things* with billions of objects reachable through the Web.

Another possible situation for 2020 would be for user-generated content to become dominant, be it via broadcast (one-to-many push), or peer to peer, or via user-controlled pull. Proposals of new business models charging for internet applications which are "free" today will be controversial. In the same way, an internet divided into paid-for and a few free services will be divisive. As mentioned in the discussion about future functionalities above, the internet will gradually evolve into the TV channel of choice, against conventional broadcast or cable TV, as a virtual VCR with video on demand.

Essentially the internet is perceived as permeating the lives of everyone across the planet over the next 15 years – directly and/or indirectly, through businesses and consumption of products and services produced online. Underlying this is the expectancy from respondents that the internet will be developed substantially, implying that however slowly it evolves, it will need to be effectively "reborn" in order to gain this status with a new architecture that avoids its inherent constraints and vulnerabilities.

"Scenarios explored users' needs against various internet models and socio-economic conditions"

In parallel with the first Delphi survey round, a key project goal was to identify the overall needs for a future internet using multiple contexts as perspectives. Through several expert workshops we constructed four scenarios of plausible future socio-economic sets of conditions, with their differing needs, which we now examine.

2.2. The scenarios and their messages

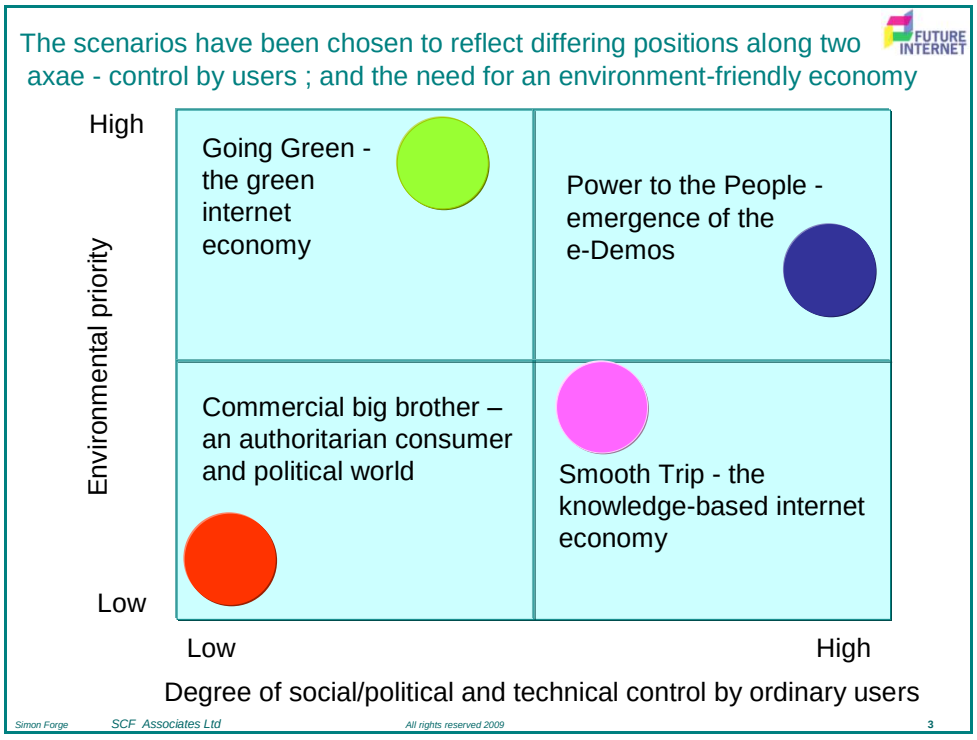
Four scenarios were developed to focus discussion in the workshops which evolved during the course of the study. Scenarios are not predictions of the future but logical projections, taking account of likely social and economic trends. We used our online

Delphi survey of experts with other desk research to identify these trends and so shape the four scenarios, which were:

1. *Smooth Trip* – the rise of the internet economy as a whole life and work style – a middle road against which we can contrast scenarios that are more disruptive.
2. *Going Green* – the internet combats the growing environmental challenges
3. *Commercial Big Brother* – an authoritarian/commercial consumer platform
4. *Power to the People* – emergence of the e-Demos, a forum for democracy and freedom.

These four scenarios are contrasted in Figure 2.2 in terms of user control and environmental friendliness.

Figure 2.2 Comparing the scenarios in terms of user control and their environmental friendliness



The scenarios are summarized below, with more detailed versions in Appendix D:

1: Smooth Trip – the knowledge-based internet economy

"The internet pervades every aspect of public and private life"

The internet pervades every aspect of public and private life. It is a major engine of social progress and economic growth, completing its transition from a repository of information to a ubiquitous tool for sharing and creation, a platform for everything from commercial transactions to socializing to education. Being the basis of global social and economic progress, internet privacy and security offline and online become increasingly important and assured. Governments acknowledge the importance of the internet to economic and political stability. Internet governance has evolved to direct interactions with citizens on many key questions. In an increasingly isolated world, with more and more families geographically dispersed, there is a growing individual need for self-fulfilment and self-expression. Individuals also desire greater effectiveness and convenience in their daily lives. Companies and governments continue their quest for productivity gains.

Demographic trends have reduced the percentage of working-age adults in Europe. Education is seen as increasingly crucial for the development of the European economy.

As a result, there is a strong focus on improving educational systems across Europe and enhancing re-training and re-skilling through digital means.

A large proportion of internet surfing by users is done on small mobile devices that may connect to larger screens or project on to any surfaces as required. Teleworking and remote collaboration are accepted across organizations, in the public and private sectors. From the user's perspective, there is very little that is not available online and this has enhanced the conveniences of daily life tremendously, allowing more time to concentrate on life goals, family, friends and hobbies. The majority of web and internet access is mobile, portable and nomadic. Augmented reality is an important added value to software applications, particularly in urban navigation, health care and gaming.

The user community is highly inclusive, bridging the problems of exclusion through e-literacy, wealth, education, special needs, etc with greater diversity and customization of uses. Income disparity remains high but has not been increasing as sharply as in previous years. There is a growing political argument in Europe that to remain competitive at the global level, all of Europe's citizens must form part of, and benefit from, social and economic growth. Governments have acknowledged the importance of the internet to economic and political stability and have learned to expand its use for communicating with citizens. Remote working is commonplace and geographically dispersed relationships are made easier through the use of enhanced social networks.

The gap in use of the internet between men and women, young and old, able and disabled, low-income and high-income has narrowed due to its widespread availability at an increasingly affordable cost. The internet has become an equalizer, helping an ageing Europe to better compete with American innovation and the Asian giants now dominating the global economic scene. Mobile devices and networks are the norm, both indoors and outdoors, and users can typically find free and easy-to-use urban networks for anytime and anywhere access. An expanded internet includes everyday "things" (from toothbrushes to buildings, signs, posters, and documents) so information is available in indoor and outdoor urban settings, stores, enterprises, museums, and in the home. Greater interaction online is an important driver of the diversity and growth of the internet. Social and professional networking, blogging and micro-blogging have led to a greater exchange of ideas, opinions and information. Finding jobs and commercial partners and products is much easier. At the same time, the user community has become more politically active against increased governmental or commercial control of the internet.

"The internet has become an equalizer, helping an ageing Europe to better compete"

2: Going Green – the green internet economy

Halting and reversing the effects of climate change has become key for planetary survival – not only environmentally, but also economically, politically and socially. It is clearer than ever that sustainability is crucial for long-term EU economic growth and competitiveness. ICT is a key enabler of a sustainable and low-carbon society. Connectivity is the backbone of ICT green solutions. The application and diffusion of ICT in virtually all industries will significantly reduce total global CO_2 emissions by 2020. However, real gains are seen when replacing carbon-intensive activities with ICT-based processes. The focus is on green and smart – green intelligence in monitoring, controlling, adjustment, management, automation and substitution is embedded in the new green industry sectors from transportation to waste reduction.

"The focus is on green and smart"

The green economy permeates all facets of political, economic and social institutions. The governance that underpins the green economy is highly regulatory, with legislation and policy measures for everything related to CO_2 reduction and environmental protection, to reinforce environmentally conscious behaviour. This is underpinned by a new generation of internet technology for the sustainability initiative – specifically the control and monitoring of the large generators of greenhouse gases and of energy generation/ consumption and of the environment in real time. It may demand a much larger capacity internet, unless all is locally filtered as although many systems may be slow, volumes

may be enormous. Also, reliability at low cost means redundant signalling protocols with code repair algorithms, as most sensor networks are radio-based, in mesh configurations.

Public, business and domestic internet 24x7 infrastructures continually measure and assess emissions generated by products, services and behaviours. Actions with an adverse environmental impact can be quickly identified, enabling immediate corrective action for optimum environmental protection. This has become essential as the situation worsens – everywhere is wired up and monitored.

Social networking tools have become core to dealing with global catastrophes by quickly mobilizing help in the global community and through the rapid conveyance of communications and information to distressed places. As it is a regulatory requirement to monitor, record and manage domestic energy consumption, the government has connected all homes to the internet, also capitalizing on it for digital literacy. Educational campaigns and information on current environmental issues, guidelines for green living and the status of green initiatives are communicated to all.

"Social networking has become core to dealing with global catastrophes by quickly mobilizing help"

Developments in internet infrastructures using third generation LEOs (low earth orbit micro-satellites) now make it possible to have a global 24/7 network even when a country's landline, mobile phone and conventional satellite infrastructures have been devastated. Individuals and online eco-communities use innovative web-based tools and applications, which have become vital in global disaster relief. Mobile platforms, computational linguistics, geospatial technologies and visual analytics are used for early warning and rapid response to emergencies and rescue efforts. Much is socially driven, and therefore is open-source and free, with no commercial IPR.

Tele-working and video conferencing are universal. Working from home is the norm. Access to the internet is via environmentally friendly mobile devices for on-the-go-anywhere connection, also essential for disaster situations.

3: Commercial Big Brother

The internet becomes a purely commercial channel for entertainment, retail commerce and advertising, mostly directed by the largest players amongst ISPs, telecoms, consumer goods, retail, advertising and media publishing. Development of a consumer-media broadband internet is the major thrust. Between 2012 and 2017, the internet becomes popular as the replacement for broadcast TV, offering an interactive consumer channel. In this commercial internet world, content providers and ISPs increasingly market a range of consumer offerings through controlled internet spaces, most often with walled gardens for TV shows, games etc, linked to retail offerings for everything from supermarket shopping to houses. The offerings are more like cable TV or satellite: tiered bundles of options rather than conventional internet access of a freely selective nature. Such domains are created to maintain user lock-in, effectively closing the network to open access. User privacy ends as companies can exchange data on every transaction without hindrance. Where restrictions exist, data is stored and exchanged in those countries where privacy laws are ineffective as there are no effective international agreements.

This form of internet is driven by three "carrier" infrastructure industries:

- Extensions of the current internet players – ISP and search engine plus social networking sites all rolled into one – who carry the above media services and link to retailer websites to make their profits
- Fixed and mobile telecommunications incumbents globally – who branch out into being national ISPs and media brokers to the main content providers, with their own "walled garden" media products
- Cloud computing – with hosting sites for applications created by individual enterprises to operate their business and to store vast silos of data, as well as for common "productivity tools" for individuals rented as a service from the major software vendors.

"The old model becomes the norm, that of vertical dominance across content and network delivery"

Early on there are two layers of internet industry structure. First is an upper layer which comprises the large players in retail goods and services, media industry, especially music, news and advertising. The lower layer consists of an amorphous set of ISPs of several kinds, players in services such as search and social networking, as well as basic communications. They offer network connectivity, processing power and data storage with the necessary infrastructure. However by 2015, these two layers have begun to coalesce. Thus the older model favoured by telecoms incumbents (both fixed and mobile) becomes the norm, that of vertical dominance across the two layers with no off-network access. Most often, such players are re-badged telecoms operators who expand from mobile into internet, followed by a phase of acquiring internet content providers. Incumbent telecoms operators offer ISP services combined with their WAN networks, now commonly labelled as "Next Generation Networks". Thus the new fibre infrastructure is often subsidized by nervous national governments who have been led to believe that closing the digital divide means installing fibre "nearish to the home", solving the incumbent telecoms operators' capital requirements while cementing their network control. These large consumer-culture, communications and internet players further consolidate to three massive global players from around 2020 onwards. They operate the global market through tacit collaboration. Consequently, using the internet slowly comes to mean being tied into this small range of content providers and ISPs, where the user pays for all uses.

Open free use of the internet, independent websites, free speech and ideas tend to shrink. Note that there is widespread government acceptance of the commercial culture for reasons of political censorship and control, by suppressing use of the internet to spread ideas, organize opposition and protest. Limited technology advances are largely aimed at consumer gadgets and efficient management of multi-channel asymmetric media flows, with peak streaming management. The old internet model is able to scale up to suit the purposes of its commercial operators – as a platform to sell consumer services, goods and entertainment.

4: Power to the people – emergence of the e-Demos

Ordinary people no longer wish to wait for governments and technologists to decide what the internet of the future should look like. They react against government attempts to use the internet for their control and as a way to cut the cost of government. People take the initiative, but in no organized way to start with – they push back against the status quo and demand their own way for the internet and to close the digital divide with applications designed for and by ordinary people. Governments and large corporations are not the drivers, but become the spectators to a newly shaped internet.

Prompted by the financial meltdown which triggered the six-year global recession, ordinary people seek new ways to earn, invest, control and manage money. So a new type of internet is an essential component to drive GDP and employment, as a job finder and creator. Increased numbers of occupations and workers are internet dependent worldwide, with novel employment, business and consumer/prosumer models. Ordinary people want an internet that enables them to "take charge" of the events that are having a tremendous impact on the lives of their generation and on the future. They demand a free and open internet environment in which they can have diverse, easily programmable devices that can connect to anything for any content, service or application. This requires a new level of technology access, aimed at the ordinary person. Access to content and information is made freer and the use of free/open source software and content becomes much more common. Creators rely more heavily on alternative business models. As everybody has free access to content and information, this becomes a key enabler of real bottom-up innovation and social progress, eliminating the knowledge divides.

Freedom extends to the choice of whatever network they wish to connect to. In the online world, the consumer wants freedom, because new business models, with flexible, low cost and a steady stream of new services favour the consumer and their rights. The drivers

for this lie in personal assertion, expressed in political movements for such causes as the environment. Society as a whole drives a strong demand for "*user and e-consumer rights*" – for transparency, trust, fraud-resistance, protection and fair, honest governance rules. Social attitudes focus on community building and bridging gaps in a highly diverse global society. Thus there is a shift in requirements to open outwards, to expand the range of contacts, and participate in new (online) communities, for more intensive participatory lifestyles. This builds against a demographic background of an ageing and already elderly population, dispersed families and single unit families, generally more politically astute and active. The advance is led by ordinary people who first build spaces for social interaction, then markets, information spaces, etc as well as a new range of much easier-to-use tools. Self-help means self-building and sharing the benefits. New directions in services and ways of using the internet largely come from the developing world, starting from Asia and spreading further out into the developing world. By employing a few simple open source tools, people build secure spaces, resistant to malware, scams, phishing, etc and to commercial intrusion – spam, pop-ups, cookies, etc. A new concept of privacy emerges, not related to any commercial interests and based on strong identity management.

"Society as a whole drives a strong demand for user and e-consumer rights"

2.3. Implications of the scenarios

The scenarios were discussed in the workshops at length (Appendix F) and their implication considered. As an example, the findings of the Cambridge, MA workshop are summarized below.

1. Smooth Trip

This scenario was seen as providing a smooth interoperable platform with a low cost to entry and easily accessible information and services:

1) Policy development and implementation: Policy will have a large impact, both positive and negative, on what is available to users. In particular, policies dealing with *data protection*, *inoperability*, *IPR*, *transparency* were raised as important. The need to not simply copy policies from other regions (ie the USA) was highlighted as well as the need to align policy with an understanding of what citizens and consumers want.

2) Open standards and access: There is a general trend towards enhancing openness and access across people and devices. However, there are differences between what users want vs. what businesses are willing to provide. This scenario requires a cultural willingness to share as well as the ability to filter information effectively. Filtering becomes a key focus, ie search engine technology.

3) Network neutrality: This is particularly relevant in enabling this scenario. However, it is not simply a matter of preserving network neutrality no matter what the implications (eg the potential damage to voice traffic). Instead there is a need to maintain a level of neutrality but without strong enforcement or strong violation, ie network neutrality stays the same but with some caveats, such as voice.

4) Economic models and incentives: Economic models should remain as varied as possible to encourage innovation. There is a high degree of interaction between government and business, both large and small, with businesses having vested interest in government. Government and end-users both fund projects.

5) Security, privacy and control: Private commercial enterprises are often responsible for security as part of the economic model – competition actually leads to more secure networks than governments' attempt to create privacy. There is a risk of a false sense of security, with trade-offs between security and anonymity. Due to the high reliance on data exchange, privacy and security issues are critical and as a society we become more vulnerable to cyberwar and crime.

6) Technological development: Development is modularized in this scenario with incremental technologies and atomized self-interest. There is a risk of slow rates

development and systemic technical problems in implementing new services (eg IPv6). Technology is developed collectively with everyone contributing to make up a larger whole while legacy systems are supported. Mobile access becomes increasingly prominent as a means for accessing services and information.

7) Social inclusion and exclusion: There are fears over new forms of inequality and a technical hierarchy of users that does not necessarily coincide with the competence and skills that we have now. Issues of inclusion and exclusion should not simply be linked to wealth and education (although these remain key concerns), but there will be new forms of exclusion and the risk of forced inclusion. New forms of filtering and aggregation will emerge alongside new forms of power and control mechanisms. Particular interest was expressed in relation to the ageing population and developing nations.

2. Going Green

In the Cambridge, MA workshop, the relevance of this scenario to the internet was questioned (although in the Brussels and Tokyo workshops attitudes were very different). More generally, this scenario raised a lot of control issues:

1) Economic models and incentives: Discussion focused on what would count as incentives. On an individual level the primary incentive was seen as lowering energy bills. The importance of government involvement was highlighted, eg energy efficient appliances would not have emerged without government incentives. However, while it was argued that government-centric economic models and incentives were critical for success of the green energy movement, market forces need to be allowed to play a more active role and subsidies should be minimized.

2) Energy consumption and sustainability: What actually counts as increased energy efficiency and sustainability is not always simple. Three main topics were discussed. First, where to source energy for computer data and processing, ie Google's initiative to build server farms near water bodies. Second, sustainability issues around provision of power for increased computing services. Third, questions around the disposal of technology and devices in a sustainable manner, eg end of life products could be recycled and secondary uses developed.

"Will the internet be national, global, or local?"

3) Culture norms and globalization: Will the internet be national, global, or local? While this scenario would speak to some audiences, eg Google spends more on power bills than on salaries and are putting money into alternative energy centres, some people do not believe in climate change. Businesses are moving data centres to cheaper countries, so globalization not only has to be taken into consideration in relation to adoption but also management, control and regulation. It was unlikely that internet services would replace travel unless government forces it.

4) Security, privacy and control: Privacy is affected in this model due to requirements for monitoring and gathering evidence against individuals. In order to monitor and hold people accountable for their energy use, data protection becomes increasingly important.

5) Standards: Standards are needed to monitor consumption at a global level. There are architectural choices, but not direct choices, eg gradual shift to low-powered devices, cloud services. NGN/clean slate is not affected.

3. Commercial Big Brother

This was considered by the Cambridge. MA workshop as the default scenario, the one which we are moving towards and most closely reflects the current one. Societal cost is distributed and innovation in this model happens (and is funded) from those who benefit the most. This has led, and will lead, to increased capabilities for data storage:

1) IPR: Copyright of data and surrounding legal issues is a huge concern. There will be less and less control of data/information by the content creator with the data collector or aggregator becoming stronger. The right to control will be on the side of the collector, eg

News Corporation vs. Google. There will be an enforcement and then expansion of the powers of intellectual property with messy legal situations due to cultural differences in data handling, copyright laws, and questions on intermediary liability. IPR takes an increasingly important role.

2) Security, privacy and control: Security concerns are ambivalent. Security could be seen as a driver for this scenario, or could be based on a "just trust me argument" with no truth in it, eg ATM fraud. Some argue that privacy is more important than security in this scenario with a downside being data storage and lack of mechanisms for minimizing data, leading to the hoarding of data and privacy issues for users.

3) Economics models and incentives: The economic model and incentives are the main drivers for this scenario. Innovation accrues benefit to those who can fund it on a large scale while those who do not fund have no benefit. Economic models such as bundled services will influence uptake and use. Services with one single provider will reduce the cost and as a result affect what is provided, eg the Google scenario, the advertising model that seems free, but is commercially paid for. There are strong incentives for companies, but little for the state in this scenario.

"Network neutrality is crucial, but it depends on how it is defined"

4) Standards: Network neutrality is crucial, but it depends on how it is defined. In Europe it is defined differently from the USA. There is a link between standards and control, but not an obvious or causal one. Some argue that open standards are counter to what Big Brother wants and others that open standards *are* what Big Brother wants. While closed standards *support* Big Brother, open standards do not necessarily work against it. If an ISP controls services it does not matter if there are open standards as they can just block access to websites. Having open standards lets users choose.

6) Energy consumption: In this scenario more is better and energy consumption could increase, eg bigger screens. But "going green" could become a competitive advantage.

4. Power to the people

This scenario was seen as most favourable to user rights and the one with the least government intervention. Reputation becomes a driving force on individual and organizational levels:

1) Economics models and incentives: There is no clear source of funding, but it is not likely that this will require high capitalization (ie communication meshes that do not involve large capital investment), resulting in a fragmented funding model. This scenario accommodates innovation and will play out when disruptive innovations are allowed to grow. Hence, innovative and associated compensation is a major motivation.

2) Fragmentation: There would be fragmentation of the internet into multiple sub-internets. This may lead to a closed architecture of the internet (eg Apple ecosystem) and there is a risk that these emerging internets end up competing with each other.

3) Standards Interoperability: Interoperability on different levels would be highly desirable so that groups can form and create their own networks, but still share technology and applications. That requires some standards, perhaps open source. Network neutrality is seen as important, as are NGN and a clean slate that is transparent to the user.

4) Key role players: This scenario creates interesting relations between various role players. What will be the role of the open source community? Government? Businesses? User/creators?

5) Cultural norms and globalization: There is tension between global and local services, in which different cultures affect services. What language(s) and technology(s) will be used? For example, the Korean network is strong and independent but their technology is common to the USA.

6) Security, privacy and control: Security was seen as really important in the context of closed internet communities, but it was argued that privacy is more important than security.

7) IPR: In this scenario there would be a commons-based model with less high protection and more incentives for sharing information.

An overall summary of these "parameters of evolution" for the internet is shown in Table 2.1, which summarizes the findings of the MIT workshop.

Table 2.1 Parameters of evolution of the internet

Parameters of evolution	1. Smooth Trip	2. Going Green	3. Commercial Big Brother	4. Power to the people
Internet infrastructure	Based on current architectural principles	Real-time, data driven, mesh, cloud services	Vertically integrated	Ad hoc/mesh, data/user driven
Technological developments	Mobility based No change in archit. principles Interoperability	Sensors Distributed network control	Streaming requires NGN or "clean slate" Walled gardens, specialized nets	Distributed control Online Reputation, Viral adoption Generalized wiki
Security, Privacy and Control	Security from competing private efforts Tradeoffs with anonymity	Sensitive to privacy, data protection	Strong Security, either real or apparent Power to data collectors	Privacy and identity more important than security
Economic models	As varied as possible. Work process evolution. Government and business support.	Natural resources consumption. May need incentives	Entertainment Driven by profits from industry, content and network providers	Distributed, user generated Innovation from the bottom
Social aspects	Social inequality	Globalization key	No social drive	Main social drive
Policy	Data protection Moderate IPR Transparency	Energy, Environment	Strong IPR protection	No IPR protection Open standards Interconnection
Standards	Some tension between open and industrial standards Filter / search technologies key	Need global standards	Competing closed standards may prevail Open standards acceptable	Open or Open source standards Multi-cultural support
Network Neutrality	Important but not strongly enforced	Important but not key	Ignored, just a burden	Key element to enforce

2.4. How experts think the future will develop

There was consensus at the Cambridge, MA workshop that although the status quo would degrade towards scenario 3 (Commercial Big Brother), it might also have some relationship with scenario 1(Smooth Trip). The interconnections between the four scenarios meant that they were not mutually exclusive. Their interaction and relationships needed to be further explored. It was felt that, although scenario 3 was most likely to happen, more could be done by governments to encourage scenarios 1 and 2 (Going Green). Scenario 2 is congruent with scenario 1, but different industries are in control. Scenario 4 (Power to the People) also has commonalities with scenario 1. It was also thought that we could expect to move from scenario 3, the closest to where we currently are, towards scenario 4, perhaps via scenario 2. However the question is whether all scenarios concentrate power in the net and not in the user. The Tokyo workshop also noted that the four scenarios are not necessarily independent nor are they parallel trajectories. They could be *sequential*. Even if the four scenarios were not contiguously sequential, each would appear in the process of the internet's evolution, as it forms a basic infrastructure and so will evolve in an incremental way, and not as a sharp discontinuity.

In the second round of the Delphi survey, experts were asked which of the four scenarios they thought was most likely to become reality, and also which they considered most desirable, as shown in Table 2.2.

The key findings are that in terms of likelihood, the "Smooth Trip" scenario is most probable scenario with 67% choosing it. No other scenario reached similar levels. The second most likely scenario is "Commercial Big Brother" with 47%, followed by "Going Green" (33%) and "Power to the e-People" (23%). But in terms of desirability, "Power to the e-People" appears as the most desirable scenario (62%), in spite of being the least likely. The second most desirable scenario is "Smooth Trip" (56%), closely followed by "Going Green" (54%). "Commercial Big Brother" is overwhelmingly the least desirable scenario (8%).

Table 2.2 Summary of Delphi round 2

Opinions of 110 experts	Scenario 1 Smooth Trip	Scenario 2 A green internet Society	Scenario 3 Commercial Big Brother	Scenario 4 Power to the people
All experts (110 experts)	**67% likely** 56% desirable	33% likely 54% desirable	47% likely 8% desirable	23% likely **62% desirable**
Research/Education (68 experts)	**70% likely** 56% desirable	27% likely 52% desirable	50% likely 5% desirable	17% likely **58% desirable**
Business (28 experts)	**54% likely** 50% desirable	38% likely 54% desirable	48% likely 16% desirable	36% likely **64% desirable**
Government (12 experts)	**75% likely** **75% desirable**	42% likely 67% desirable	34% likely 8% desirable	25% likely **75% desirable**
EU (67 experts)	**61% likely** 48% desirable	30% likely 56% desirable	51% likely 7% desirable	23% likely **65% desirable**
Non-EU (43 experts)	**75% likely** **70% desirable**	37% likely 51% desirable	43% likely 10% desirable	21% likely 57% desirable

In terms of perception of the likelihood and desirability by type of stakeholder, government experts were even more convinced than the average that the Smooth Trip scenario was not only the most likely (75%) but also desirable (75%). Government experts also rated the Power to the People scenario as equally desirable (75%), but much less likely (25%). The views of experts from the research and education sector closely matched the average, while business experts rated the likelihood and desirability of the Smooth Trip scenario slightly less than the average. Compared to the group as a whole, business experts thought Power to the People was more likely and more desirable. Surprisingly, business experts thought Power to the e-People was more desirable than Smooth Trip.

Results were also analysed according to geographical location of experts – European Union vs. non-EU. Opinions on likelihood and desirability were similar. However, non-EU experts thought that Smooth Trip was both more likely (75% vs. 61%) and more desirable (70% vs. 48%) than their EU counterparts. EU experts thought that Power to the e-People was the most desirable scenario (65%), but unlikely to become reality (23%). A brief survey of the key drivers of change over the next three decades with more detail appears in Appendix B.

2.5. Trends and drivers – outputs from the workshops and other research

Expert workshops were held in Brussels, Cambridge (hosted by MIT) and Tokyo (hosted by Keio University) to further refine these Delphi findings. A second Brussels workshop was held to validate the study's findings. At each event scenarios were used to stimulate wide-ranging discussions and identify the main trends and drivers. We categorized these into five major types – economic, social, technology, psychology and human interface.

2.5.1. Economic trends and drivers

"An internet-based economy is shaped by the prosperity of its user base, location, demography and business models"

The world already has an internet based economy – it is an essential mechanism driving GDP and employment – so the internet's future evolution will inevitably be shaped by economic forces. The network itself has spawned a whole new industrial sector since the early 1990s. The overall level of internet demand (and choice of services) is set by the degree of prosperity in real purchasing power terms of its users. Prosperity-based demand is also constrained by a range of economic-behavioural factors such as trust and confidence. Interestingly, both project workshops in MIT and Tokyo pointed out the need to develop new ways to measure and evaluate choices for the internet, beyond simply the monetary, eg in metrics such as reputation, trust, happiness, social worth, etc.

A first economic driver is the "globality" or global scale, because in trade, reach is sometimes everything – also indicating that geographically limited internets (eg only one country) are to some extent restricting trade, putting limits on economic growth. The speed of commerce is accelerated. This has effects on the rate of investment, so internet-based trade stimulates higher global liquidity as the ease of international commerce increases.

Moreover globalization of trade shifts the focus of the internet, as developing nations will be dominant in gross GDP terms between 2030 and 2040. Emerging markets will show the fastest rates of inward investment as well as growth over the next few decades and so will tend to define the internet's future shape. As the first Brussels workshop pointed out, their lack of wired infrastructure will promote the *mobile* internet model.

Education is a factor whose value is accelerating in the knowledge economy. A future internet will be driven and shaped by increased demand for education. At all its levels, education is a major economic driver, at both a micro- (personal) and a macro-economic level, for the move to knowledge work. Learning over the internet will be a key ingredient and background to future education especially at the higher levels, and so a key economic driver, as noted in the first Brussels workshop.

Linked with education is a further economic driver – the demographic trend to an ageing population, and with it, an ageing workforce with extended longevity. These workers will need to reskill to gain employment in a future knowledge-based economy, now a serious future issue for Europe and globally, as pointed out at the Tokyo workshop. The ageing population will also depend on more in-home health and social care, to reduce costs of health schemes – again drivers for a pervasive internet. Such an internet will require specific features suited to caring for the elderly and maintaining active life, with a prolonged working life, particularly as under-funded pension schemes across the developed world lead to delayed retirement for many workers.

2.5.2. Social trends and drivers

"The internet is now a socially facilitating infrastructure that must avoid exclusion"

A future internet will be some partial mirror of society, a component part of a complex social, human system, in a restricted view. Major social trends that drive the internet as a new component of society include globalization, accelerated lifestyles into which more has to be fitted, increased complexity of daily life and demographic change. For instance, one lifestyle-related change is the reshaping of personal privacy on the largest social networks, reflecting commercial imperatives and the behaviour of their main users – teenagers and young adults. But the internet must also reflect social norms of acceptable

behaviour – many societies set strong constraints on activities and capabilities. Such conditions set the general trend – from an internet of PCs, to an *internet of persons*, for ubiquitous socializing, as noted in the second Brussels workshop. It implies pervasive communications and therefore mobile radio as the preferred access network, for activities such as social networking applications. This model supplants the traditional internet model of PC and wired connections for applications such as email, noted in both Brussels workshops.

The next several billion users will bring in influences from a far wider range of societies, but that also implies a host of cultural enclaves rather than a single cultural and mental model. The first Brussels workshop emphasized that success as a social channel means the human signals and markers (visual, audio, gestural) must not be lost in the communications channel. It also sets certain goals for the internet's evolution into an increasingly significant platform for social interaction. As the Tokyo workshop pointed out, when the East European countries moved from communism to democracy, television was a key technology, but now the internet has become a potential infrastructure for global democracy. This has not been lost on authoritarian states, who are becoming increasingly sophisticated at monitoring and controlling internet communications. At best the network can enable dialogues among different cultures and thus between different states. Carelessly designed interface and usage technologies can create effective segregation, eg for older people. Understanding is required of how internet technologies can exclude anyone, eg via poor user interfaces.

Legal issues will also be important in a future internet operating across national legal regimes. How they can be implemented and enforced in a borderless international market is still unclear. Existing national law may suffice – but do the current laws need to be extended, where insufficient? For example, even within the European Union's single market, consumers are reluctant to buy goods and services online from other Member States.

2.5.3. Technical trends and drivers

Development of the internet's underlying technology has been surprisingly slow (eg IPv6) as pointed out in the MIT workshop and in both Brussels workshops. Large European telecommunications incumbents have invested billions of Euros in "Next Generation Networks" providing additional services (such as guaranteed Quality of Service), but it is not clear these will win in the marketplace against cheaper "best-effort" networks. This experience should make us think carefully about pure technology drivers. An evolutionary mode of internet advance is more likely. A complete new generation of fundamental internet technology may be too ambitious. As the Tokyo workshop noted, infrastructures have not really evolved since around 2005 as the technology vendors are increasingly static in their designs because the major players in the private sector are taking control of the upper layers. Thus the only innovations are for various traffic controls, such as deep packet inspection, to enable major players to identify and police internet communications. If effective use of open standards is ignored, the technology may become an inhibiting driver which could stifle internet advance and so block free entry to the internet infrastructure market.

"Technological advances have been surprisingly slow as influences on the internet"

Hence, community driven innovation will be a key driver of future internet progress, alongside commercial innovations from companies within the internet business who retain intellectual property rights. The second Brussels workshop noted that a community approach can also emphasize the power of the individual by amplifying it through a community as a collective action, to carry more weight. The latter point is related to the concept of whether a European framework is required as the basis for an enabling infrastructure as well as for creation of new services.

However, there are some technology trends with promise: state management at the web layer, application layer multicast, data-centric networking, publish and subscribe,

resource pooling through multi-path for more robust handover, and an identity layer for the internet were pointed out at the MIT workshop. Potential new directions for technology may be in growing user involvement in design, for more user-friendly applications and also those that better protect the common user. Sensing and sensors and interactions with the real world will become far more important. A continuing area for investigation is whether the internet should continue as a "dumb" network, with "intelligence" (computing power) located at the edges, or have more 'intelligence' as part of its infrastructure.

Also when looking at future internet drivers, we need to be able to make a clear distinction between the technology of the internet and technology trends in general, eg wider use of RFID or cloud computing. These advances may impact the internet's future engineering but may not become core internet technologies. One technology driver that does need to be assessed further on its implications for infrastructure is the *internet of things*, looking beyond simple RFID tags as the first Brussels workshop pointed out.

Internet history is less relevant for future storage, processing and network transport models, for the general ways in which we handle data. Today the ratio of network capacity to storage capacity of data is quite different to that of 30 years ago, as storage capacity attached to the internet is currently increasing rapidly. New directions towards semantics and knowledge processing may be significant drivers of change, coupled to advances in storage, access and distributed processing of very large data sets.

2.5.4. Psychological trends and drivers shape the future internet

Key to the internet's future is the psychology of trust. At the core of user trust lie privacy, protection, security and reliability. In a digitally pervasive world, where dependence on technologies will increase, the effects of outages or deliberate scams or invasive interference are easily magnified. Consequently user demand for protection, resilience and trust – for an autonomic self-healing internet – will increase enormously.

"User psychology, in terms of desires and fears, will dictate internet usage – what it is used for and degree of usage"

The psychology of human needs is closely linked to the strong attraction of social networking and its expected growth. As the first Brussels workshop pointed out, in particular, the trio of human desires for presence/belonging, relationship and contribution will continue to drive internet technologies to create infrastructures for communication, creation and interaction. At the basis of these desires is the need to be included. Therefore in order to avoid exclusion owing to technophobia or alienation, a future internet needs to have the characteristics of a "flexible internet" – that is subjective, diverse and intuitive. The ultimate goal is that a user can take it everywhere and reshape it according to personality, locality, and each lifestyle situation. In essence the user would have the capability to create "my" personal network over the internet. Our psychology of internet use is also governed by the desire to achieve aspirational goals, therefore a future internet should be an enabler of individual and collaborative creative endeavours. Two design implications in particular that arise are the desire for immediacy and for rich media interactions.

The potential success of the future internet will depend on the extent of its compatibility and adaptability to the psychological anatomy of users. The two primary drives – desire and fear – translate into needs and demands. Demands are driven by fears of intrusion and harm – hence the need for trust and privacy. Fear is sensitive to multiple factors – culture, age, health and socio-economics. Thus cultural re-assurance requires familiar presentation, with cultural signs and accepted behaviour to reinforce acceptance, trust and take-up. The fear and mistrust factor extends beyond intrinsic engineering considerations, stemming from the commercial exploitation of user behavioural data by large ISPs, portals and search engine services. Using what may have become an unhealthy customer intimacy, these service providers are generating significant revenue. As pointed out in the first Brussels workshop, future internet design should consider how relationships of all kinds, in business as well as socially, are facilitated through the internet. This especially

links to how to value emotions – and more cynically, of how to make money from emotions. It is also a pointer towards future governance rules.

2.5.5. The human interface must influence the future internet

We have separated the human interface as a distinct subject for consideration in the evolution of a future internet because it is a fundamental driver of its take-up. This was demonstrated by the impact of the World Wide Web as the key enabler of the internet into popular culture globally. Effectively the WWW placed a human interface layer (the browser) on top of a relatively simple messaging and document file exchange system. It was easy to use compared to the past. Human interfaces also will be crucial to digital inclusion. Here it is useful to broaden the notion of human interface to user environments and socio-psychological dimensions of user and context. Thus limits on what may be considered as the human interface are a difficulty. For instance, does it extend into exploring the internet environment, or is that an application's role? We need to analyse the human factors in the setting of the interaction, ie the traditional but less exploited notion of the human interface environment. The rise of mobility is a trend of expanding importance here. As the Tokyo workshop pointed out, the human interface also includes language diversity, a critical issue as the upper layers of the internet including applications and user interfaces become more important. Only those who cannot speak English well understand the importance of multi-lingual interfaces. Minority languages risk being lost in the internet world, without convenient translation methods for internet interfaces, a serious factor, as language diversity and cultural diversity are closely linked.

A further discussion point is the type of media in use in the interface – previous advances have been from text to still images, to video, while tomorrow will include 3D immersion and virtual reality worlds. The underlying impact is that the architecture and engineering, as well as the business models will need to offer more and richer multimedia access, transport and display than before.

"The human interface holds the fundamental key to take-up of the internet"

The interface is also linked to online identity and its protection. Two aspects of internet identity should be considered – first, recognizing the digital presence aspect of our identity and of how to create that and then protect it, and second, the use of identity as an asset or service, which social networks (such as Facebook) see as their route to the monetization of their user base. Thus a significant driver in design of a future internet will be the need for an interface for protection of self but one that suits our modes of thinking and doing. Greater reliance on the internet introduces significant problems for internet design related to personal (and organizational) identification. Digital identity management is the core issue here. The ideal is "anonymous personalization with assured loci of control".

Chapter 3. Guiding principles for a needs-based future internet

The internet has the potential to become a ubiquitous and universal channel for socializing and creative expression for all, as well as a non-stop global business environment. Indeed, it is already well on its way to becoming the largest platform on the planet for information, communication, trade, employment and social exchange.

In order to fully harness its potential, however, its growth and direction can be shaped to meet the needs identified in Chapter 2. Which fundamental principles should guide the internet's future evolution to effectively support individual and social requirements? By considering the scenarios and analysing the workshop discussions, we have generated an ideal list of "paired" principles:

1. Available & Accessible	**6. Reliable & Resilient**
2. Diverse & Inclusive	**7. Safe & Secure**
3. Scalable & Sustainable	**8. Private & Trustworthy**
4. Open & Shareable	**9. Appealing & Usable**
5. Green & Affordable	**10. Adaptable & Customizable**

These ten paired principles, discussed in greater detail below, are wide in scope and relate to overlapping social, technological, psychological and economic domains (see Figure 3.1). In Chapter 4, these core principles are mapped onto specific technical requirements for the optimal design of a future internet.

3.1. Available and Accessible

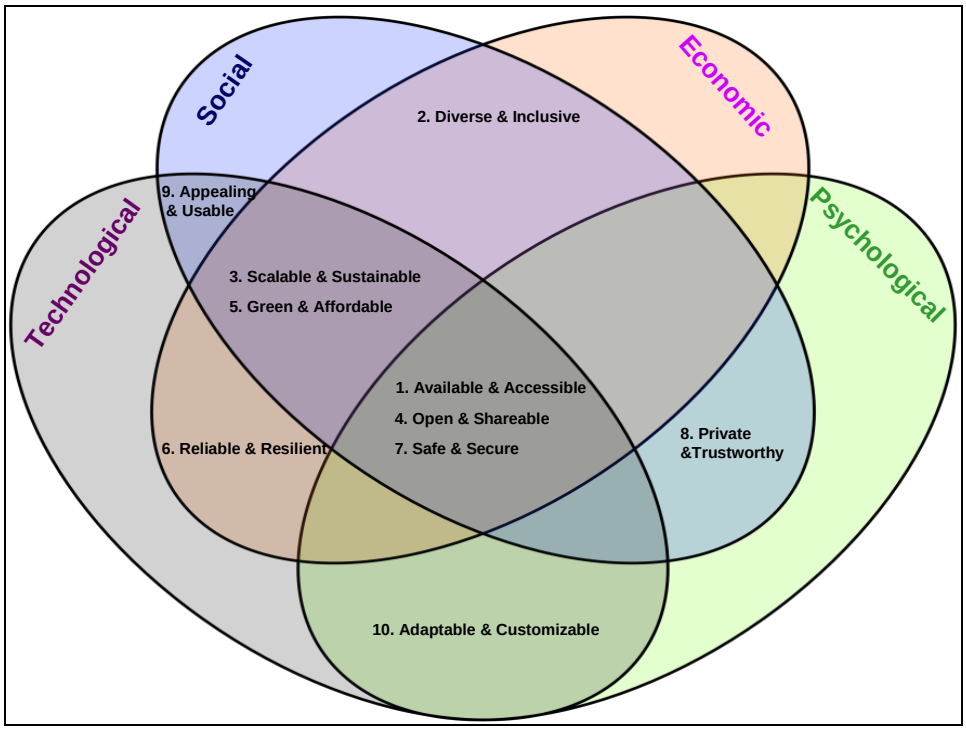
"The internet has the potential to become a ubiquitous and universal channel for socializing and creative expression"

The first principle, identified in workshop discussions, is that the internet should be available to everyone – it must have global reach. Internet coverage should reach 100% of the EU by 2013, the Digital Agenda goal being to roll out fast broadband ≥ 30 Mbps to everyone by 2020. Beyond this, the internet should be accessible and provide ease of use for all at a basic level, for global inclusion – intuitive interfacing with no exclusion due to high e-literacy requirements and so be equally accessible with confidence to everyone. This means understanding and coping with differences in education, diverse physical and mental abilities and special needs, as well as e-literacy, to dispel technophobia and rejection. It means designing for all people, whatever their needs. It implies higher overheads in communications and storage from richer interfaces, often integrating multiple senses to produce a fusion between cultural/psychological demands and technologies. It also, importantly, means the network should be mobile and ubiquitous.

Workshop discussion emphasized the fact that the basic network connection and transport level, the traditional internet definition, is not what the mass of users perceive. They are inclined to bundle what may be strictly defined as an application or user interface, more specifically the World Wide Web, as forming "the real internet" for them. This human

interface environment may become "thicker" and "richer" in a future internet, to be of greater use. A meaningful semantic and identity layer would take this further, with the notions of "Web 3.0". This concept also engages the related question of whether the internet should be a "dumb" network with intelligence at the edge, when telecommunications operators wish to replace today's model as they strive for smarter "intelligent networks" that they can control. This issue is also associated with any move towards a more centrally controlled future internet, as against the dispersed locus of control of the original, as today.

Figure 3.1 Fundamental principles by overlapping domains



3.2. Diverse and Inclusive

"The threat of possible exclusion was deemed unacceptable in the workshops"

The issue that provoked much, if not most, of the debate in the scenario workshops was the threat of possible exclusion for a significant proportion of the EU population, and the effects this might have on dividing European society. Some participants found that the idea of gaps in society being magnified by technology was entirely unacceptable – even though this might be due to reasons of access, digital illiteracy, technophobia, etc. At the same time, forced inclusion was viewed as worse than forced exclusion; there was no black and white, connected or disconnected. Freedom to participate was seen as multi-faceted: the when, the where and the how. Most participants took a dim view of anti-piracy laws leading to disconnection, eg the French Création et Internet three-strikes law.

The need, therefore, to design an internet to ensure everyone participates was more controversial than might first have been expected. It also confirms the undeniable socio-economic and psychological dimension for any design effort.

A related and common theme emerged as to whether users would perceive one internet or multiple internet environments, differentiated by capabilities and the protection of users – whether or not the underlying infrastructure remained globally homogenous. The workshop consensus was that in the future, there will be multiple internet environments, based on user preferences and personalization, rather than the more homogenous environment we have today. The question of whether such differences will be enabled by telecommunications operators, ISPs, app providers, merchants or users is a major challenge to the "constitutional architecture" of the future internet.

3.3. Scalable and Sustainable

"In the future, there will be multiple internet environments, based on user preferences and personalization"

As the majority of future users will be in the developing world, constructing the future internet on a more resource-limited infrastructure is an important challenge. The languages of the internet have already expanded – but the future is an internet whose users are non-English-speaking for the vast majority who expect an internet in their native tongue. The internet must be scalable globally.

The workshop discussed the notion that the internet's current degree of chaos might be a positive factor, for to some extent its faults may become self-healing. Indeed, its "robust-yet-fragile" nature is essential to the functional performance of the system as a whole. Under this kind of thinking it is important to maintain the state of the internet as open, as it gives global access at low cost for those with new ideas with new business models. This makes it a new business creation machine – too useful to discard. But can a balance be struck between controls for safety and entrepreneurial opportunity?

Technology trends and drivers influence internet development. Strong trends may be muted by development forms which are evolutionary, not revolutionary, and possibly by stagnation or "punctuated equilibrium". The new may be expected to be built on top of the original as next-generations progressively displace the old. Workshop participants expect migration to a mobile access network, a semantic web, real-time monitoring for the *internet of things* with guarantees of performance and permutations on the theme of net neutrality. However, against this, are unexpectedly slow developments requiring careful reflection on the possible (eg the long march towards IPv6). This might suggest the need for a clean start, as proposed for example by Stanford University's Clean Slate project.

3.4. Open and Shareable

"The future internet should avoid lock-in to proprietary constraints"

The current internet is a victory of open standards over a sea of proprietary offerings that previously occupied the data communications space (SNA, DNA, AppleTalk as well as limited telecommunications standards with heavyweight protocols aimed at a world of incumbent telecoms operators – X25, X32, X400, etc). This insistence on interoperability is most likely to drive the development of a ubiquitous network. It implies some common pooling of intellectual property rights – a pool of future patents for instance. It also indicates an standards-setting process open to all, not dominated by a privileged set of countries or governments.

"Shareability" should certainly be encouraged – to increase efficiency, lower cost and provide resources and information at any time to anyone, opportunistic networking may be useful. The future may be one in which sharing content between peers, the users, is both more efficient and more effective. But necessary sharing also implies broadcasting, especially of rich media into environments close to users to save on network capacity and encourage content-based societal interactions. In this respect, mechanisms such as embedded caching servers at the edges of the network become attractive. It would be supported by the further development of open interfaces to cloud computing services, especially across multiple service providers. This also requires mechanisms for remote execution of tasks which are efficient and secure, yet use open protocols. Mobile agents may be a major new use of remote execution.

3.5. Green and Affordable

Participants in the workshops thought that future internet technologies will have a range of energy impacts, both positive and negative and spread across a range of equipment and devices. For example, making telepresence and related mechanisms easy to use and trusted will make it possible for businesses to reduce corporate travel – although historically, they have often led to the opposite outcome.

The future internet architecture will control two key parameters in terms of energy use – how much energy goes into the lifecycle of equipment, and in its operation. Both of these

depend on the detail of hardware implementation. However hardware design is predicated on the software footprint in terms of MIPS, storage and active memory (RAM) demands. There is also the question of basic design of protocols and their operation, eg constant polling uses energy and generates heat. Thus all elements from packet switches/routers to operating systems and software applications need to be "eco-designed" with emissions, heat, toxics, recycling and energy-in-use considerations. For instance, the quiescent power consumption on standby can be of the order of 10% of all energy consumed – can this be cut?

Moreover, the cost of the network is a major parameter in its take-up and in its network and application support by various commercial and other (open source) players. There is also the thesis that there is not enough value in current business models to support its universal spread.

The cost of internet technologies will have a more significant impact in future. Developing nations will be the largest users and their concerns will become the basis for its engineering. These include a) low cost, b) low-energy, c) ease of access by billions d) thinly-spread infrastructure, e) lower educational resources and f) energy and environmental management using smart grids and metering, etc,

3.6. Reliable and Resilient

"Careful design around security and privacy together with resilience is required"

Societies in the developed and developing world will become increasingly dependent on the future internet's availability. Care needs to go into design for crisis management, failover operation, with autonomic features of self-healing, via failure prediction, prevention and automatic recovery at all levels, plus detection and protection from all forms of attack. These risks may vary from physical destruction of concentrating hubs, to server and infrastructure malware attack, to insider attacks on critical information infrastructures. This is concerned primarily with the technological aspect. The societal aspects are (and will increasingly become) important, too. Such mechanisms may be drawn from analogues with biological systems and imply consciousness of status, with self-awareness of resources available, and their performance, capacity and comprehension of context, such as load demands. Principles of co-operating automatons, rather than a single system, may be relevant.

Careful design around security and privacy together with resilience is required. In this case, the potential failures in the case of attack or accidental damage have to be carefully provided for. Ever-higher resilience will be needed as the internet becomes an ever-more critical infrastructure, on both a technical and socio-economic level.

3.7. Safe and Secure

The global reach of the internet has meant that malevolent uses of the network are becoming more and more widespread. The future internet must be made safe and secure for users and organizations, by protecting them from malware and unsolicited communications. Children were identified in the workshops as a particularly vulnerable group and special measures are required to protect them from harm. Defining what is harmful or objectionable content is not easy, and tracking their sources is a colossal and continuous task. Preventing access to such content using blocking tools has led to fears of censorship.

Workshop participants pointed out that defining boundaries of acceptable behaviour and enforcing standards of morality are something that societies have always grappled with. Nevertheless, some aspects of cybercrime are an entirely new and rapidly growing area of criminal activity, encompassing identity theft, disseminating harmful or malicious content such as viruses, spam and malware, and cyber stalking and online bullying.

Generally speaking, the internet is a critical infrastructure requiring protection at all levels: not only from accidental shut downs but also from malicious attack, both nationally and globally. Ensuring the internet is safe and secure first means that users

must be able to protect themselves as far as possible by being educated about the dangers. It also requires evolution of liability and regulatory regimes placing responsibilities on network and service providers to ensure safety and security.

3.8. Trustworthy and Private

"A balance must be struck between a safe society and a surveillance society"

Personal identity and identification (for personal and national security) were raised consistently in the workshops. The option of an internet identity layer was considered, with users actively owning and protecting their data and identities and their (re)use. In other words, users should have control of what is released, and information transmission should be minimized at the point of collection. Only then can full or partial anonymity be achieved, for purposes of personal security (eg child online protection) and privacy safeguards.

Identity protection (or rather too much anonymity) could be a double-edged sword, as it might protect perpetrators of harm as well as the law-abiding citizen. Technology must aim to identify and distinguish innocent and malevolent actions. A balance must be struck between over-regulation and under-regulation – a safe society and a surveillance society.

A related dimension is visibility – that is the balance between ubiquity and security, pervasiveness and privacy, centralization and surveillance. Visibility could be seen in terms of two main "faces" of the internet:

- Visible internet applications, obvious to users, requiring input or observability
- Invisible internet applications, operating without active user input or observation.

Difficulties arise when dealing with the second "face", ie which aspects should be invisible, and how? This concept invokes the multiplicity of the future internet and how it will be manifested. Major sources of multiplicity include: privacy domains – an internet analogue of public and private space; identities; levels of user trust (eg high security retail vs. no-control segments); national or regional internets; and so on.

"A future internet should have a more holistic, participative and transparent governance structure"

This principle also implies protecting an individual's freedom of expression, action and association from government, ie the individual's rights to both security and privacy, with protection of identity and personal transactions (financial, health, etc). This is crucial to engender user trust. It requires a balance of rights – between the citizen/consumer and content providers, ISPs and network operators, as well as the government and its regulators. It also implies an ongoing respect for human rights – avoiding the internet's potential for centralization of control and surveillance.

Discussions of trust, identity, ubiquity, inclusion and openness led to the overarching theme of governance and how governments can shape technology. Satisfactory governance is not yet with us and current internet administration has limited transparency. A future internet should have a more holistic, participative and transparent governance structure.

3.9. Appealing and Usable

As noted in the workshops, the "internet" today is more than a just an end-to-end transport connection. For future social and economic development, we will need to reconsider what has traditionally been the boundary of the "internet". This means that what we refer to as the internet from a technical perspective will catch up with what the population at large perceives it to be, including the World Wide Web interface, search engines, applications and so on – in other words, the totality of the *internet experience*. Consumer demand can only be guaranteed if applications and hardware are made attractive and user-friendly. There should therefore be a strong emphasis on the performance and overall usability of technologies and services.

In this context, a further major influence on future internet design is the human interface. It is the controlling and fundamental variable that dictates internet take-up. The discipline

of human interface design will impact all aspects of future internet engineering, from the scale of take-up to the types of traffic, to forms of naming and addressing that users will require. It considers the user's context, as social and psychological factors, with a richer media composition. Note that the interface does not necessarily reside in the end-user device and can be a remote application.

3.10. Customizable and Adaptable

Workshop participants were clear that the internet should be adaptable to all user types. This means designing for machines as well as for people – the connections of billions of sensors and actuators over the internet is certain to arrive if reliable, secure working can be achieved. It implies high volumes of bursty communications, as well as some data streaming for remote processing, eg for some form of pattern recognition.

"The internet should be adaptable to all user types – machines as well as people"

The need to design an internet that would enable all to participate was more controversial than might first have been expected. This also confirms the undeniable socio-economic and psychological dimension for any design effort. The general conclusion was that the internet should be open to participation by all in a technically and socially neutral manner, with no barriers stemming from digital literacy. Overall this implies that the internet interfaces of the future should be conceived on sociable design concepts. This means the engineering of more sophisticated user interfaces (ie the internet was originally accessed via command line interfaces, but today users may want to use a sensory interface with speech recognition and in the future this is likely to be further developed).

In conclusion, each of the ten paired principles discussed above encompasses a combination of social, technological, psychological and economic concerns. Referring back to Figure 3.1, the analysis indicates that the three design principles which can be said to most address all four classes of concern are:

1. Available/Accessible,
2. Open/Shareable, and
3. Safe/Secure.

This has important implications for the mapping of the core principles to specific technical requirements, discussed in Chapter 4.

Chapter 4. Drilling down: from principles to functional specifications

"It's no surprise that 'always keep the user in mind' lies at the core"

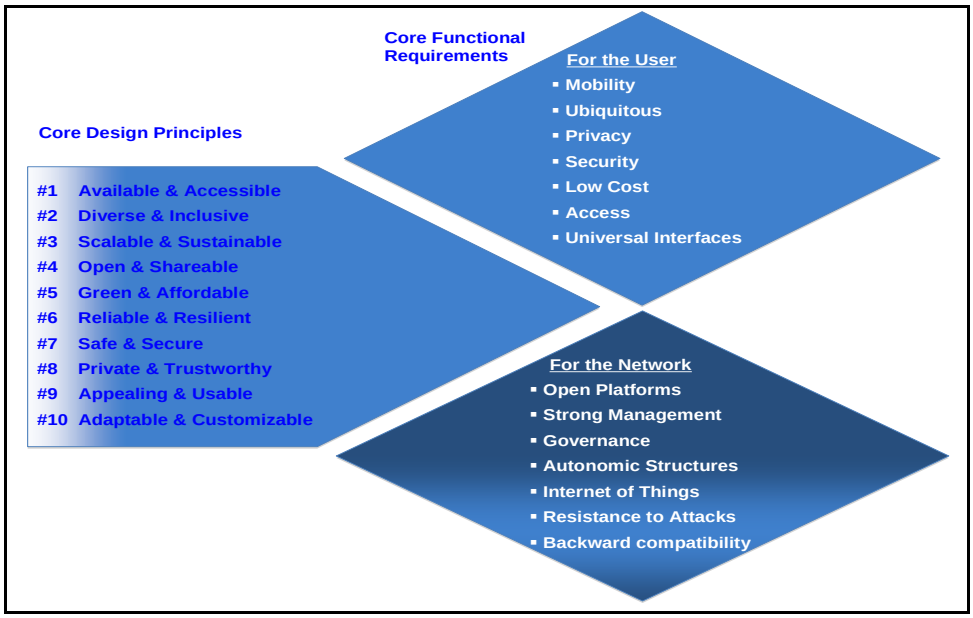
4.1. Taking design principles a step further

Design principles are high-level statements intended to guide design decisions and direct rational design outcomes. Principles ensure the consistency with and the integrity of the requirements. Inasmuch as the design principles have been distilled from an analysis of users' motivations, needs, demands and requirements for a future internet, it's no surprise that *"always keep the user in mind"* lies at the core of each one. Underlying these requirements are services, applications, content and network behaviours which shape the design requirements for a future internet. In this chapter we examine the different levels of requirements against the core design principles described in Chapter 3.

4.2. Mapping overarching principles to functionality

The juxtaposition of the design principles on the left of Figure 4.1 to a preliminary set of core functional requirements illustrates how they can be applied to underpin the design and development of a future network.

Figure 4.1 Core design principles and functional requirements



Two points in particular stand out from these preliminary core requirements. First, they indicate that a future internet is likely to require a wider remit than just for networks and will include domains previously belonging to application areas. Second, the future network will be characterized by users' requirements, which should define and specify the network, so it will be designed to meet those requirements.

4.2.1. Requirements at the network level

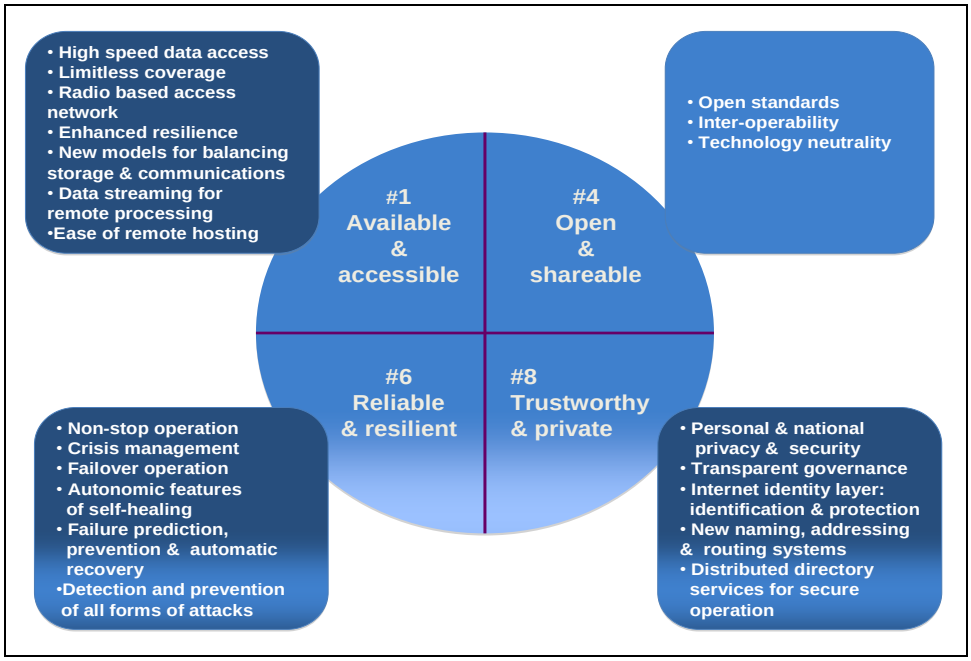
Until fairly recently, for the human being connected to the network, internet needs were relatively straightforward. The network simply needed to work reliably and at reasonable speed – always. On the hierarchy of users' needs this represents the first layer of "basic network survival".

"We need to reconsider what sits at the network layer and what is best at the application layer"

The nature of both the internet and users has undergone a dramatic shift. No longer does an end-to-end transport connection just support file transfer and email since users' demands are constantly expanding. Today the key infrastructure layer consists of network, applications and content with application level interfaces and standards. The infrastructure of the future internet will still consist of a layered architecture but it will need to focus more on issues at upper application layers.

Whereas the requirements at the network layer shape the design of the future internet, the design principles provide important boundaries within which requirements and ambiguities can be contained and guided. The network level requirements map on to six of the ten design principles. There are two layers of requirements – one directly relating to the future needs and demands of the human being connected to the internet and the other as a direct response to future political-economic and global needs and demands. These are illustrated below in Figures 4.2 and 4.3.

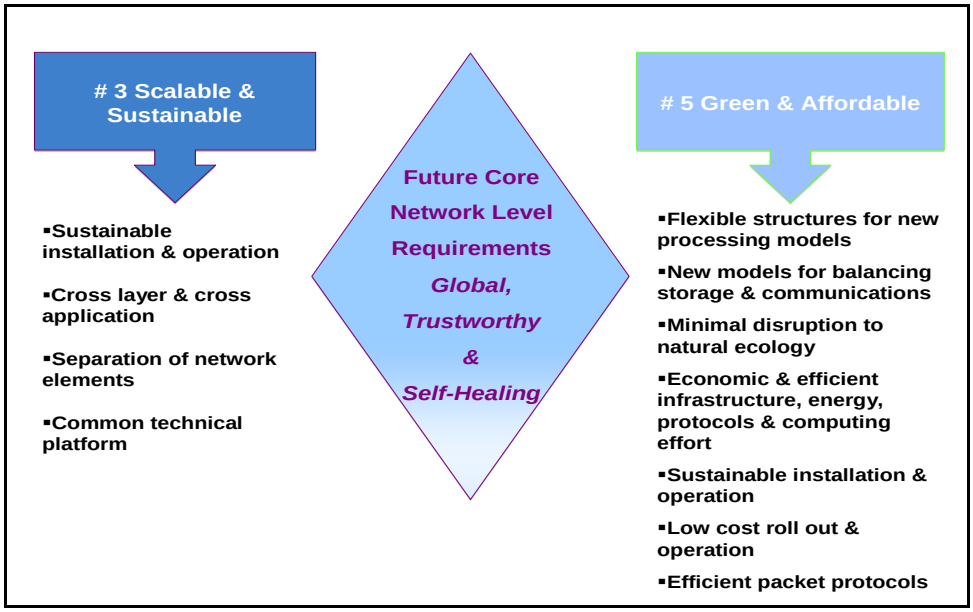
Figure 4.2 Future network requirements arising from users' needs



"Three ingredients shape requirements: users' motivations, needs and demands"

Thus one of the most significant transformations in the state of the internet will be the blurring of the lines of demarcation. Consequently future internet research will require a much wider remit than just for networks. It will need to encompass domains previously seen as purely application areas, for example, like information access, processing and human interfaces. However in going beyond what has traditionally been the boundary of the internet, ambiguities arise concerning what belongs where. What sits at the network layer and what is best at the application layer? This blurring is illustrated in the kinds of network requirements that have emerged from the study, for example, those relating to personal privacy and security. As the boundary of the internet has pushed it into new domains, so network level requirements go far beyond the scope of the original network. At a network level, future core network requirements relate to certain principles. A good example is the requirements relating to the principles "scalable and sustainable" and also "green and affordable", as shown in Figure 4.3.

Figure 4.3Changing times shape future network level requirements



Greater "application-awareness" has also been identified as an important requirement. These are entirely new domains that future internet design must carefully take into account the network if it is to be truly ubiquitous and universal.

4.2.2. Specifications at the application/content layer

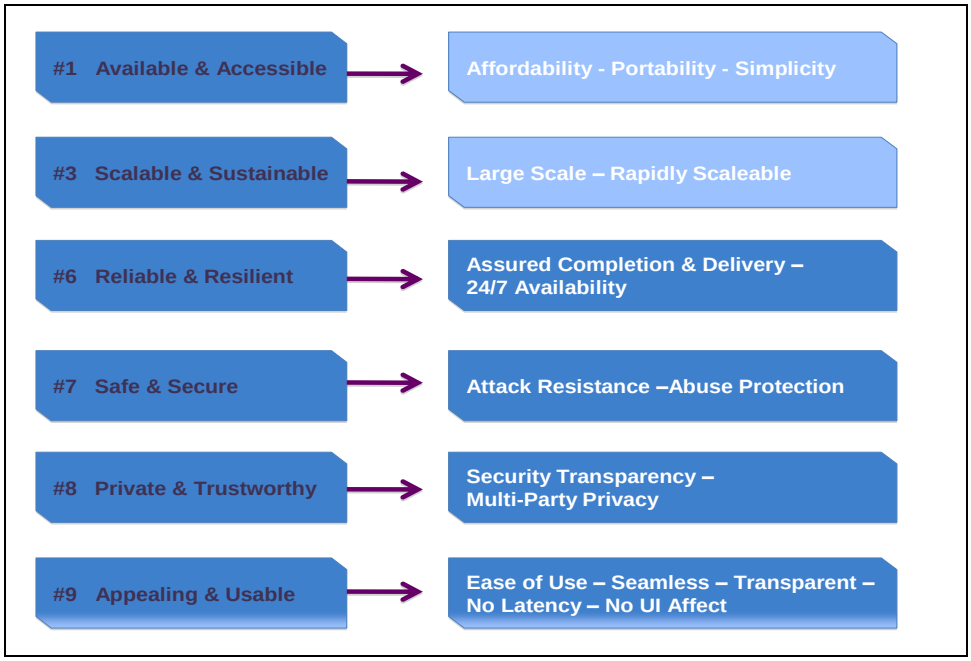
The identification of the functional requirements for applications, services and content is a fundamental step towards defining the overall architecture of the future internet. The analysis of the different strands of needs – user-centred and socio-cultural – form the basis for identifying the functional requirements of users at the application layer. Three primary ingredients go into shaping these requirements: users' motivations, needs and demands. These functional requirements are categorized around the kind of services in the application layer that users will demand and the kind of content required to fulfil needs and that motivate use (see Table 4.1).

Table 4.1 Application layer requirements

SERVICES	CONTENT
Ability for future socializing applications to be shaped collectively	Internet business services, e-commerce
Ease of remote hosting & launch of applications. Agenda functions, multiple task control for dialogues & transactions	Personalized services; alerts, news, reminders, diaries, events, management time, unexpected events & reaction
Cross layer & application working: state management, multicast, resource management, identity & personal data management	Agents & proxy services
Creative freedom in applications; user-defined structures; user control of services & information.	Educational, creative, design applications
Transactional capability – all user groups	Distance learning with mobile education & training
Participation services: political, social, cultural, government	Entertainment & leisure –TV, sport, games, music, gambling, quizzes, etc
Security, health monitoring, emergency – Location enabled applications	Security & privacy data, physical environment data
Security authentication services	Personalized environments
Real-time control of "smart" industries	Social networking, dating services
Monitoring, scanning, sensing, carbon accounting	Location identification: personal, local.
Internet of things	Visualization & virtual presence

There is a spectrum of attributes associated with these application layer requirements. Attributes are important to register because they play a central part in shaping the design requirements for a future internet. There is a direct correlation between these attributes and the design principles (see Figure 4.4).

Figure 4.4 Correlation between design principles and attributes



Flexibility will be needed for a new breed of user with new demands when considering these application layer requirements. As yet unknown services and content will appear and they will be shaped and constrained by the underlying infrastructure. We should always anticipate that the infrastructure itself may be superseded in unpredictable ways. To a large extent, the future is with the mass consumer, the "must have" user, whose behaviour is predicated on "can do", "can have", and "why not?"

4.3. Key to the internet's design – human interface requirements

"Consequently future internet design is a multi-disciplinary science"

Why is the human interface a separate and relevant subject for consideration in the design of a future internet? Fundamentally, because it alone determines the level, form, and quality of net-interactions people can and will have in the internet world. We have separated it out because it is a core variable that will dictate internet take-up and its usage. All facets of internet engineering are impacted by the discipline of human interface design – from the scale of take-up to the types of traffic, to the forms of naming and addressing users will require. Consequently future internet design is a multidisciplinary science.

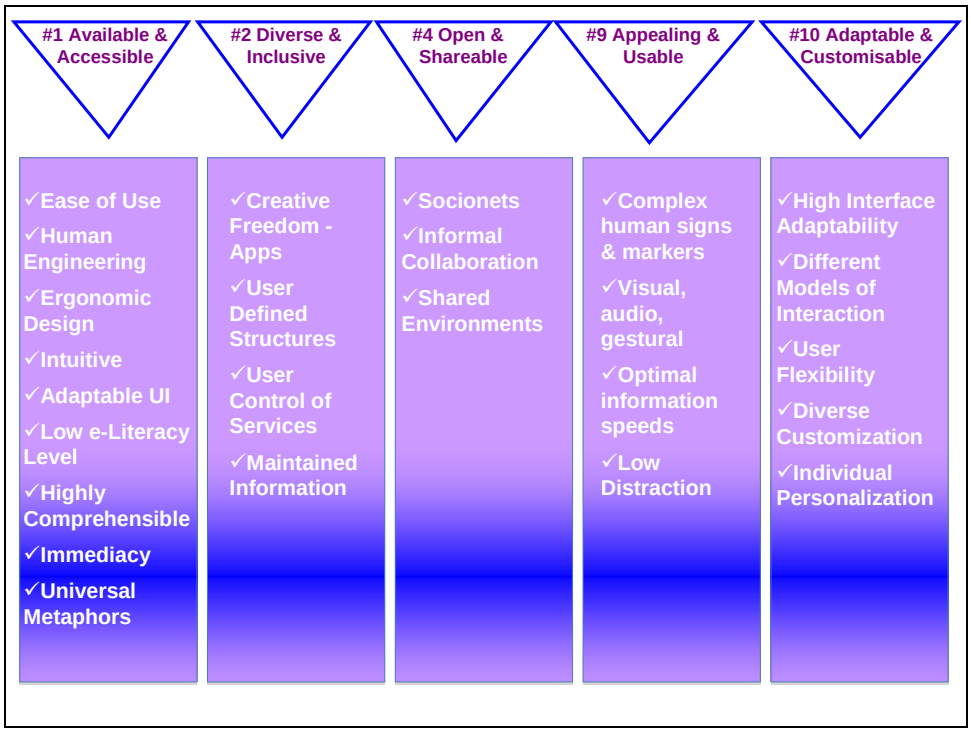
A future view of the internet goes well beyond today's email, blogs and social network sites. We can expect the way in which humans interact with computers and networks to be very different from what we know and experience today. Design of a future internet will need to take into account new interaction possibilities like proxies and agents based on artificial intelligence and cognitive adaptive capabilities and the *internet of things*.

We can expect to see innovative leaps in human computer interaction design as we move beyond the traditional concepts of how humans interact with computers. When the wider contextual dimensions that make up the user's world are extended to the social, psychological and the economic-political, the factors that determine a user's environment can be understood. In this conceptual approach, interface requirements can be broadened to include users' experiences within particular environments. The concept of the user

"experience" *in their environment* becomes the key to interface and interaction design. This will be essential in the future, as users flip between new environments in a manner similar to TV channel surfing.

Two significant themes emerge from the analysis of the human interface requirements for a future internet. One is rooted in the role that developing countries will play as their dominance of internet usage will have a direct impact on the design and engineering of the future internet. At a more general level this theme may be seen as the need for digital inclusion – both nationally and globally – to encompass everyone. The second theme is the user push for increasingly sophisticated interface environments, which reflect the user's desires. Rather as early cars were difficult to drive, widespread take-up reshaped their user interfaces to meet popular demand for ease of use of far more capable machines by hiding the complexity

Figure 4.5 Mapping design principles to human interface requirements



Chapter 5. Policy and research to humanize the internet

Drawing together all of the findings and analysis and thinking about the contribution of the study in guiding the future internet, this concluding chapter considers three main questions.

- What are the implications for policy and regulation?
- How can socio-economic dimensions be better integrated into ICT research?
- What should be the focus of new research initiatives related to the future internet?

Since they are closely related, the latter two questions are taken together in Section 5.2.

5.1. Policy and regulatory requirements

"A strong clear policy for planning and creating a future internet is needed"

Many experts and stakeholders consulted in this study expressed a need for policy leadership to positively influence the development and impacts of the future internet, not least because the current financial crisis has highlighted the need for effective regulatory governance of many globally networked socioeconomic systems.

As society's dependence on the internet increases, a legal framework for internet regulation becomes increasingly necessary. Where practical and enforceable in an internet context, existing practices, regulation and laws, should be used. This implies discovering arbitration processes that are rapid, low-cost and effective. Internet governance processes in which ordinary users could participate are needed.

Recognition of this need has found political support in recent European-level initiatives, ranging from the Economic Recovery Plan to the Europe 2020 strategy and the Digital Agenda. Consequently, there is a need for stronger linkage across policy instruments (eg research and deployment support, standardization, procurement and regulation), regions and sectors, government locations and levels; and stakeholder domains (administration, business and civil society).

Regulation is often confused with, yet entwined with, governance. As used here, regulation is that part of governance involving rules issued and enforced by state authority. The future governance of the internet will be much influenced by how well governance institutions arise. In time, the current bodies may give way to specialized internet regulators. Migration of activity from traditional domains (of child safety, criminal fraud, commerce, broadcast, content distribution, personal data exchange, etc) to the internet may change regulation in those areas.

"Regulation has evolved as a confusing mix of local laws, rules and guidelines"

Internet governance is already evolving in response to competitive and cooperative interactions. It has been the object of partial regulation from without – inherited rules applying to separate activities converging on the internet such as: content (broadcast); telecommunications; (e-commerce; privacy and security, etc) – and within – self- and co-regulation and existing "internet governance". However, it is partial and contradictory. It

"Almost every area of public and social policy is in some respects part of internet policy"

needs a more comprehensive, coherent, transparent and accountable approach. Moreover there may be a sea change in the problem area, eg globalization of e-commerce can reduce the *need* for competition rules, by enhancing competition, but also could make the practice of antitrust regulation harder. Infrastructure regulatory principles choose between utility regulation and facilities-based competition. The utility approach offers controls in exchange for specific protection (eg entry regulation, investment and standardization support). The market-led approach adapts general competition rules to harness competitive discipline to promote efficiency, affordability, quality and innovation – key when the authorities cannot fully predict the evolution of technology or its markets.

However, these inherited regulatory frameworks do not always work well, especially for a truly global structure – and especially those from telecommunications. Dominant incumbents with bottleneck power and legacy relations with "their" regulators may seek to influence regulations and regulators in order to conserve market power. As the second Brussels workshop discussed – a critical problem for the EU would arise if the group of major telecommunications operators took control of the internet infrastructure, ie the networks, and increasingly the services that run over it. Also we may see new dominators from the software and computing industry enter these markets. Largely left out of the rise of the current internet industry, they may see this as a second chance to gain a controlling market position. Moreover, the internet acts through network effects as a lens to concentrate market power for the leading player. The current internet titans gain their power through being intermediaries in aggregation, eg as the major search engines and portals. There thus is scope for monopolistic behaviour with abuse of competition law.

"Just as in any other 'market', the internet is open to abuse of dominant market power"

This chorus of differing views and conflicting interests might lead to calls for a "world governance" approach. But this was not the consensus view among the experts consulted. There is no single internet jurisdiction, no common legal foundation for regulatory powers, no agreed basis for regulation and no structure for enforcement. Note however, that there is a quite different and contrarian view of governance, which asks why "convergence" of different regulatory approaches need be logically coherent? A "self-organizing criticality" might emerge, from the self-regulating character of the internet itself. It comes down to the fundamental policy questions being:

- should cyberspace be treated as a separate "governance space" with different laws, aims and enforcement?; or
- should existing regulation be employed when appropriate as a baseline – but then reconstruct the internet governance regime from the ground up, eg as a WTO-like consent mechanism?

Overall, internet governance should consist of a range of technical, economic, legal and societal *rules* and *instruments*, set in a clear framework. The framework should encompass the transfer of useful inherited principles from other sectors into the internet domain. And the priorities among regulatory domains may need to be respected. For instance, security and law enforcement generally take priority over economic regulation.

"Net neutrality is about practical compromise, while not yielding to market dominators"

Perhaps the most sharply divisive regulatory issue is net neutrality. It has crept into almost every aspect of internet regulation and internet governance. It was originally viewed as a specific problem arising in the context of a US market where competition among channels was limited, giving platform providers the power to control communications between content owners and end users. Although originally a dispute between content owners and vertically integrated and oligopolistic service providers, it was cast as a matter of principle, ie discrimination of any form was damaging to the public interest. However, bandwidth is not infinite. This politicized version of the debate might be better focused on the underlying *objectives* of freedom of expression, freedom of commerce, IP ownership, quality of service, and so on.

All of the above suggest four key principles for reworking regulation for the internet: smart regulation; openness including transparency; innovation-friendliness; and suitable leadership.

Smart regulation is a matter of approach in which governance is concerned with finding optimal strategies for regulation processes. Governance problems arise when regulators have less knowledge than the stakeholders and thus cannot regulate effectively. In some cases, the smartest regulation may be self- or co-regulation, or even deregulation (see Table 5.1).

Table 5.1 Types of potential internet regulation

TYPE OF REGULATION	DESCRIPTION	
No regulation	No explicit controls on an organization	
Self-regulation also, broad categories of *embedded* self regulation can be discerned as *sub categories* of regulation:	Regulations are specified, administered and enforced by the regulated organization(s). However, the role of the state in such regulation e is seen to be the most important factor.	
Self – regulation 1	Co-operative	Co-operation between regulator and regulated on the operation of statutory regulation
Self – regulation 2	Delegated	Delegation of the implementation of statutory duties by a public authority to self regulatory bodies
Self – regulation 3	Devolved	Devolution of statutory powers to self-regulatory bodies, often thought of as "statutory self-regulation", ie the specification of self-regulatory schemes in statute
Self – regulation 4	Facilitated	Self-regulation explicitly supported by the state in some way but where the scheme itself is not backed by statute
Self – regulation 5	Tacit	Close to "pure" self-regulation – self-regulation with little explicit state support, but its implicit role can be influential
Co-regulation	Regulations are specified, administered and enforced by a combination of the state and the regulated organization(s)	
Statuary regulation	Regulations are specified, administered and enforced by the state	

Source: Bartle and Vass, 2005.

Openness covers the tensions between commercial and public objectives and conflicting interests within these domains. As the Tokyo workshop discussed, openness includes transparency, and that means not just all countries, but also that users should have a say in governance. Internet governance and management will have to develop to be more transparent with clear liability and management responsibilities.

Innovation-friendliness is an essential characteristic of the future internet, as highlighted by the Aho Report, so regulation needs to be support this. In the globalized world, continuing innovation is necessary for the economic survival of those parts of the world – like Europe – whose only unique (and renewable) resource is intellectual and social capital.

Leadership and planning are necessary. Policy makers usually wish to lightly influence internet development rather than attempt to micro-manage it, which requires flexibility to identify and continuously monitor the basis for regulation. Rapid reaction is the key to effectiveness.

The global context is also the basis of an internet rooted in common values. Generally the experts consulted supported a regulatory system based on attractive policy principles and values, endorsed throughout the EU and other developed nations. But values such as freedom of expression are not universally supported nor receive the same priority. This requires strategic engagement at a global level in negotiations over internet architectures and governance.

In summary, national and regional regulatory bodies need to keep pace with the rapid rate of change in internet industries, but emphasize flexibility and foresight. Improved understanding of how the internet works does not necessarily mean that the regulators will take on more powers or directly regulate more entities and types of conduct. As mutual knowledge advances, the internet may become effectively more self-governing.

5.2. Research focus for future internet and ICT research

Turning to the question of future research, our needs analysis suggests that a key thrust for a future internet should be centred on human culture and social interactions, with understanding of psychological factors and economic dimensions. Moving towards an internet at the meeting point of human-centred aspects and technological complexities is the challenge. Our approach views the internet as a societal artefact, a form of a very large socio-technical structure, whose design has to be human-oriented, holistic and user-centric. Research should focus on the internet as a large social machine.

"Future research must conceptualise the internet as the global social machine"

In all the workshops, especially the final one in Brussels, the theme that research in the EU on the internet must be far more multidisciplinary was made clear. A specific way forward is required because each discipline brings a different form of conceptualization – and an approach to it – for similar problems. Defining the nature of the problem depends on the perspective and observing position, so problems require "multidisciplinary framing".

Future research has to strike a balance between pragmatic choices that will achieve notable rapid advances and getting caught up in highly detailed wide-ranging research without concrete outcomes. The Cambridge, MA workshop in particular produced a wealth of recommendations on future research directions:

- In order to come up with more independent research, an institutional buffer is required. This implies a need for public/government research, or some other mechanism that is focused on the public good. Thus the framework for such research should be based on institutions that explicitly work for wider public goods.
- Such research should be rather like an open-source project. Once something has been developed it can be published, deployed and experimented with and can be continually improved on in a public space.
- The above approach requires the development of test beds that simulate the real problems for users and supports evaluation and improvements, and moves incrementally towards novel solutions in a "create–test–redesign" repeated development cycle.

Discussions in the workshops also suggest a research programme should:

- Not have too many directions at the same time – instead develop one direction at a time with other initiatives supporting it.
- Make incremental changes as opposed to a "clean slate" approach of starting from scratch.
- Not duplicate work that industry is doing – a common problem in shared "pre-competitive" research.

Introducing social and psychological factors as a prime research theme has profound structural design implications for a future internet. Thus consideration, from the viewpoint of the socio/psychological/economic needs analysis, highlights several preliminary directions for future research areas:

- More research should be done on usability for the mass-user base. This involves investigation of better models of how users employ and interact with systems. This should also involve modelling to better understand how users conceive systems

(perhaps their own, eg in a "mash-ups" sense) and how they interact with them. It also points to more detailed initial tasks:

  - Detailed needs analysis for each type of user, with motivations and requirements, using sociological and user psychology techniques.
  - Abstract simulation models of an internet based not on technology constraints but on social and legal structures and psychological mechanisms and constraints, following needs analysis.
  - Understanding what may be optimal in human interfaces, for the wide variations in digital literacy.
  - Building in new levels of trust and security.

- As the above implies and as outlined in the needs analysis, the research emphasis should "move up" the protocol stack to higher layers, which involve user interactions and environments and concentrate less on networking engineering. This implies much deeper functional specification from the detailed needs analysis.
- As already indicated, the focus must be on multidisciplinary research. To manage that within specific projects, one discipline might take the lead role and other disciplines have supporting roles, for instance, a cognitive psychological approach could be the main focus, while other disciplines such as sociology and the various technical disciplines are tailored to the project's main goals.

Note the above approach, of empowering ordinary users in new development models to inspire innovation, implies that there should be no fear of failure. Advanced research always implies high risk. Apparent failures may be excellent learning models, perhaps of what not to do. At a more detailed level, research programmes might focus on:

- Building architectures that maintain flexibility to move across the scenarios as the conditions dictate.
- Creating interfaces for inclusion that ameliorate the digital divide, eg for older people, or for young learners or individuals with special needs, as well as for the mass of people to maximize digital participation.
- Research into the "mechanics" of information: ways to think about and organize information for its privacy, security, reputation, etc.

There are also some wider domains of research, in legal areas and economic policy, in terms of a governance framework:

- Governance structures for the future, especially for user participation and global transparency and participation.
- What standards should govern in a future internet environment? There are different types and practices of standardization: with ISO-styled standardization, the process may be heavy-handed; or IETF types – global and motivated by desire to keep the internet running effectively, a place where some consensus will be found, and based between ISO and IEEE; or IEEE types of standards – in some ways the opposite of ISO in process and being purely technical; finally we have various Web consortia (eg OASIS) becoming even more important since they are high level, including the various open source standards for interfaces and whole applications, which may or may not be normalized.
- Intellectual property rights – exploring what IPR should mean in a future internet, especially important for the media industries facing a new consumer environment
- Developing traffic management standards and initiatives to analyse the network neutrality problem. At a governance level, the EU may set a foundation in standards for basic levels of service and transparency in network neutrality.

A multidisciplinary Internet Science, in support of the EU's Digital Agenda, must research at a technical level with full consideration of social interaction, psychological drivers and economic factors. Table 5.2 suggests some potentially useful areas of research implied by the study's analysis.

Table 5.2 The focus for future research

The human interface emerges as a key research area, but there are many other opportunities for future research to shape the next internet. Key areas to be explored include:

The sociology and psychology of the internet user:

1. Social interactions in electronic groups
2. Psychology of perception in internet interactions
3. The interface structure
4. Interfaces optimized for various social surroundings (workplace, home, driving, etc)
5. Identity, security and privacy
6. Cultural, age, gender and class difference in online requirements

Re-engineering the internet using social and psychological factors:

7. Locus of control and intelligence in large intelligent networking structures for reliability and security with privacy
8. Relations between data, information, knowledge, semantics and wisdom for interfaces
9. Cultural symbols in interfaces
10. Media for new user interfaces
11. Novel e-commerce environments (eg in the sense of micro-multinationals)

Combining novel internet design with socio-economic drivers

12. New internet technology (as in Clean Slate project and higher levels eg semantic web)
13. Wearable and invisible computing
14. World scale reliable applications, eg geography and mapping, labelling (including RFID) and logistics, semantic directories
15. Functional requirements for the *internet of things*
16. Massive data intensive compute structures using grids and virtualization
17. Chaos and complexity models for large networked systems' operations/performance

Future applications to test and drive development

18. Specific planetary-scale internet applications, eg real time environmental monitoring and control
19. Large scale demonstrator applications – healthcare, education, e-democracy
20. Future social networking structures with high user protection
21. Large trading, retail and financial platforms and payments systems

Technology to support new modes of internet use

22. Efficient storage, retrieval, transmission of very large digital multimedia objects and streams with semantic methods
23. Broadband radio systems for access networks
24. Infrastructure-less mesh radio networks for broadband diversity and resilience
25. Cloud computing functional and technical requirements.

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Appendix A. Methodology and context

Study details

The study was carried out between February 2009 and November 2010 for the European Commission, DG Information Society and Media, Directorate F: Emerging Technologies and Infrastructures. Tender Specifications are available here.

Context and objectives

The internet has changed out of all recognition from its original conception in the 1970s as a network for exchanging scientific data. In a few decades it has become fundamental to social and economic activity throughout the world. The extraordinary development, with enormous take up in applications such as email, information search, commercial transaction, social networking, and video entertainment, has taken internet use into directions that were not initially anticipated. The resulting policy challenges in domains such as security, privacy, intellectual property rights, mobility, social inclusion, etc in turn are placing increasing technological demands on the internet's underlying network architecture.

The response to these challenges so far has been typically ad hoc, perhaps providing temporary patching pending more fundamental "clean-slate" solutions, eg GENI, FIRE. An alternative view is that the current internet is fully scaleable, some even suggesting that efforts to impose a new architecture pose the biggest threat to long term stability and growth, eg see Mueller.

Clearly any radical technological changes in internet architecture could have unexpected consequences at the economic and social level, and even possibly carry some ethical concerns. Therefore it is crucial that the future internet build in social and economic dimensions as fundamental aspects. This was the main motivation for this study.

The overall objective of the study, therefore, was to investigate the deep interrelations existing between technological, social and economic trends related to the future internet. This was done, first, by analysing how the current internet evolved to its current state, its main drivers and effects, and then by discussing the possible technological options for its further development and their likely socio-economic impact.

The study team

The study was managed by Ian Brown (Oxford Internet Institute) with a core study team comprising Simon Forge (SCF Associates Ltd), Colin Blackman (Camford Associates and Editor, *info*), Karmen Guevara (independent consultant on human science), Lara Srivastava (University of Aalborg/International Telecommunication Union), Motohiro Tsuchiya (Keio University), Jonathan Cave (Warwick University), and Malte Ziewitz (OII). The study was also supported by a panel of experts who participated in workshops and commented on the study's deliverables: Rudolf van den Berg, (Logica, the Netherlands), Professor Erik Bohlin (Chalmers University of Technology, Sweden), Professor Jon Crowcroft (University of Cambridge, UK), William Drake (Graduate Institute, Geneva, Switzerland), Professor Ian Miles (University of Manchester, UK), Christopher Marsden (University of Essex, UK), Professor Jun Murai (Keio University, Japan), and Xavier Dalloz (XDC, Paris, France).

Methodological approach

The study comprised three work packages:

- Work package 1 – WP-1: Internet history and evolution
- Work package 2 – WP-2: Building future internet scenarios
- Work package 3 – WP-3: Analysis and recommendations

Figure A.1 below gives an overview of the main actions in each work package, the methodology for which is described below.

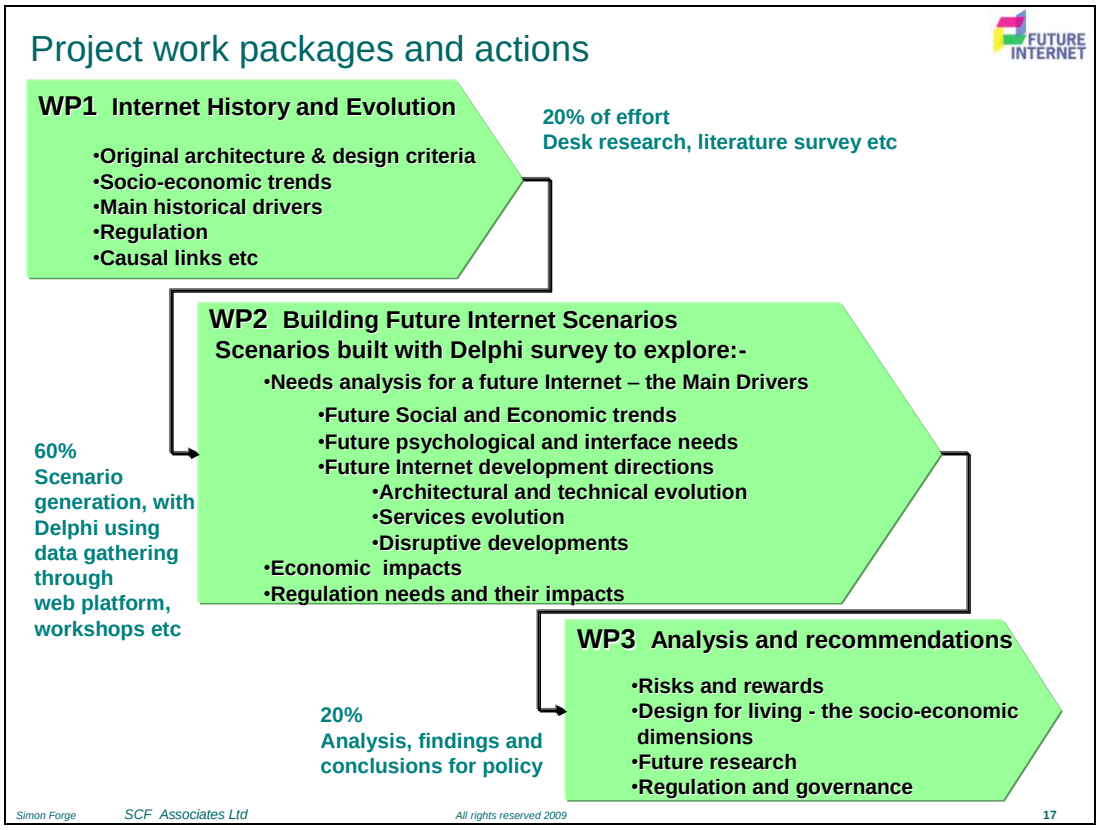


Figure A.1 Outline methodology used across the study

Work Package 1: Internet history and evolution

The underlying objective of the work package was to establish a sound basis for the rest of the project by first elaborating an inception report to specify in more detail how the overall study would be conducted. This included drawing up the schedule of workshops that formed a key part of the study's consultation process as well as research to compile a database of individual experts and organizations to be consulted in the course of the study.

The work package also included the important step of setting up a Web Platform for the study. The purpose of the Web Platform was twofold: first to provide an easy way to promote the study and its findings; and, second, to provide a facility for interaction with experts enabling feedback on the study's work as it progressed.

The main substance of this work package was a detailed examination of internet history and its evolution, mainly through desk research. The focus was on technological, social and economic aspects and their interplay. This resulted in a comprehensive State of the Art report, available on the study's website.

Work Package 2: Building future internet scenarios

This work package lay at the heart of the study in that its main objective was to consider possible future evolution of the internet. The study methodology acknowledged that there has been much deliberation about the issues surrounding the internet and there are diverse views on how it could or should develop, both from a technical and socio-economic perspective. In order to achieve some kind of consensus on the way forward, the study used several tried and tested foresight techniques including environmental

scanning, scenario building, scenario workshops and a Delphi survey. Used intelligently, these can be powerful tools enabling issues and concerns to be encapsulated, providing a mechanism to enable debate and, ideally, bringing various stakeholders together in pursuit of a common goal. The key activities in the work package are shown in Figure A.2.

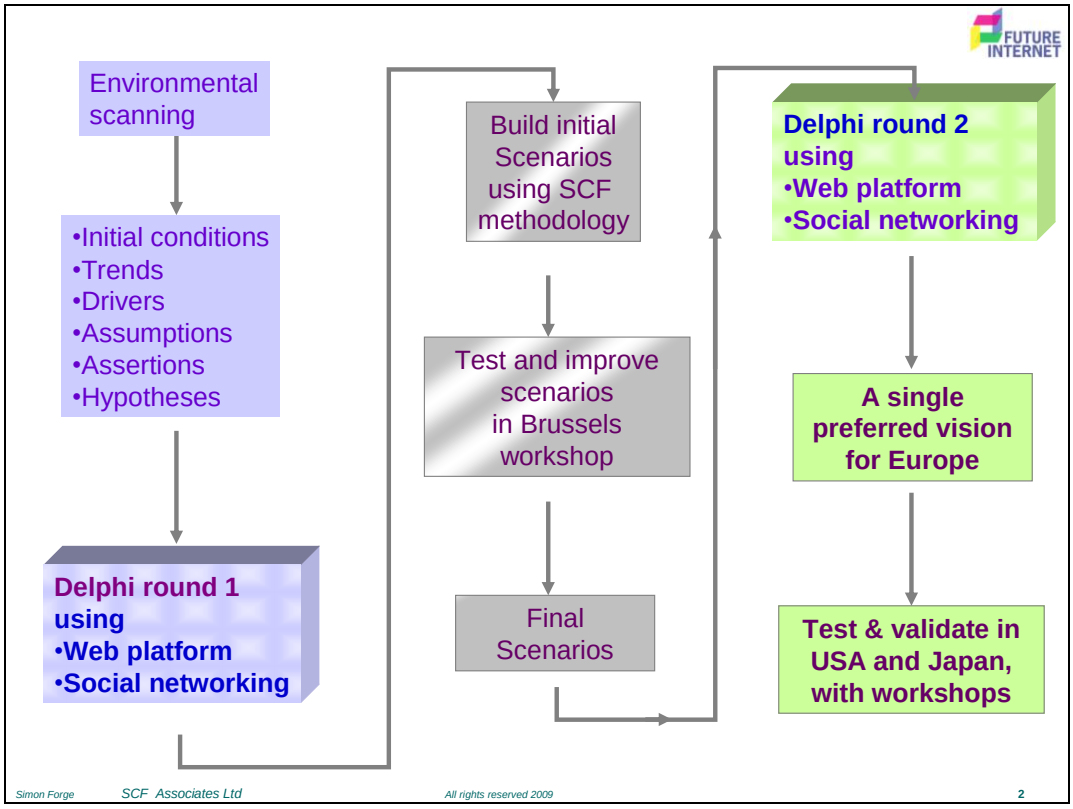


Figure A.2Work package 2 methodology

The first step was to identify the trends and drivers of change that are likely to affect, to a greater or lesser degree, the development of the future internet. This consisted of an environmental scanning exercise whereby a diverse range of sources of information were scanned in a systematic way to pick up relevant trends and weak signals. Sources of information included academic articles and books, journalistic sources, websites and blogs.

The team used a social, technological, economic, environmental, and political (STEEP) framework to ensure comprehensive coverage. Care was taken to ensure that not just evolutionary trends were identified but also disruptive notions for the future internet, eg bio-inspired approaches, autonomic management, self-configuration, mesh and ad-hoc opportunistic communication. Following a broad ranging and comprehensive capture of these trends, the next task was to group and categorize similar items, through which the main drivers of change were identified. From this some assertions and hypotheses were formulated about possible alternative futures for the internet.

At this stage the first round of a Delphi survey was carried out, in which experts were invited to respond to some assertions about the future development of the internet and to state, for instance, the extent to which they agreed with a certain statement, or the date by which they anticipated a particular development occurring. The online Delphi survey was carried out with the technical support of the iKNOW project coordinated by the University of Manchester. Over 1000 experts were invited to participate in the survey. Experts were identified by the study team as being knowledgeable on some aspect of the internet and were drawn from the spheres of government, business and academic research. Experts were drawn from a wide variety of disciplines – engineering, law, economics, political science, sociology, futures research, psychology, etc. The first round elicited responses from 235 experts.

Delphi is a well-established foresight technique that involves polling of knowledgeable individuals, feeding back (sometimes) anonymized responses from earlier rounds, with the idea that this will allow for

better judgements to be made without undue influence from forceful or high-status advocates. The technique was developed so as to circumvent "follow the leader" tendencies of face-to-face exchanges, and other problems such as the reluctance to discard previously stated opinions. Delphi surveys are usually conducted in two rounds. Delphi surveys are most often employed to elicit views as to whether and when particular developments may occur, but the technique can be used for any sort of opinion or information – such as the likelihood and desirability of specific outcomes, impacts of policies or technologies, scenarios, etc. Likewise, Delphi is frequently used with a focus on the dominant views that emerge, but the technique may be oriented more to delineating different points of view. Delphi surveys are often carried out online, and findings are used to prepare policy recommendations, action plans, roadmaps, etc. A guide to the technique, including advantages and limitations is provided by Linstone and Turoff.[1]

Following analysis of the results of the first round,[2] the study progressed to building alternative future scenarios. The particular method used, Scenario Construction for Forecasting, has been successfully used by members of the study team for over 20 years, including in several recent studies for DG Information Society and Media and the EC Joint Research Centre's Institute for Prospective Technological Studies.[3] The method builds scenarios from the bottom up, specifying assumptions and key drivers to make assertions, hypotheses and finally a rich scenario.

Using this method, four alternative scenarios of a future internet were constructed, with a timeframe of 10-15 years into the future, ie 2020-2025. Some scenarios are more evolutionary in nature, others more discontinuous, the intention being to highlight possible interactions of an economic, social, and environmental nature with technological issues and questions of governance. They were consciously designed to be provocative and challenging, to be rich and differentiated, considering market and industry aspects including regulatory influences, implications of less open architectures, environmental aspects, and individual and societal needs.

It is important to remember that scenarios are not predictions but, rather, are possible alternative futures. They need to be internally consistent and broadly plausible but the objective is not to produce one scenario which is more plausible or more preferred than others. Instead scenario analysis is a technique intended to highlight issues and to act as a focus for discussion and debate.

The next step was to use the initial outline scenarios in a "brainstorming" workshop in Brussels, with a mixture of external experts and small number of European Commission staff. The purpose here was to test the approach and the initial plausibility of the scenarios and to provide further input to refine and improve them. Together with findings from the first round of the Delphi survey and further desk research, the workshop helped the study team to enrich and improve the scenarios, as shown in Figure A.3.

An interim report was produced at this stage, gathering together the work that had been done so far, presenting interim Delphi survey results, the evolved scenarios and preliminary work on a needs analysis.

The "evolved scenarios" were then used to facilitate discussion in two further workshops, a Boston workshop hosted by MIT, and a Tokyo workshop hosted by Keio University. This enable the study to benefit from the input from world leading experts and importantly allowed a comparison to be made on the future internet from a European, North American and Asian perspective. The make up of the Boston workshop allowed the focus to be oriented more towards internet architecture, while the Tokyo workshop was designed to have a more consumer-oriented perspective.

Further feedback on the scenarios was sought through the second round of the Delphi survey. The results of the first round were provided as feedback and experts were invited to consider to which of the four scenarios they considered to be the most desirable and which was the most likely to become reality.

[1] See Harold A. Linstone and Murray Turoff, editors, The Delphi Method: Techniques and Applications, http://www.is.njit.edu/pubs/delphibook/

[2] The full Delphi survey report, is available here.

[3] Eg, see SCF Associates, Future; SCF Associates, Benchmarking Impacts of EU Policy - Options for Economically Efficient Management of Radio Spectrum.

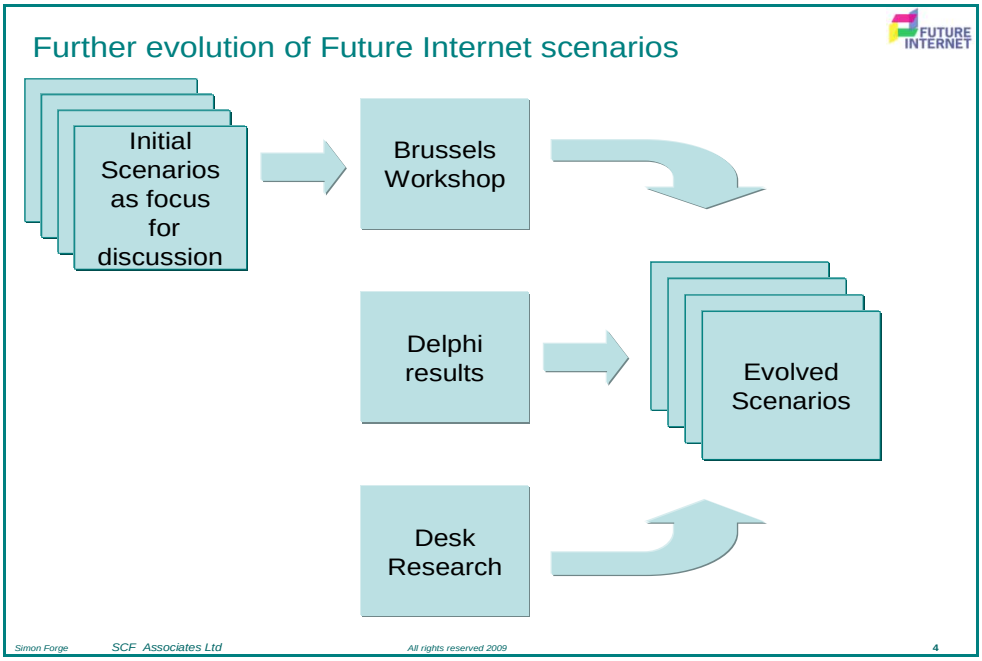


Figure A.3 Evolving the future scenarios

Discussion at the Boston and Tokyo workshops was oriented towards the needs and requirements for the future internet, as needs analysis was a key input into the key objectives of the study, ie identifying design principles for the future internet. Thus, the workshops provided important inputs into the STEEP analysis, presented in Appendix B, and the needs analysis in Appendix E.

The next step was to build on the needs analysis to determine the services the internet would need to provide to its users. To do this, the study team drew on the scenarios as well as the STEEP analysis, the Delphi survey results and the findings from the workshops, to identify the demand side requirements. Elucidating needs from the scenarios requires identifying patterns of lifestyles with their services and from these the applications, content and networking to satisfy those needs. The attributes of services with applications and content were then used to shape design requirements for a future internet, as explained in Figure A.4.

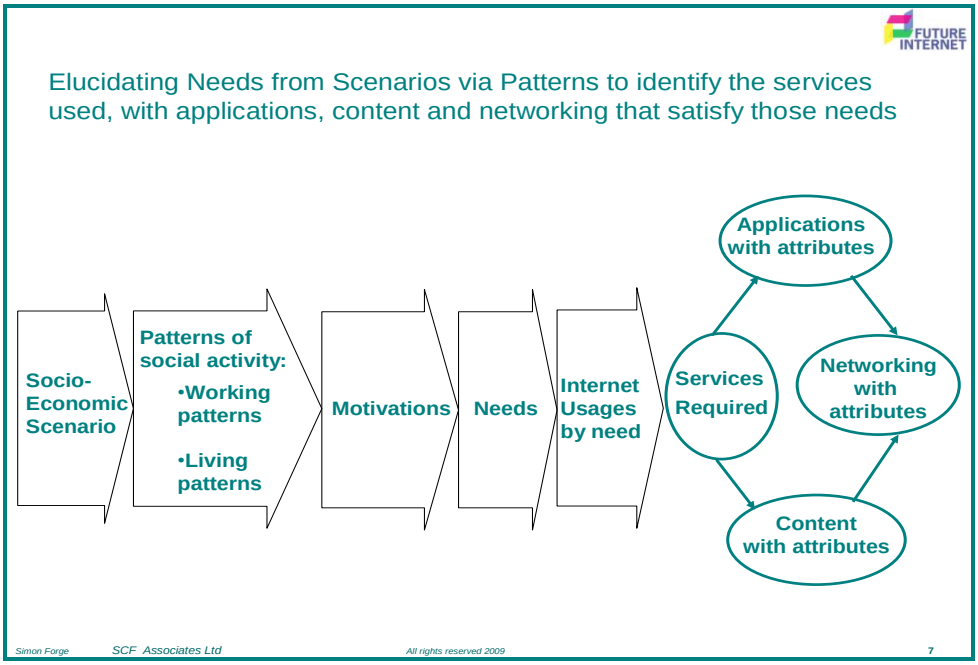


Figure A.4 Elucidating needs from scenarios

Further description of this work and the outcome is presented in Appendix E.

The second work package culminated in submission of an Interim Report. The findings were discussed and validated at an Interim Brussels workshop. This event was a larger scale, more open meeting than earlier workshops with participation from many more external experts as well as European Commission staff, with some 40 people attending. Participants were encouraged to continue the discussion on the findings of the study via the study's Web Platform, a channel for communication that would be available until the end of the study and beyond.

Work Package 3: Analysis and recommendations

The objective in the final work package was to bring all of the findings together in the study and make recommendations. This entailed bringing together the learning from the historical analysis of the first work package and the forward-looking exploration of the second work package to consider the strengths and opportunities for Europe as well the weaknesses and threats that European policy should take into account in shaping the future internet. In particular the analysis aimed to focus on key issues for DG Information Society and Media, including:

- how to bring the socio-economic dimension into ICT research,
- possible policy and regulatory measures, and
- the focus of future research initiatives related to the future internet.

The work package comprised two key elements:

1. Preparation of the Final Report (link to website?). This was to be based on the Interim Report with additional inputs and analysis arising from the Boston, Tokyo and second Brussels workshops, and the second round of the Delphi study.
2. Organization of a Final Workshop/Conference in Brussels to present and discuss the Final Report

Appendix B. STEEP analysis

The future of the internet will be shaped by a range of factors well beyond its technical aspects. We took a global view of its social, technical, economic, environmental and political influences, innate aspects and impacts using a STEEP analysis. Key parts of the social forces are personal motivations, the psychology of users. This contrasts with the tendency for the internet industry itself to focus on technology and in doing so underestimate the influence of the general socio-economic context of the internet, while overestimating the power of the current players in the industry to be the sole determinants of its future. Engineering constraints and drivers are important but are just one component. The *supply* side is significant but, ultimately, the internet will be shaped by all facets of the *demand* side. Thus two contextual layers influence its development: STEEP forces, then industry and external players such as government:

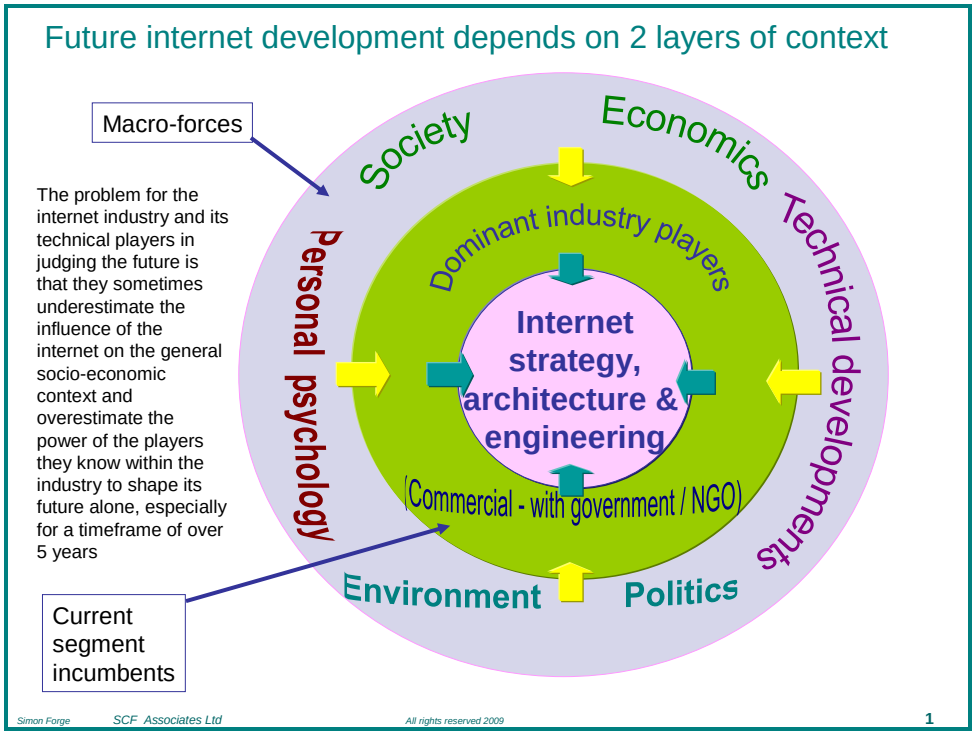


Figure A.5 Internet evolution is dependent on the socio-economic and cultural context

Thus a key aspect of our research has been to analyse non-technological expert views to complement the more prevalent technology-based perspective. This has been implemented by developing a needs analysis (see Appendix E) through use of four scenarios (see Appendix D) based on a combination of the following input activities, all aimed at understanding the future needs for the internet:

- Analysis of the first and second rounds of the Delphi survey (Appendix C)
- The first workshop's results on socio-economic/related issues (Appendix F)

- Environmental scanning for trends – evolutionary, or inhibiting, or disruptive.

Emerging trends and drivers of change

The first workshop, an intense two day event, highlighted a range of points across the major forces for change, from the economy and society to human interfaces and technology. In analysing each of these drivers, we seek to build a requirements analysis that can shape a functional specification and then on to a high level architectural outline. The drivers discussed below are based on both a synthesis and an interpretation of the workshop discussions, catching concepts, themes and emphases that in some cases might have been be lost in the raw interchange:

Economic trends and drivers

- Economic forces will be a major influence on the design of a future internet because today, much of our economic foundation in the developed world, and increasingly beyond, is internet-based. We will continue to build an internet-based economy in the future, so that access and take-up including affordability, utility and accessibility will be paramount design goals. Thus to design a new internet, the place to start is with what people want, and a key part of this is the economic question, of what is good for the economy.
- Economic dependence ranges in scale from general business applications (eg tele-working, communications, sales) to being the foundation of specific sectors (media, telecoms, logistics and retail, banking, etc). This suggests that internet governance and regulatory issues will have to be taken more seriously in future. The question is whether policy can be built into the internet, as is already the case in certain common large-scale business systems at a real-time level (eg in SOX compliance[4]) and more especially at a basic architectural design level. Policy for economic dependence may also include reliability goals – for economic reasons, robustness will be paramount, so an autonomic self-healing internet will be a design goal.
- The level of internet demand (and the choice of services) is set by the degree of prosperity in real purchasing power terms. Prosperity-based demand is constrained by a range of economic-behavioural factors:
    - trust, especially that of consumers – it could be said that the internet's use as an economic foundation comes down to trust and perception, and how to build trust technically in applications and networks
    - business confidence
    - education in technology
    - rate of formation of a knowledge society and economy

Thus, for business operations it is worth considering whether a more transaction-oriented internet for business and consumers may be desirable.

- Developing nations will be dominant in gross GDP terms between 2030 and 2040 and their markets will show the fastest growth from now on over the next few decades. Therefore, the developing world will be a major influence on future internet design. Technical characteristics will tend to be set by a) low cost b) thinly-spread infrastructure c) ease of access by billions d) lower educational resources – as the dominant user market. Hence an internet for those on US$2 to US$3 per day is one design goal for the near future. Note that this trend will to tend to feed back to basic internet models, networks and attached devices in the EU.
- The overall internet governance and management system needed might be very different compared to today's, ie more *transparen*t – with clear *liability* and *management responsibilities*. Operational management units should be instantly contactable, whether they be carriers, ISPs, portals or application service providers, perhaps gathered into single-point of contact response centres, formalized in common SLA structures. So a range of legal factors and resources may need to be

[4] The Sarbanes-Oxley Act, which sets standards for all US public companies strengthening public accountability.

added. As the internet creates business, it should heavily influence contract, commercial and company law. The internet should thus be designed to easily enable four key processes:

  - Accounting and tracking of relationships, eg in a transaction
  - Authorization, that an action is allowed
  - Authentication of parties in a business transaction in terms of both identification and permitted activities (eg who can be a merchant, who can be a bank)
  - Access – who can see what, who can do what, who must be informed of what activity or event

- However, there is a key counter point: the internet as it exists, has been a fairly innovative catalyst from an entrepreneurial viewpoint and has generated many economic benefits. So perhaps its chaos is a positive factor for to some extent its faults may become self-healing. Under this kind of thinking it is important to maintain the state of the internet as open, as it gives global access at low cost for those with new ideas and businesses with new business models (some of which break, some of which disrupt for better or for worse, or just supplant previous models). This makes it a new business creation machine – and too useful to throw away. The question is can a balance be struck between controls for safety and entrepreneurial opportunity?
- The internet came into being as it was not a purely government or commercially controlled environment. A common ownership role needs to continue if the internet is to be a centre of trade, with a status of open ownership rather like the high seas. If it becomes a 'walled garden' for commerce, or a government granted licence as with the frequency spectrum, its inherent economic nature and advantages of no owner will be lost.
- The internet has been so successful because of its relative ease of inter-operability as it brings simple technical standards that are common and universal – the economic power of this aspect cannot be over-estimated. Any future internet must continue this basic tenet.
- Global scale – in trade, reach is sometimes everything – indicating that geographically limited internets (eg only one country) are to some extent making a restriction on trade, thus putting limits on economic growth, and so may even be viewed as self harming in some cases. So a more interesting future design may be to have a geographically based internet environments in terms of social and business values, eg one for the EU, one for Asia etc, attractive to local interests and expectations but accessible worldwide.
- Today the internet presents us with a separation of a technological world, from an economic world on top of it. A key issue that was not present in the original design requirements was security in a malicious environment. This has introduced a "stealth" element to the internet. To counter this, can we influence the basic technology in terms of security, in addition to the security layers that have developed?
- For internet business, identity is vital. We thus need to imagine new forms of address classification with naming. Currently internet addressing is handled by the domain name system (DNS). Currently DNS applies to network devices, but in the future we could need the equivalent of a DNS for humans – that is, you are your URL, it is not held on your laptop or any device recognized as a network entity, ie the notion of identity becomes far more sophisticated. So it is possible to imagine applications for anytime, anywhere, any device – for which we would need to use a "personal space" or an "attributive digital domicile". For further security, should digital identity also be based on "partial identity" and therefore all the various pieces of identity never come together, thereby leading to overall "anonymity" (at the macro-level)? More generally, should identity information only be transmitted on a 'need to know basis'?
- The internet world continues to see rapid disruptive innovation. However, some of the 'real' world has not kept up, eg court processes, emergency numbers with VoIP, etc. The internet will eventually change our institutions – if it is allowed to. This means the economy is operating more rapidly. Thus there is a limit to how much the internet brings intensive and extensive economic competition set by

the real world. If more economic activity and business transfers to the internet then the speed of global trade, and investment, will accelerate leading to greater financial liquidity.

Social trends and drivers

Major influences on a future internet design from social forces can be foreseen:

- Most generally, although artefacts created by humans might be human, the internet can never be even an incomplete reflection of our society. There is the question of whether we will get the internet we deserve, ie the future internet will be some partial mirror of society. Possibly, it will only reflect a restricted part of society. If it is more successful in its appeal it may reflect a far wider swathe of society across the planet but that also implies a host of cultural enclaves rather than a single cultural and mental model.
- The internet is moving to be an increasingly significant social interaction platform. If the internet is to fulfil its potential as a social channel then the complex human signals and markers (visual, audio, gestural) must not be lost in the communications channel. This sets certain goals for its design.
- There will be a shift from the internet of PCs, via an 'internet of things', but to an *internet of persons*. This implies pervasive communications and therefore mobile radio access as the preferred user access channel. Other impacts on technology could be new naming and addressing spaces, eg to make the existing DNS mapping not to PCs and content, but to individual people first – and to things, including PCs, second.
- Avoiding social exclusion due to the internet is not so much determined by whether someone is physically on the internet or not but whether the interface and usage technologies work for or against exclusion and so create effective segregation, eg for older people. So it follows that we need to be clearer about the exclusion capabilities of technologies.
- The ways in which we link to people should greatly influence a future internet design, if it is viewed as a socially facilitating infrastructure – and if it became an entitlement to communicate and interact through the internet (ie almost a form of universal service). If driven by this social goal, a different form of internet may be shaped, ie of so much bandwidth, so much spare capacity per person. The norms of internet uses ('netiquette') spread with everyday social interactions and these could influence design.
- The internet must also reflect social norms of acceptable behaviour – our societies set strong constraints on activities and capabilities. These pressures are likely to increase in the future as dependence rises. How the internet will push people to evolve in social relationships, and in terms of self, will be a synergy between the two that will push the design of the internet. The question is how can these norms be reflected in its architecture and engineering as they form a key part of a future requirements specification from a social standpoint?
- Also, there is strong feedback between things that change the rules of acceptable behaviour via the internet and social norms. This interaction between people's behaviour and the internet will generate new applications. Future socializing applications will tend to be shaped collectively – how much individual desires will push future applications, in ways that we perhaps cannot even imagine, is unclear but likely to be low. So the dominating social networking applications are likely to be common but flexible for personalization on a large scale – implying real-time *scalability* with accompanying expansion, on demand, for the key base parameters (bandwidth, storage and processing power).
- Not only is user perception for trust a major challenge, but legal issues will also be important in a future internet operating across national legal regimes. How they can be implemented and enforced in a borderless international market is still unclear. Existing national law may suffice but the question in some areas is whether the current laws need to be extended, if insufficient. Also, are there quite new areas of law where fresh legislation is required? For instance, questions include whether a website that sells goods must be registered to trade and show authentication of its status against a commercial register, with its web, URL and physical address.

Technical trends and drivers

Major influences on future internet technical design from technological developments include:

- An evolutionary mode of development is more likely than stagnation or revolution. The new may be expected to be built on top of the origins of the internet with the newer trends progressively becoming stronger, eg more specifically migration to a mobile access network, semantic web, support for real-time monitoring with guarantees of performance and various permutations on the theme of net neutrality.
- Moreover, we have seen some unexpectedly slow developments which should make us think carefully what is possible. Resistance/barriers to move to a new generation of fundamental internet technology may be far higher than we appreciate, eg the long march towards IPv6 (first deployed on a large scale at the Beijing Olympics, 2008 although formulated a decade before), multicast, and QoS – leading to lack of guarantees for communications channel quality.[5]
- However, there are some key trends today which do have change effects, with some important advances including: state management at web layer (seamless applications across networks as for Google Maps, Facebook, etc), application layer multicast (data-centric networking, publish and subscribe), resource pooling through multi-path for more robust handover and an identity layer for the internet (idM).
- A new direction for technology is in response to growing user involvement and the desire for more user-friendly applications.
- At the same time, there is also a need to be aware that sensing and sensors and interactions with the real world will become far more important. So that the apparently simple but large scale movements, eg towards the internet of things and RFID, should be watched for suitable emphasis when considering what constitutes 'inclusion'. These demands may have complex real-time implications.

There are also certain important points of open disagreement and discussion:

- Do we want the internet to continue as a dumb network with intelligence at the edges? Is that what telcos wish to replace as they strive for smarter 'intelligent networks' they can control? The conclusion may be the opposite – to pour intelligence into the device in the user's hand, not the network – and is this right?
- We need to be able to make a clear distinction between the technology of the internet and technology trends in general, eg cloud computing. These advances may impact the internet's future engineering but we should be wary of saying they are the internet itself. Moreover we have to be careful about their real impacts, eg to not overstate cloud computing's significance.
- In looking at storage, processing and network transport models, for the way in which we handle data, internet history is less relevant. Today the ratio of network capacity to storage capacity of data is quite different to that of 30 years ago. Storage capacity attached to the internet is currently increasing rapidly.
- Will the internet function the way it should function as a network? For instance, have the major suppliers in traditional telecommunications delivered anything technically yet for the internet of the future? Are the great networking advances of NGN, IMS, QoS, etc and even IPv6 just marketing speak? Where are the results? Have internet advances in this area run into the sand and so is a clean start required?
- Is the future a distributed architecture or centrally controlled future internet? Software as a service (SaaS) seems to imply less user control and more centralized operation, and so does this conflict with current moves to a more creative freedom in applications, with user defined structures.

[5] eg there has been little use on the public internet of IntServ and DiffServ. Differentiated Services, or DiffServ, is a network management function for applying different service levels for different types of Internet traffic and so provide some Quality of Service (QoS) guarantees. Packets are marked according to the type of service they need. This replaces the earlier Internet management function for this, 'IntServ', using reservation of network resources, which has scaling problems.

- Personal data may be handled in better ways in the future. For instance, the Max Planck Institute is working on mechanisms for protecting online data with encryption so the service provider eg Facebook, no longer knows what is a user's personal data (but can use matching tags for advertisements from the encrypted domain so anonymity protected) to give a potential to satisfy both goals.
- Organizational mechanisms and human factors have to be taken into account on a technical level. To encourage SMEs or entrepreneurs to enter the market, we need to make the environment more conducive in terms of trust, awareness and skilling and re-skilling. This is in part a technical problem.

Psychological trends and drivers

Major effects on future internet technical design due to psychological influences:

- The key point for the internet's future, which is likely to lie in greater social use, is a psychology of trust, which is linked with privacy. Essentially, the internet should offer a degree of privacy in life which it cannot offer today, in order to generate that trust. This need for privacy is driven by fears of intrusion and harm. Moreover, fear is sensitive to multiple factors – culture, age and socio-economics. Each of these sensitivities should be reflected in the flexibility for implementation of internet interfaces. Thus cultural re-assurance requires familiar presentation, with cultural signs and accepted behaviour to reinforce acceptance, trust and take-up.
- This mistrust or fear is not just due to the internet's intrinsic engineering, but also because of the freedom allowed to its major stakeholders and exploiters – the largest ISPs, portals and search engine services. Through what may have become an unhealthy customer intimacy, these service providers have all harnessed private information for large-scale revenue generation. This is a pointer towards future governance rules.
- Two further questions arise that have design implications based on how to build and maintain trust on the internet:
    - How to facilitate relationships through the internet – linked to how to value emotions – and more cynically, from a business viewpoint, how to make money from emotions.
    - The strength of desires for immediacy – and what does 'immediacy' mean? What engineering requirements does this immediacy imply, eg for rich media interactions?
- Our psychology is governed by a further motivation – while fear is first, desire is second. These two forces of desire and fear have strong engineering implications. Thus to satisfy the aspirational goals, or desires, and in contrast with its protective stance, the future internet should try to be one of *individual* creative endeavours as well as individual privacy. Desire for personal freedom is highly important.
- In a digitally pervasive world, dependence will increase, so the effects of outages or deliberate scams or interference may be magnified. Consequently the psychological pressures for protection, resilience and trust – for an *autonomic* self-healing internet – will be enormously increased. This has major implications for critical infrastructure and its protection.
- Ideally, to avoid exclusion owing to technophobia or alienation, a future internet should be a "flexible internet" (subjective, diverse) that goes with you and reshapes by adapting to where you are, who you are and the core needs in each lifestyle situation. More specifically, this implies personalization – "my" personal network over the internet. What it means, and then how can it be attained, is the technical question.
- In terms of applications we can expect on a future internet, the immediate desire is always for more of the same thing (eg Henry Ford said that if he had asked his end users in 1900 what they desired, they would have asked for a faster horse). This indicates that today's major applications (gaming, social networking, email, etc) will be equally important to a future internet in the medium term. The longer term is less predictable.

Several key psychological themes will dictate future internet forms of use:

- *Presence/belonging*, ie being part of a family or group – this drive explains the attraction of social networking and its expected growth. Immediacy may be taken further in family or close networks, so news travels faster and people will be electronically 'together' for more of the day.
- *Relationships vis-à-vis others are now in transition* – the internet (especially the mobile internet) with its always-on ubiquity is currently changing the forms of human relationships.[6] Demands on the internet will reflect this need for a more human form of contact.
- *Contribution to society through group experience and individual experience* – people's position and impact on society changes with the internet, as one person can influence many others, while far more influences can be easily experienced by one individual than ever before.
- *Sense of self-fragmentation* – with alienation through heavy electronic communications, comes an impact on values – morality, integrity, honour. A greater need for contribution to society to be fulfilled may be manifested. Moreover the internet can give altered/distorted/illusionary perceptions with changed behaviour, so consideration should be given to ways in which this could be reduced. But it may only be at application level, without infrastructure implications.[7]

Main human interface influences on a future internet

It is perhaps useful to ask: *why is the human interface a separate and relevant subject for consideration in the design of a future internet?* We have separated it out because it has such a fundamental impact on take-up of the internet.

- The World Wide Web was the main driver of the spread of the internet into popular culture globally, beginning from 1995 onwards with the launch of various free internet human interfaces, browsers. Essentially for most users the worldwide web was a user interface device – not just for its imaging possibilities but for the linked server and document structure. Effectively the WWW placed a human interface layer (as the browser) on top of a relatively simple messaging and document file exchange system. It provided the user with an environment that was easy to use compared to entering raw URLs. Thus interfaces will be crucial to help digital inclusion.
- The discipline of human interface design impacts all aspects of internet engineering, from the scale of take-up to the types of traffic, to forms of naming and addressing users will require. This may even go down to the issue of relevant human computer interface (HCI) parameters to do with concentration, comprehension and distraction, eg how to improve attention is a key issue, and what information speeds can optic nerves appreciate, etc.
- Here we extend from the basic idea of the HCI (which is very specific). Instead the concept of a human interface *environment* (HIFE) taken as being more useful – a combination extended from pure HCI, to include social and psychological factors. We might use the term "experience"- as used by MIT Media Lab – as a way of describing this.
- Positioning of the HIFE is also a question: it seems to be in the user device but it could actually be in the network, or at the edge or on a server, either in an application server, or in a special human interface environment server that hosts personal HIFEs. Where does the internet stop and so where should intelligence be placed? This is also linked to the concept that there may be things that could be all pervasive, and persistent, like identity. That could happen at the server level, but could be at other levels. Or will there be no more intelligence at the network, only in the edge devices?
- Limits on what may be considered as the HIFE are a difficulty. For instance, does a HIFE extend into exploring the internet environment, or is that an application's role, eg it is important to be able search for things that you do not know exist, as much as those that you do, ie is there need for an extension of a HIFE as a form of search engine (like Google) but for your 'life'. And how do we handle the privacy concerns, as some users may not really want that in an interface, owing to intrusion issues.

[6] Forge, S., Guevara, K., Blackman, C., 'The role of ICTs in shaping the family', paper prepared for the OECD International Futures Programme, 27 November 2008.
[7] McCormack, M.L. (1998) 'What sex is the Internet? Internet and Web technologies as social tools and reflections of our inner selves', *Futures*, Vol 30, No 9, November 1998.

- For the human interface environment a central discussion point is the type of media in use – previous advances have been from text to still images, to video, while tomorrow may be 3D immersion and virtual reality worlds. The underlying impact is that the architecture and engineering, as well as the business models will need to offer more and richer multimedia access, transport and display than before. Relying on the internet far more, for instance, we may want substitutes for newspapers, as well as for handling IPTV on a large scale. Audio-visual newspapers may be without text, or very little. Instead it might mean interfaces that emulate newsprint, ie high contrast text as for e-reader displays, downloaded or streamed. Thus bandwidth implications of a HIFE are significant, especially in consideration of mobile access.
- Some parts of the problems of internet design for a useful HIFE are to do with personal (and organizational) identification. Identification is the transactional aspect of digital identity. We need an interface for protection of self but one that suits our modes of thinking and doing – so *we need "anonymous personalization".* Users also will require situational awareness, anonymity, minimal divulgence, accreditation checks, referral loops, prior warning, and assured loci of control in the HIFE to navigate across the internet. Digital identity management is at the core, because it must be applied not only to people, but also to things/devices/environments that people interact with. Note that a person's own identity is also linked with the identity of things in their environment and so can be used as pointers to identification (which follows human processes of identification using associated clues). The subject becomes more complex with the notion of owning multiple identities on the internet. Fundamental questions of freedom versus malicious intent enter here.

Appendix C. The Delphi survey

Introduction

This Appendix summarizes the results of the Delphi Survey. Detailed reports on the first and second round survey are available on the study web site.[8]

Results of the Delphi survey: Round 1

The first of the Delphi survey's two rounds focused on underlying trends and needs. The online survey[9] generated opinions from some 235 experts on a wide variety of subjects concerned with the future use of the internet, such as when would the internet become vital for everybody, and what percentage of daily life would be associated with the internet. Most generally the survey attempted to forecast lifestyle impacts, types of applications and degrees of dependence across a wide range of categories.

The analysis of the first round Delphi survey is grouped and categorized according to themes and emerging needs and requirements produced the following results. These are portrayed below, with the opening questions related to the significance of the internet in people's lives. The frame of reference for respondents was the European Union.

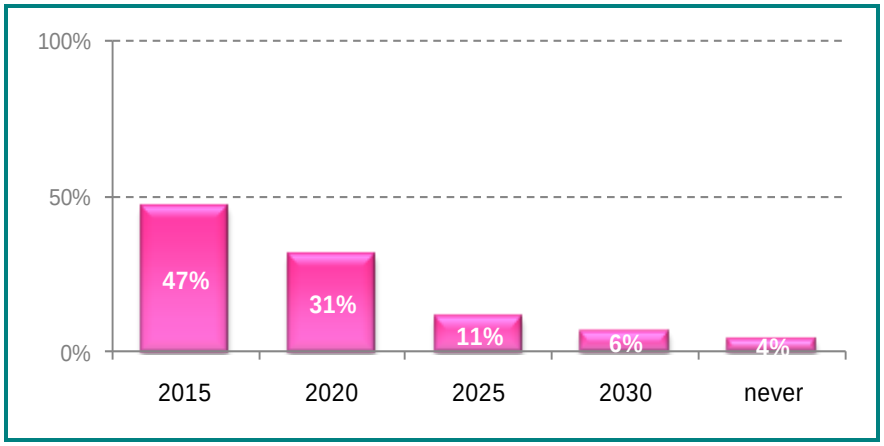


Figure A.6 When will the internet become vital for the vast majority of people in ordinary everyday living?

Thus, from the survey responses, when the internet will become vital is apparently only a short time way. Some 78% of respondents in total believe that the vast majority will find it vital for everyday life in only 5 to 10 years' time. But how much of the day will be influenced by the internet?

[8] See reports of the First Round and Second Round Delphi survey here.
[9] An overall response rate of over 20% was achieved in the first round, an encouraging result given the complexity and detail of the survey questionnaire: http://prest.admbs.mbs.ac.uk/surveylet/takesurvey.asp?surveycode=4633WTOL46166

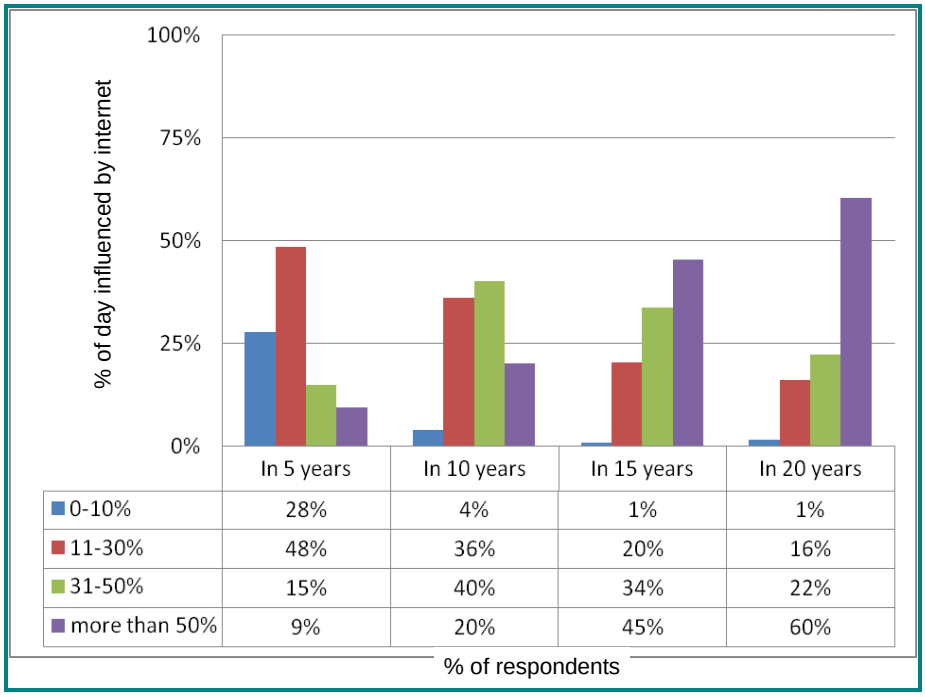


Figure A.7 What percentage of the day will be influenced by the internet for the vast majority of people in ordinary everyday life?

Note that in 10 years time, 60% of the respondents believe that the internet will influence over 30% of everyone's day but that it will take a long time – 20 years – before the majority of respondents think it will touch over half the day (some 60% of replies).

We may expect that people will use the internet far more in the future. For our analysis, it is essential to understand what needs the future internet will have to meet.

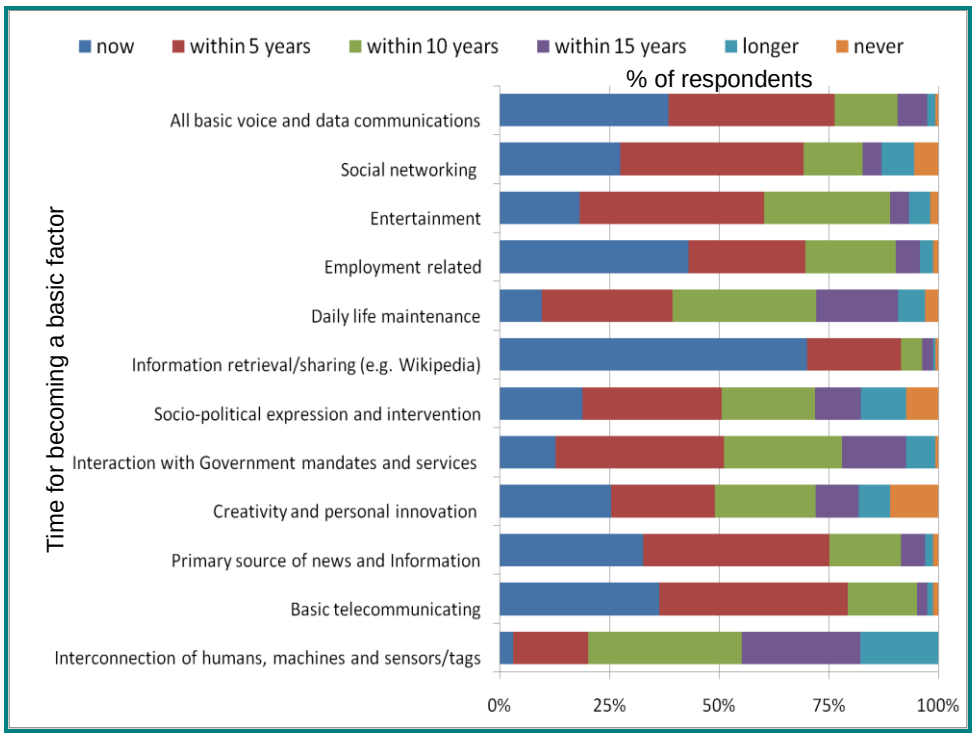


Figure A.8 Internet use will increasingly permeate all aspects of our lives, but for which types of need?

Looking at the results in Figure C.3, while basic communications (data and voice) are likely to be already largely based on the internet in the short-term, creativity, daily life maintenance and socio-political expression may take longer. Employment, telecommuting and information retrieval and news sources are seen as internet-based today, with interaction with government becoming common over the next five years. From the above, respondents expect that internet use in 10 years will be oriented more towards business, social and employment activities rather than personal creativity or political aspects.

For delivery of public services such as health, unemployment, education and social services, governments and people may well turn to the internet to access these services, entailing a need for increasingly deeper interactions between providers and citizens/consumers and greater trust and security.

How long that will take is the next question, shaped to evaluate when the internet would become the main form of interaction and communication. This reflects the trust that users would need to have in its reliability and respect for privacy and security. While they might well use it for searching for a cinema showing, reliance on it for telesurgery is likely to be further way. We asked when this would occur for a variety of levels of criticality to the user.

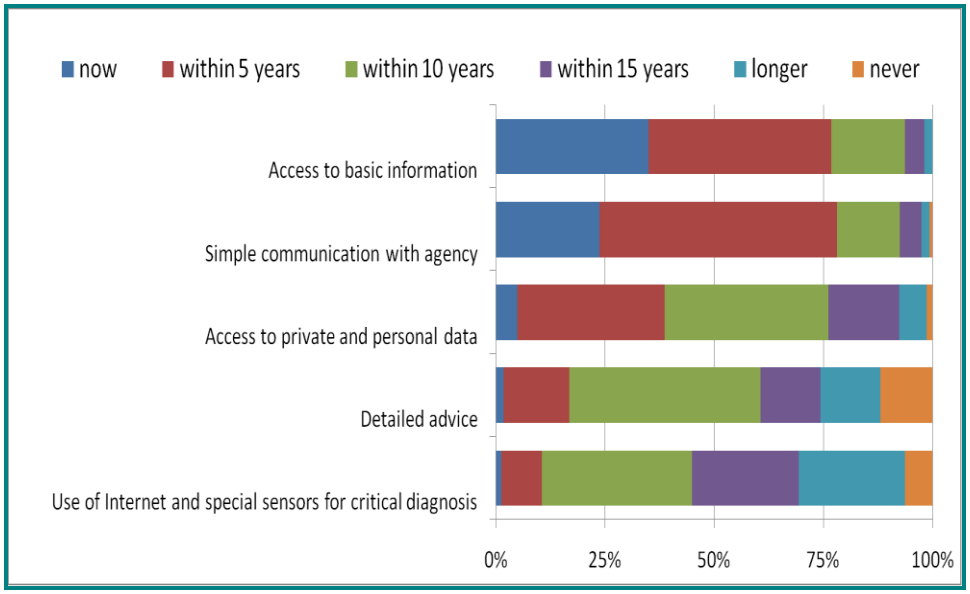


Figure A.9 Time for internet to become the main form of interaction

The trust of users decides the purpose and types of access. Thus public services may benefit from increasingly intimate relations with their users but only if their trust can be generated. In Figure C.5, survey respondents indicate that basic information access may be common now but not use of the internet for critical medical diagnosis – this will take between 10 and 15 years for the majority of respondents, but longer than that for nearly 30% of experts canvassed.

A key area for future society is education, which is likely to be impacted by the internet but at what stage and by when are key questions.

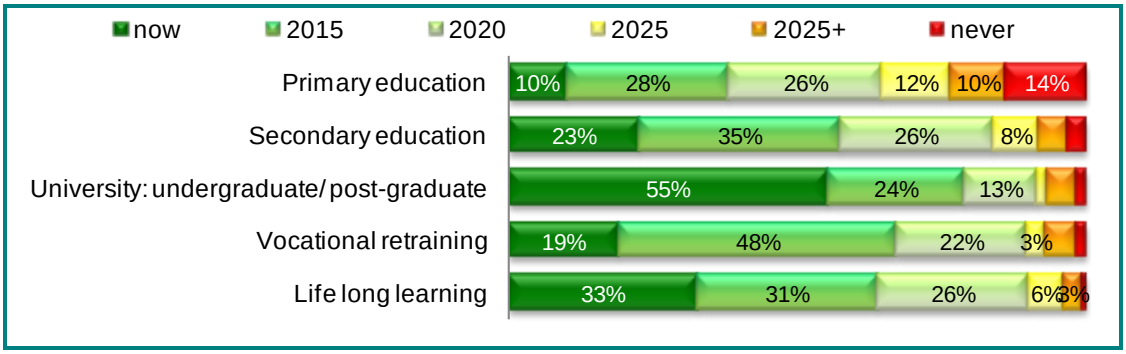


Figure A.10 The internet is likely to have an impact on all aspects and phases of the education

The responses shown in Figure C.5 underline the major impact already felt at higher education levels today, but with greater scepticism over its impacts on earlier stages. By 2015 the majority of respondents believed that all education beyond primary level would use the internet as an essential educational tool and platform.

Who uses the internet - and for what?

Understanding the importance of the internet to business in the future EU (ie importance to people, business and government) is of key concern. The main value chain functions of business seem to be becoming dependent on the internet. Thus the degree of dependence for each major function and its timescale was our next question (Figure C.6), with a comparison against electricity as a fundamental need for business.

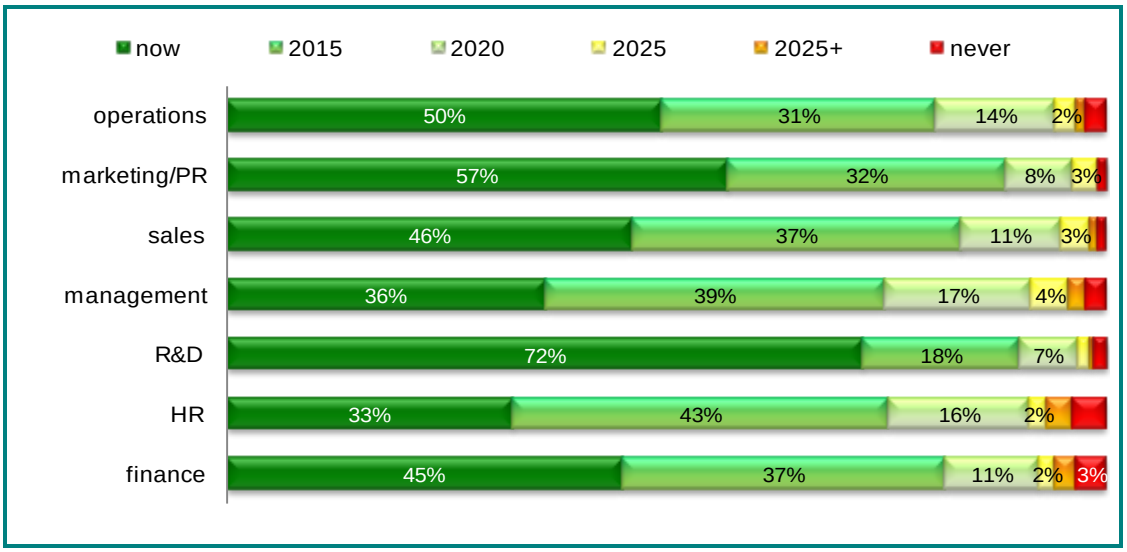


Figure A.11 When will the internet become as vital as electricity for these business functions?

Perhaps unsurprisingly, apart from management and human resources (HR), most respondents thought that the key functions were already internet dependent today, and certainly all would be by 2015.

Who will be using the future internet in terms of age, wealth, gender, education and so on, is a further key factor, in particular whether the divides seen today for these categories would diminish in the future. The Delphi survey questions probed this area and produced the results shown in Figure C.7.

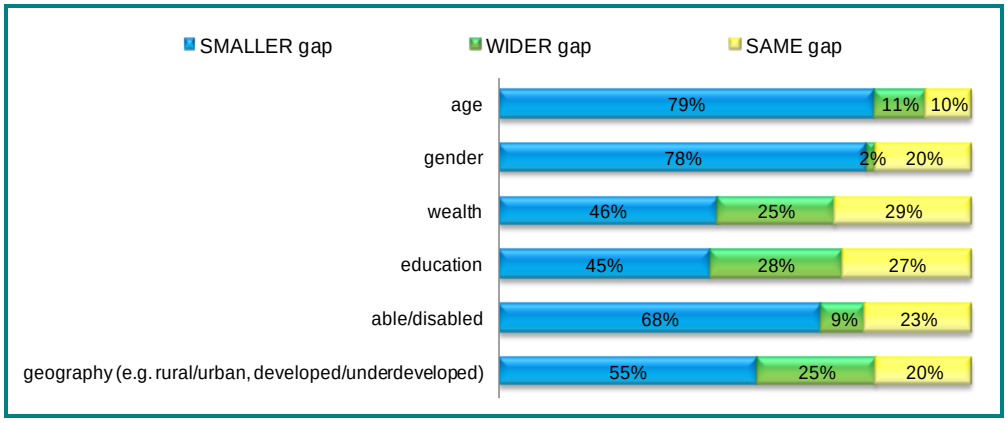


Figure A.12 Today there is a digital divide among users, eg by age or geography. By 2020, will the gaps narrow or widen?

Here there is strong concertation that the digital divide will close for age, gender and for the disabled by 2020. However for wealth and education factors, the divide is expected to remain the same – or perhaps even widen – showing some pessimism for future universal take-up. Whether the divide owing to

geographic location will close by 2020 was less clear, perhaps expressing doubt over the development by 2020 of ubiquitous access.

So what could be the limit of take-up is the follow-on question – whether it would peak – and if so what would be the peak level? Note that the percentage of the EU population currently using the internet is about 60% with user growth between 2000 and 2008 of 214%.

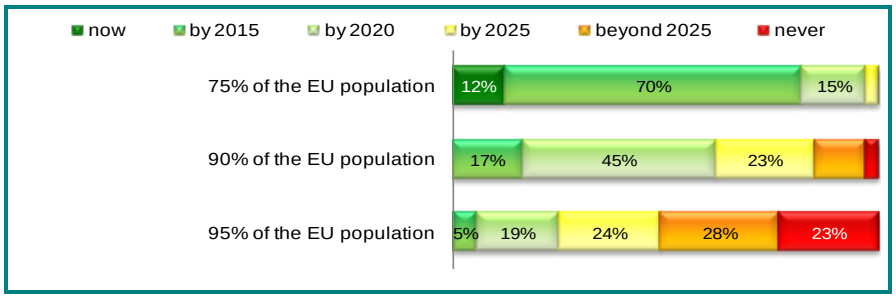


Figure A.13 Internet usage could peak but at what level and when?

There is high scepticism among the respondents that over 95% of the EU population would use the internet in the near term. Near-universal take-up of the internet is not expected until beyond 2025. Moreover, nearly a quarter of respondents expect that it will never reach 95%. This is significant for governments especially and business who expect to conduct their business via online platforms. It also reflects the respect our respondents hold for the barriers perceived for today's internet – possibly owing to its perceived technical complexity, the absence of real need and a lack of trust.

This requires thinking about what will be more important for a "socially-positive" development of the internet over the next decade. We should like to understand what users could reasonably expect of a future internet, in terms of scope of functionality and human interface. In terms of an access mode that has high ubiquitous coverage and a populist appeal, mobile is the killer access technology for the next internet – but when will it be rolled out in the EU?

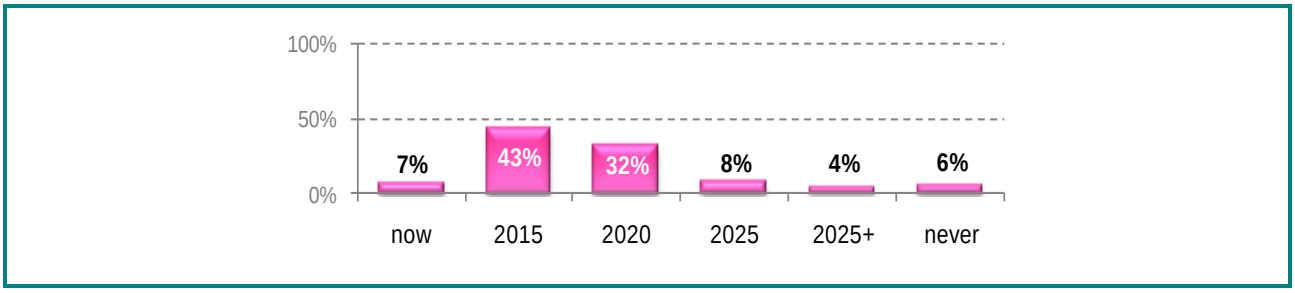


Figure A.14 When will a mobile internet be available throughout the EU, via a mobile handset as the most common internet access mode?

The majority (75%) see an EU-wide mobile internet being available by 2020 – a significant step forward for popular internet access, perhaps likely to drive take-up further than fixed be it via WiFi or cabled. Against this there is still the nagging question of trust, explored below.

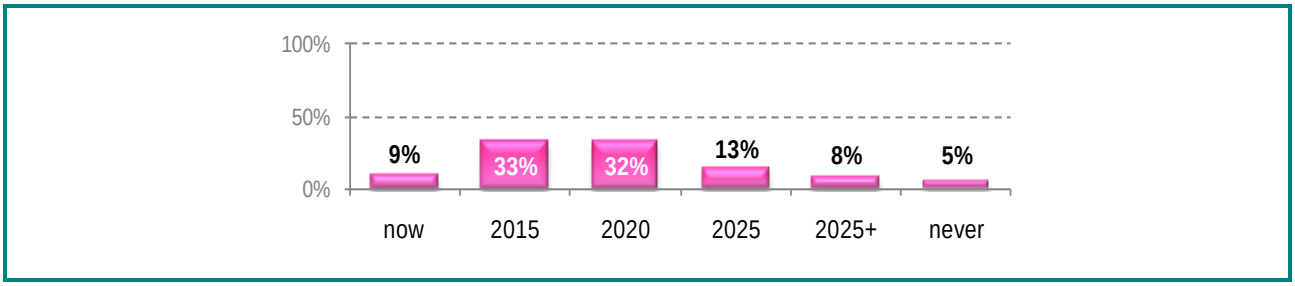


Figure A.15 When will the internet provide an environment where the majority of citizens feel confident in conducting transactions and using financial services online?

Significantly the majority of respondents (75%) thought that achieving trust in financial transactions for most citizens would accompany mobile rollout, in the time frame of 2020. This is crucial for take-up of m-commerce and m-banking, which in turn could spur further internet take-up. To further examine this, we explored when acceptable levels of risk from crime over the internet could be expected.

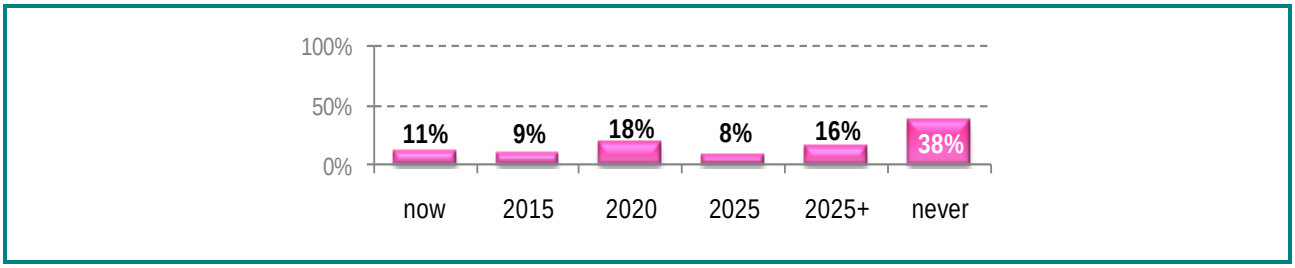


Figure A.16 When will the internet provide acceptable levels of privacy and minimal risks of criminality?

The majority of the survey participants thought such a time was beyond 2025. Nearly 40% felt acceptable levels of privacy and freedom from crime will *never* be possible. This confirms that major efforts for security and privacy are necessary for a new internet, but it also indicates a significant disconnect – how can experts think that using the internet will become essential for the vast majority while believing that the risk is unacceptable?

How far can we go with internet dependence is then the question. This was posed in the form of whether the internet can ever be secure and reliable enough for vital services in which lives could be lost (by malware or malfunctioning), eg remote telesurgery or air traffic control? If it does become secure enough, when will this be?

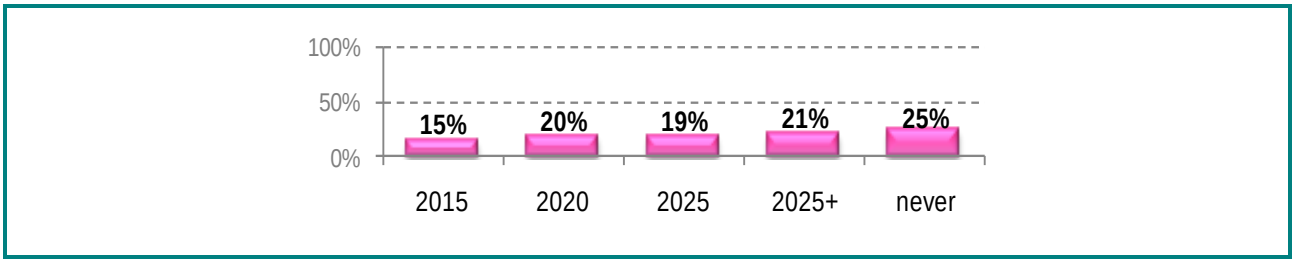


Figure A.17 Will the internet ever be secure and reliable enough for vital services in which lives could be lost?

Here we are asking about dependence rather than elimination of risks over privacy issues and criminality. The majority (60%) see such a level of dependence as at least a decade away and 40% as 15 years away. However, a quarter see such dependence as being a step too far. The interesting issue is whether the perception of potential development of the internet, guided by practical expertise today is that the internet can never achieve such reliability.

Turning to a lower risk application, eg watching TV, is interesting in terms of how the internet's 'bandwidth of choice' may dominate where financial risks or threats to life are not involved. Exceeding the time spent watching broadcast TV is the criterion in Figure C.13.

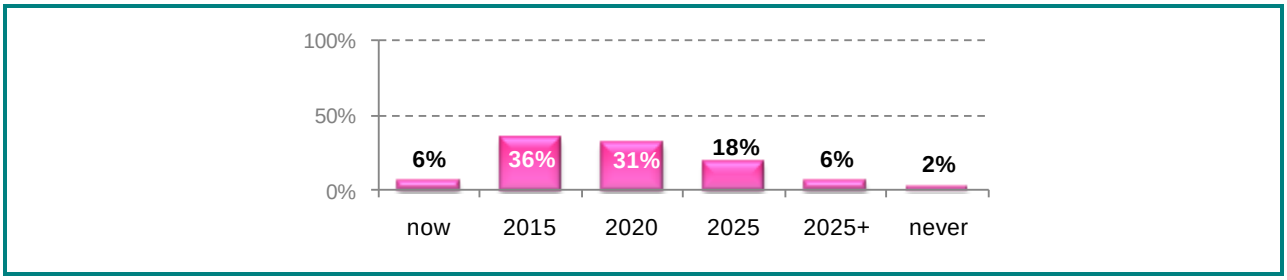


Figure A.18 When will average internet use exceed watching broadcast TV?

Total online time exceeding watching broadcast TV is expected by the majority by 2020. Furthermore, over 40% of responses expected that the internet will be dominant over broadcast TV channels much earlier, by 2015. Note that among the future uses of the internet is expansion in web TV watching. Thus the future laptop, PDA, tablet or smart mobile handset could be used as the 'TV' display of the future as much as the general online terminal for social networking, etc. Moreover, conventional TV may become internet connected and a display for online services as much as for TV, broadcast or web.

Global considerations for a future internet

The Delphi survey explored views on the impacts of a future internet from an economic, social and psychological perspective.

A major issue as dependence rises is the reliability of the internet infrastructure against cyber attacks. The question posed was when will a far better state of affairs occur in all areas of risk.

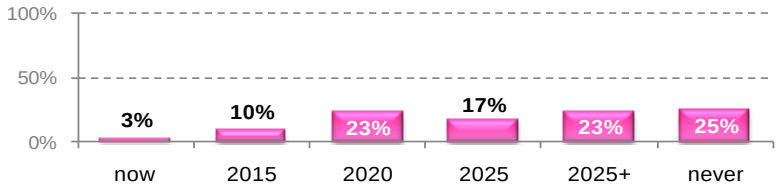


Figure A.19 When will far better resilience, end to end, and a network infrastructure protected from critical failures and cyber-attacks occur?

Our expert base was pessimistic on finding an easy solution to the infrastructure problem. Nearly a quarter thought it might never happen and another near quarter only after 2025. The majority (63%) expected a possible solution sometime after 2020, but largely by 2025 or beyond. The conclusion is that the internet's vulnerabilities are deeply embedded. In fact for a significant proportion (25%) of respondents, they are incurable.

The internet may seem to be bringing the poor of the world forward, in terms of including them in a future global economy and respondents were asked if this was their view in Figure C.15.

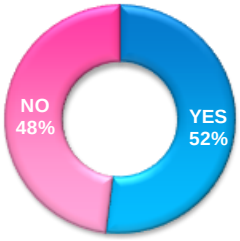
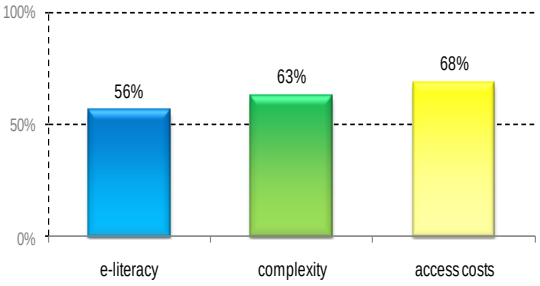
Will low cost telecoms and internet usage bring the poor into the mainstream of the global economy so the gap between the haves and have-nots will diminish?	*Which of the following would contribute to creating the digital poor? – would it be e-literacy, complexity, access costs?*
	

Figure A.20 Will the internet create digital exclusion and thus social exclusion – ie widen or lessen the exclusion gap?

The response was more evenly divided than might be expected – with a slight 4% majority thinking the internet would close the gaps between the haves and have-nots in the global economy. The major inhibitor was felt to be access cost, followed by complexity for the less educated and the challenge of gaining e-literacy. The majority of respondents saw each of these factors as significant.

Breakdown by respondent category

For certain key questions, respondents were classified by geographic region, age, gender and occupational segment. The overall classification of respondents is shown in Figure C.16.

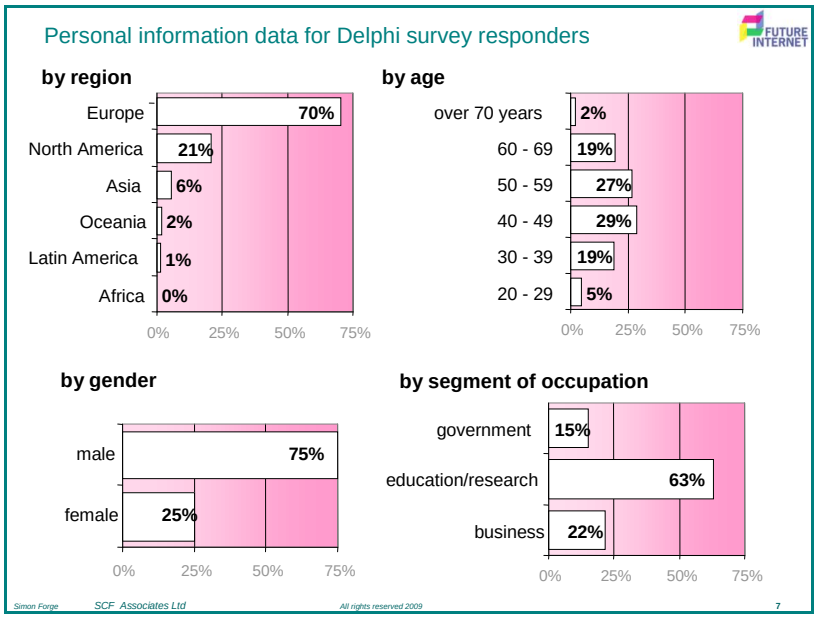


Figure A.21 Overall classification of respondents

Conclusion from the first round

On the whole, the first round of the Delphi survey confirmed the internet as an increasingly significant influence on daily life and lifestyle. Most believe that it will become indispensable for finding and maintaining employment, and represent the principal social interactive conduit for a majority across the globe.

Overall, experts believe that in 2020 the **general usage** of the internet will become vital for the vast majority of people. It is expected that between 11-50% of a person's day will be directly influenced by the internet. The internet will basically permeate most aspects of our lives. Today most of us use the internet to retrieve or share information. However, by 2020 the internet is expected to support all basic voice and data communications. It is also going to continue playing an important role in the promotion of social networks such as Facebook, LinkedIn, Twitter and the like. Entertainment and employment related services will also be widely accessible and used via the internet. It will be a central pillar of basic communications and it will be the primary source of news and information. From its many possible uses, the interconnection of human, machines and sensors/tags is possibly perceived as too challenging to be achieved by 2020, probably a few years later. Overall, the socio-economic use of the internet will without a doubt exceed the **political usage**. The majority of government services will use the internet to interact with people. For instance, citizens will be able to access basic information or to engage in simple communications with government agencies. Detailed advice, however, will still be delivered via face-to-face interactions. Politicians and governments will seek to use the internet to influence politics. Nowadays the internet has proven quite a powerful tool to help campaign groups to coordinate supporters in specific political actions. Political parties will be fundraising, recruiting and interacting with their members through the Web. We may also see more widely use of online consultations on specific legislation or government polices. However, we may not see the internet being used to organize e-referenda for direct democracy leading to legislation. Such an ambitious objective may never been achieved if we do not improve the security of the World Wide Web. Learning and education processes will also be impacted at most levels. Today the internet has penetrated education mainly at the university level (both undergraduate and post-graduate). But, by 2020, vocational retraining, secondary education and long life learning will also be deeply influenced by the internet. The impact on primary education remains to be seen. A few people even suggest that the internet will never have a considerable effect on primary education.

In terms of **business usage**, there is a general perception that by 2020 the internet will become vital for the vast majority of business functions. Today research and development, marketing and personal relations are heavily influenced by the Web, but the internet will soon be as vital as electricity for most business activities, including operations, sales, management, human resources and finance. By 2020 there will also be considerable changes for the **users** for the internet. On the one hand, social exclusion will be reduced with smaller gaps for the age, gender and able/disable divides. But, on the other hand, the geography divide may or may not be reduced and wealth and education level will remain important causes of the digital divide. Nevertheless, by 2020 the internet use is expected to increase from the current 60% to 75% of the EU population. Turning now to the issues which may be more important for a "socially-positive" development of the internet, by 2020 low cost and user-friendliness will be the most significant factors, followed closely by trust, security and secure applications, mobile access and open access. Developments such as open standards, network neutrality, multicultural/multilingual interfaces or collaborative tools seem to have lower levels of importance or impact for a "socially-positive" internet.

By 2020 some **functionality and human interface expectations** will be met while others, unfortunately, will not be achieved. First, mobile internet will be available throughout the EU. Second, most citizens will trust online transactions and financial services. Third, the internet will not reach acceptable levels of privacy or crime prevention. Fourth, the internet will not be secure and reliable enough for vital services in which lives could be lost by malware or malfunctioning, eg remote tele-surgery or air traffic control. Fifth, the average internet use across the EU will exceed watching broadcast TV (including watching TV over the internet as well as other hobbies, such as playing games, listening to music, among others). Closely related to this, we can find the expectations for the internet to become the main TV channel by 2020. The internet will quite probably be more user-friendly, and users will interact in ever more wide-ranging, refined and spontaneous ways. For example, image recognition and gesture detection (with machine vision) or multi-sense technologies may or may not become widely used. Other interface extensions may probably not be extensively used by 2020 but some segments of the user population may be able to test advanced prototype versions of natural language understanding for all EU languages (with interactive voice) or useful intelligence-interpretation interpolation. The widely use of 3D and holographic virtual presence is certainly not expected by 2020, any major developments in these areas will be received with great surprise by the community of users. What is obviously a not very encouraging message is that by 2020 the internet will still remain vulnerable to critical failures and cyber-attacks.

Whether low cost internet usage can contribute to bring the poor into the mainstream of the global economy remains to be seen. There are no clear prospects. The internet may or may not contribute to lessen the **exclusion** gap mainly because access costs (even if they are very low) and complexity will be key contributors to the Digital Poverty in 2020. Of course, there will continue be new **sociological and psychological behaviours** as a result of internet usage and penetration in society. Internet cultures will tend to be more creative and the internet will form new adjunct to society with increased social interactions. Jobs and the economy are more likely to be dependent on the internet by 2020.

The internet will also play an important role in **global issues**. For this reason, there will be many further attempts to apply more political control to the internet (globally and nationally). The current global and economic conditions will accelerate internet usage in many areas and sectors with new actors trying to enter the game and conquer spaces while existing actors will try to maintain or improve their position. There are strong conflicting views on whether the internet will ever contribute to create a new form of ‘capitalism’, based more on individuals, SMEs and personal content thus leading to a form of post-corporate economy in which the larger organizations have less of a leverage of size. Similarly, there is no consensus on whether the internet may or may not challenge the global balance in trade and power by 2020. What is clear is that **governance** structures will be needed for the internet and that it will be politically difficult for the internet governance to go to international actors, such as the United Nations.

With regards to the **evolution** of the internet, we may or may not see revolutionary changes by 2020. The internet will be mainly characterized as a convenience and lifestyle management tool for everyday life, on the one hand, and a safe utility for information, work and entertainment, on the other. A third feature, which is rapidly growing, is the role of the internet as a social place where people can learn, discuss and form opinions. The idea of having multiple “internets” with special attributes by usage (eg a secure e-commerce version, and/or a real-time safer/more resilient form for vital functions such as surgery, and/or

a social networking internet with privacy functions) does not seem to convince a considerable number of people, thus its realization will certainly surprise many, perhaps not in a positive way. An alternative, apparently less conflictive and possible situation for 2020, would be to have an internet with tiers of value and privacy/security. Given that tiering implies premium services against standard offerings, the key question here is: what does society gain with tiering? Is this going to reduce or increase exclusion or the digital divide between those with premium services and those with standard ones? Another possible situation for 2020 would be for user-generated content to become dominant, be it via broadcast (one-to-many push), or peer to peer, or via user-controlled pull. Equally feasible would be for the *internet of things* – with billions of objects reachable through the Web – to become increasingly significant. As for the idea of the internet of smart things, it certainly sounds catchy but the truth is that it is very unlikely, at least by 2020. Now, internet services will quite probably not be mainly paid for by subscription and advertising by 2020, instead, new business models are expected to emerge and flourish. The internet may also become more 'intelligent' and be able to understand users' requirements with greater use of semantics, for example. Proposals of new business models charging for internet applications which are "free" today will be controversial. In the same way, an internet divided into paid-for and a few free services will be divisive. As mentioned in the discussion about future functionalities (above), the internet will gradually evolve into the TV channel of choice, with a virtual VCR.

One of the interesting findings of the Delphi is that the promotion of e-literacy, the improvement of general levels of education and the reduction of poverty and social inequality appear as the most important **drivers of success** for the take up of the internet by 2020. Naturally, the future development of the internet could also be hampered or slowed down by a number of factors or **inhibitors of success**, such as: the growing uncertainty over the use of personal data and privacy concerns; the new and unexpected threats to internet usage; the percentage (between 10-20%) of the population who categorically refuse to use the internet as it is considered as an unnecessary imposition; and the fears that government interventions to neutralize cyber-crime may slow down future developments of the internet. Furthermore, the inevitable dynamic of these and many other driving and inhibiting factors – not to mention surprises! – together with the speed of research, technology development and innovation (RTDI) in the area of information and communication technologies (ICT), will definitely shape for better or worse the expectations about usage, roles of users, functionalities, interfaces, governance schemes and evolutionary changes presented in the Delphi results.

Results of the Delphi survey: Round 2

In the second round, experts were asked which of the four scenarios they thought was most likely to become reality, and also which of the scenarios they considered most desirable, see table below.

In total 110 experts participated in the second round. The key findings of the Second Round are:

- In terms of likelihood, the "Smooth Trip" scenario is considered as the most likely scenario with 67% likelihood. No other scenario reached similar levels of likelihood.
- The second most likely scenario is "Commercial Big Brother" with 47% likelihood, followed by "Going Green" (33%) and "Power to the e-People" (23%).
- In terms of desirability, "Power to the e-People" appears as the most desirable scenario (62%), in spite of being the less likely.

The second most desirable scenario is "Smooth Trip" (56%), closely followed by "Going Green" (54%). "Commercial Big Brother" is the least desirable scenario (8%).

Opinions of 110 experts	Scenario 1 Smooth Trip	Scenario 2 A green internet Society	Scenario 3 Commercial Big Brother	Scenario 4 Power to the people
All experts (110 experts)	**67% likely** 56% desirable	33% likely 54% desirable	47% likely 8% desirable	23% likely **62% desirable**
Research/Education (68 experts)	**70% likely** 56% desirable	27% likely 52% desirable	50% likely 5% desirable	17% likely **58% desirable**
Business (28 experts)	**54% likely** 50% desirable	38% likely 54% desirable	48% likely 16% desirable	36% likely **64% desirable**
Government (12 experts)	**75% likely** **75% desirable**	42% likely 67% desirable	34% likely 8% desirable	25% likely **75% desirable**
EU (67 experts)	**61% likely** 48% desirable	30% likely 56% desirable	51% likely 7% desirable	23% likely **65% desirable**
Non-EU (43 experts)	**75% likely** **70% desirable**	37% likely 51% desirable	43% likely 10% desirable	21% likely 57% desirable

In terms of perception of likelihood and desirability by type of stakeholder, government experts were even more convinced than the average that the Smooth Trip scenario was not only the most likely (75%) but also desirable (75%). Government experts also rated the Power to the e-People scenario as equally desirable (75%), but much less likely (25%). The views of experts from the research and education sector closely matched the average, while business experts rated the likelihood and desirability of the Smooth Trip scenario slightly less than the average. Compared to the group as a whole, business experts thought Power to the e-People was more likely and more desirable. Surprisingly, business experts thought Power to the e-People was more desirable than Smooth Trip.

Results were also analysed according to geographical location of experts – EV vs. non-EU. Mostly the opinions on likelihood and desirability are similar. However, non-EU experts thought that Smooth Trip was both more likely (75% vs. 61%) and more desirable (70% vs. 48%) than their EU counterparts. EU experts thought that Power to the e-People was the most desirable scenario (65%), but not very likely to become reality (23%).

Appendix D. Scenarios of internet development

Development of alternative scenarios

This appendix describes the four alternative scenarios for internet development that were developed during the course of the study. The scenarios formed the basis for discussion at workshops in Brussels, MIT and Tokyo. The scenarios were developed organically and, consequently, they were modified significantly throughout the course of the study. The versions here are abridged for reasons of brevity so that sections on the key drivers, assumptions and assertions have been removed but they may be found on the website in their full original versions, in the Interim Report.

The purpose of the scenarios was to support the formulation of needs by exploring different potential trajectories of development along plausible paths of what could happen in the future. The scenarios are therefore characterized by different technological options, driven by social, political and economic conditions. They share common initial conditions for economic, demographic, environmental and political factors.[10]

The result was a set of four scenarios that fall along a spectrum ranging from highly evolutionary in nature to highly disruptive. Each scenario has been developed within a framework based on the socio-psychological, economic, technological, political and environmental drivers and inhibitors. The resulting four scenarios are:

1. Smooth Trip - The knowledge-based internet economy
2. Going Green – the green internet economy
3. Commercial Big Brother – a controlled consumer and political world
4. Emergence of the e-Demos – Cooperative solutions: power to the people - user and e-consumer rights rule

Using the previous work from the Delphi and the first workshop with different economic and social contexts, this appendix describes four alternative scenarios for internet development as seen through the eyes of society and individual users.

These particular scenarios have been chosen to take in certain strong trends that we have detected and wish to explore further through appropriate scenarios:

- The rise of the internet economy in general - ie a whole life and workstyle far more dependent on the internet for social and economic operations. In a way this forms a middle road against which we can put scenarios that are more extreme
- Secondly, the rising significance of environmental challenges to everyday life - our technical response to that, through use of an internet for controlling and monitoring everyday impacts on the environment
- Thirdly we consider the trend that the internet is becoming a consumer platform with a social networking environment. We also consider the rising trend of a politico/commercial interest in an

[10] The initial conditions common to all scenarios may be found in the Interim Report, Appendix 3 on the website at.

internet which is generator of revenues from consumers, and a political channel for governments of all stripes. So the internet, to some extent, becomes the 'opium of the people'.

- Finally we consider the trend for the an opposing view, that the internet has been an important forum for democracy and freedom, for dissent and creativity and that this will expand into technical and even governance control by ordinary users – an 'e-demos'.

We can compare and contrast these choices along the axes of social control and awareness of environmental concerns:

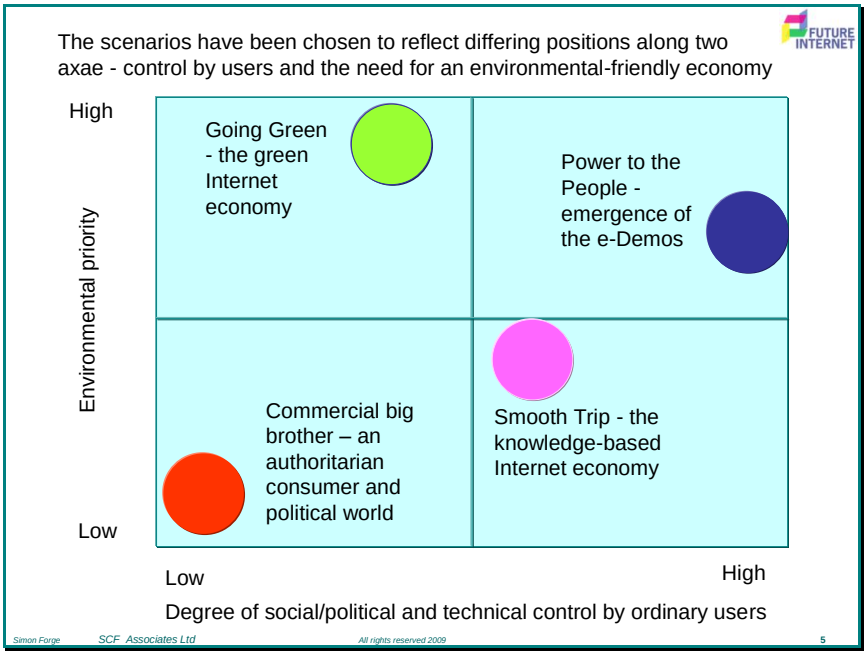


Figure A.22 Positioning of scenarios along two strong trend axes

Scenario 1: Smooth Trip - the knowledge-based internet economy

Overall theme and context

The internet pervades every aspect of public and private life and has become a major engine of social progress and economic growth. It completes its transition from a mere repository of information to a ubiquitous tool for knowledge sharing and creation, a platform for commercial transactions and a simple means for working in teams, within and between organizations.

Hypothesis

The internet becomes a major engine of social progress and economic growth. It pervades every aspect of public and private life. At the same time, privacy and security offline and online become increasingly important and assured. Governments acknowledge the importance of the internet to economic and political stability. Internet governance, under government support, has expanded its direct interactions with citizens. A large proportion of internet surfing by users is done on small mobile devices that connect to larger screens or project on to any surfaces as required. Teleworking and remote collaboration are more and more accepted across organizations, both in the public and private sectors. Users conduct more and more activity online and this has enhanced the conveniences of daily life tremendously, allowing more time to concentrate on life goals, family, friends and hobbies. It completes its transition from a mere repository of information to a ubiquitous tool for knowledge sharing and creation, a platform for commercial transactions and a simple means for working in teams, within and between organizations. The majority of web and internet access is mobile, portable and nomadic. Augmented reality is an important added value to software applications, particularly in urban navigation, health care and gaming. Although the user community is more united, there is greater diversity and customization in the use of the internet.

Scenario

Governments have acknowledged the importance of the internet to economic and political stability and have learned to expand its use for communicating with citizens. From the user's perspective, there is very

little that is not available online and this has enhanced the conveniences of daily life tremendously, allowing more time to concentrate on life goals, family, friends and hobbies. Remote working is commonplace and geographically-dispersed relationships are made easier through the use of enhanced social networks. The gap in use of the internet between men and women, young and old, able and disabled, low-income and high-income has narrowed owing to the widespread availability of the internet at an increasingly affordable cost. Mobile devices and networks are the norm, both indoors and outdoors, and users can typically find free and easy-to-use urban networks for anytime and anywhere access. Moreover, an expanded internet that includes everyday items (from toothbrushes to buildings, signs, posters and documents) means that a plethora of information can be dynamically uploaded in indoor and outdoor urban settings, stores, enterprises, museums and in the home.

The development of the new internet was incremental, with changes occurring on the demand side and the supply side, in response to both commercial interests and the public interest by users, enterprises and governments. Although this evolution was not always smooth, open multidisciplinary dialogue across sectors together with the growing power of online political expression and user-generated content ensured a strong voice for the user community. A solid focus on social development emerged. Moreover, following a number of crises in the financial sector, awareness grew of the need to foster longer-term visions and to reward based on merit and performance. The public discourse revolved around the need to build a new digital world for the many rather than the privileged few. A dwindling middle class was viewed as an ill for which a knowledge-based internet economy could offer a much-needed cure. The internet thus became the great equalizer, helping an ageing Europe to better compete with American innovation and the Asian giants now dominating the global economic scene. European competitiveness also benefitted from a shift in immigration policy that was intended to address a shrinking labour force and so-called brain drain.

In contrast to policies in the US, European digital policy placed a strong emphasis on consumer protection and privacy. This fostered a greater trust in the network and encouraged more and more interaction online. eGovernment services thrived, although there remained concerns for those being left behind. The use of the internet by small and medium-sized enterprises (SMEs) grew significantly, as a result of concerted European and national awareness campaigns and training centres. Given the preponderance of SMEs in Europe, the fact that an increasing number became network-enabled also encouraged individuals at home to take-up internet services. This led to greater collaboration between businesses, more teleworking and remote group working, as well as enhanced transparency and continuity of operations.

Internet services are more and more customized and personalized and search engines become more sophisticated in terms of knowledge dissemination and filtering. But at the same time, some governments impose limitations on internet networks (eg nationally controlled search engines and content), in line with their legal and cultural norms or ideology. This continues to cause tension in what has always been hailed as the world's global and equal network for all.

Vignette for Scenario 1: A day in the life of Alex

The day began as it always does. But for Alex this was no ordinary day. It was 7 am and the coffee maker had begun making those all too familiar noises. Soon the aroma of dark brown roast invaded the house. Lights began turning on automatically. But Alex didn't need the smell of coffee or even her household *robodog* "Bot" to wake her up. She was already sitting up in bed. Her first trip to meet her boss in Hong Kong was in less than 8 hours and there was so much to do! Although she knew her well and had worked with her for over a year, they had never actually met offline. Most of their interaction was via chat, email or video. But she was now up for an important promotion and they both decided on a three-day face-to-face meeting in Hong Kong, where they would be joined by partners and their CEO.

Alex sips her cup of coffee at the kitchen table while browsing the latest news. Her kitchen table is made of transparent glass through which she can view a high-definition screen. She navigates using simple voice commands (though there is also a small control panel navigator embedded in the table itself). She decides to broadcast a message to her network concerning a recent event of interest. She sees by the images and activity on screen that there is a lot of interest in this little bit of news. Maybe she'll use it to make conversation when she meets the CEO. Alex also checks her hotel reservations. All of her data is stored digitally in a remote location, from files and documents to pictures, music, movies and so on.

Over breakfast made from only low-fat organic ingredients her fridge ordered over the internet, Alex has a video chat with her fiancé who is currently living in another city. He's very excited about Alex's possible promotion and will be meeting her in Hong Kong after her interview for some sight-seeing. As usual, he has left things until the last minute and since he hadn't booked his flight yet, they find a suitable flight together online. They share a screen making it easier to collaborate and multi-task. After breakfast, Alex starts getting ready for her day. As she has had a couple of warnings from her doctor about cholesterol levels, an automatic health check is performed as she brushes her teeth, using special sensors in a finger-checking device (blood test, cardiovascular checks) as well as in the floor (for weight and balance distribution).

Alex remembers that she has to prepare a document with a colleague and they do this together on what has replaced the wiki. They use voice-only communications combined with an effective way to draft text in real time. Somehow they have mastered the art, and get on rather quickly. Once that's out of the way, Alex turns her attention to packing. As all of her clothes are embedded with ID tags, there is a secure database that itemizes every item in her wardrobe. Using a user-friendly touch interface, Alex is able to coordinate her outfits, based on colour, type (top, skirt, jacket) and occasion. She finishes packing in no time, and even better, she can easily check if she's forgotten anything using her suitcase's RFID reader.

After packing, Alex heads out for some last-minute shopping. With her mobile device, she can request easy low-traffic routes to get to her favourite stores, as well as customized interactive maps with comments from retailers or other shoppers. She has the choice of using her in-car screen when stopped. Her sensor-equipped car enhances road safety through anti-collision mechanisms. It has also taken the hassle out of finding parking and squeezing into a spot. Its auto-pilot function can take over if the driver is inebriated within 5 km of the home location, and can warn the driver they are asleep at the wheel. Most people still prefer the fun of driving themselves, but it's good to know it's there just in case.

Once at the mall, she scans items in stores to see if they are the correct size or if they have any ingredients that she dislikes or to which she is allergic, eg aspartame, monosodium glutamate. She can also read reviews by other customers or access additional information from the web. As usual, she has activated fairly strong privacy settings, which enable anonymous browsing and purchasing of items. While waiting to try something on, she checks in for her flight online. A fingerprint sensor on her mobile device already checks her identity securely and will reduce security checks at the airport.

Having accomplished so much in a few hours, Alex has time for a workout at home. She really enjoys her motion-sensitive multiplayer gaming system and hopes that her favourite challengers are online. Nothing better than "burning off steam" with friends particularly before a big interview! So for a good hour, Alex forgets all about the stress of her upcoming trip. Who knows what might be just around the corner? Imagine that: passed level 19 already! With the winnings, she buys her virtual property another floor – she always wanted to have a gym there too!

Scenario 2: Going Green – the green internet economy

Overall theme and context

Global warming and the internet economy are inextricably linked. The internet plays a crucial role in combating climate change and achieving sustainability in Europe. The internet underpins new *über-green* technologies that enable a low-carbon green society.

Hypothesis

The internet becomes key to achieving environmental sustainability. It is no longer seen as just an important part of the solution for combating climate change in Europe – it is the enabler of a low-carbon society. The internet becomes the foundation of an emerging green economy.

Governments take ambitious and aggressive action as they move forward with green legislation and taxation, regulatory policies and with financing the manufacturing of *über-green* technologies. Vast investments are made in innovative clean and green technologies and in the high-speed broadband networks infrastructure that are vital to the implementation of green solutions.

The urgency to deal with the global warming crisis unites EU countries. Close industry alliances are formed to accelerate the development of green technologies. New commercial markets arise for green

products and services. The EU leads the way in creating a low-carbon society and becomes a market leader in the global environmental market.

Although the demands upon society to change attitudes, behaviours and actions are onerous, there is a collective cooperation and full participation in governmental climate change directives and programmes.

The increase in natural disasters brings global attention to other parts of the world. This leads people to feel greater interconnectedness as a human race and interdependence with one another. People turn to the internet as a vehicle for summoning the collective will to do what is necessary to meet the global warming crisis. The internet enables individuals to create a united global front for aid and assistance in the face of natural disasters and devastation.

Scenario

Time has run out. The global environmental crisis has accelerated beyond all predictions and peaks around 2018. Although governments have taken steps to reduce CO_2 emissions, giant leaps are now required. Mitigating climate change has become core to human survival – not only environmentally, but also economically, politically and socially. It is clearer than ever that sustainability is crucial for long-term economic growth and competitiveness for the EU.

ICT is a key mechanism for achieving a low-carbon society. Since connectivity will be the backbone of all ICT green solutions, the internet is intrinsic to all solutions. The application and diffusion of ICT in virtually all industries will significantly reduce total global CO_2 emissions by 2020. However, real gains come when replacing carbon-intensive activities with ICT has become dominant.

To gain a competitive edge there is a further convergence among the ICT industry sub-sectors: consumer electronics, equipment manufacturing, service providers and internet and software companies.

The focus is on green and smart – smart motors, smart logistics, smart grids, smart buildings and dematerialization. The smart comes from the intelligence in monitoring, controlling, adjustment, management, automation and substitution. Smart and green is embedded in the new green industry sectors: transportation, building and construction, environmental protection, manufacturing, recycling, regeneration and waste reduction.

The vast investment in tackling climate change has generated millions of new green jobs in many sectors throughout the EU. Although the areas with the greatest growth have been technical ones with technicians, technologists and engineers in most demand, the opportunities for green employment are immense. The green economy is dependent upon a wide spectrum of diverse non-technical expertise, skills and labour in traditional fields with added green expertise. Online green educational courses become core to 'greening' the workforce.

A green economy takes hold and permeates all facets of political, economic and social institutions. The common denominator is environmentally sustainable and socially responsible actions and activities. The shared goal is to reduce or avoid environmental damage and not to contribute to it.

With the green economy comes market mechanisms for monetizing carbon emissions in which energy efficiency and emissions reduction are rewarded. The free market of carbon-emission trading doesn't only take place among industry or countries. A personal carbon allowance gives individuals the right to emit the same amount of carbon – effectively a cap-and-trade scheme. Those who live beneath their allowance can sell their carbon credits to others. The personal allowance isn't free however – there is a flat carbon tax that applies to all households. Carbon accounting helps individuals and business to take responsibility for their use and provides incentives to use energy efficient products and services.

The governance that underpins the green economy is highly regulatory, with legislation and policy measures for everything related to CO_2 reduction and environmental protection. Regulation enforcement is through penalties and taxation to reinforce environmentally conscious behaviour.

Public, business and domestic internet infrastructures are put in place with monitors, sensors and data collectors with which to continually measure and assess emissions generated by products, services and behaviours. Actions with an adverse impact on the environment can be quickly identified. The 24/7

monitoring enables immediate corrective action for optimum environmental protection. This is not optional – it's compulsory – all homes, businesses and public places are wired up and monitored.

All carbon footprints are scrutinized and held accountable including ICT and internet footprints. Through a green low-carbon reconfiguration of the internet and server farms it's no longer the fastest growing source of CO_2. Access to the internet is mainly with environmentally friendly cell phones and devices that fit in a palm, slip into a pocket or a petite bag – for on-the-go-anywhere connection. Since personal computers accounted for half of the internet's energy consumption, this is significantly reduced as they are no longer the main source of connectivity. ICT and internet footprints are further reduced through e-production – e-consumption and e-disposal.

Governance of the internet puts its sustainable growth at the forefront of all policies and legislation. Ensuring that the future growth of the internet is consistent with climate change mitigation brings stakeholders together in accordance with the development of a green internet.

Societies everywhere are forced to undergo a major transformation. The erupting global warming crisis forces society to make rapid changes to cultural attitudes and behaviours. The very fabric of society is changing – from one of plenty, growth and individual fulfilment to one of reduction, re-use and elimination.

The shock to the social system reverberates and at first it feels like a "Can't Have – Can't Do" green society. Society is perceived as one that induces guilt for carbon greedy behaviours and that rewards environmentally acceptable behaviours and penalizes others.

Society unites around the global crisis and reorganizes around the need to shift to a green society. The internet becomes the foundation of a new social order. It has been the key enabler for the shift in environmental consciousness that was necessary to reduce greenhouse gas emissions and thereby restore the planet to a healthy state.

Inasmuch as it is a regulatory requirement to monitor, record and manage domestic energy consumption, the government has equipped all homes with broadband communications and small devices with which to connect to the internet.

The government capitalizes on this direct line to homes to re-educate the populace on individual contribution and responsibility. Through the internet they deliver educational campaigns and information on current environmental issues, guidelines for green living and the status of green initiatives.

The psychological shift required from individuals has been tremendous. It continues to be difficult for people to make the trade-off between the daily choices that will erode the quality of their lives so that others in the world can have some quality in their lives and for the sake of future generations. Local community internet pods offers both online and human support to help individuals to make this tough transition. Members of the community congregate around online forums and real-time video links to other parts of the globe. This has helped to cultivate a think globally, but live locally perspective and attitude. Although individuals have access to the same links in their homes, the community pods provide social unity and a sense of comradeship.

Tele-working and video conferencing cease to be high technology luxury concepts of the 20th century. Working from home is now the norm. Carbon accountancy includes car usage and air travel. Ultra-green automobiles – plug-in hybrids, battery-electric, micro-hybrid – cars with plug in technologies use far fewer carbon credits, nevertheless individuals still need to make conscious decisions about whether to drive, walk, bicycle, order over the internet and stay at home.

Government policies heavily subsidize plug-ins in order to stimulate the take up of alternative forms of transport, both public and private. By 2020 a car free society has been achieved. Besides walking and cycling, electric powered pods are the primary source of transport.

Since air travel had been the fastest growing source of carbon dioxide, business travel has been reduced to the absolute bare minimum. Corporations are careful not to use up their carbon credits in this way unless it's necessary. Technological advancements in video conferencing combined with sophisticated project interaction tools no longer place this form of conducting business second.

Air travel has been further reduced through the decline in tourism. This has been driven by the instability and havoc caused by natural disasters in other parts of the world and also by the carbon costs of air travel that are deducted from personal carbon accounts. People chose to spend their energy quota in other ways – ways that make a direct contribution to the well being of the planet.

The internet culture has also undergone a dramatic change. Individuals have been forced to change their pattern of usage in order to cut energy consumption. There is no longer the luxury of endless hours of frivolous searching, downloading and printing of information. Specialized and focused applications reduce time and energy wasting information searching. Information is downloaded to environmentally friendly hand-held devices and projected onto minimal energy consuming surfaces. Internet governance has made it increasingly difficult for the internet to be used for socially, economically and politically subversive activities.

Social internet media takes on a new dimension in the green society and thereby is instrumental in the psychological and behavioural shifts that are crucial to a green economy. Tweets and Facebook-like communications give way to an eco-conscious internet culture. Social networking enables people to feel a global inter-connectedness. The feeling of being part of a greater whole inspires eco-socionets to broaden their vision globally instead of focusing on personal and local environmental issues. Collectively they rally around the globe via Ewits to spread environmental consciousness – consume less, share more, live simply so that others can live.

The race against the climate crisis and the competition to develop green technologies continues to make it difficult to balance EU needs with global ones. As the number and nature of environmental catastrophes intensify and entire nations are demolished individuals find it difficult to focus only on local environmental issues. There is a perception that the governmental focus on regulatory and commercial environments excludes addressing the climate crisis at a global level – saving the planet has become secondary.

However strong online eco-sociopolitical communities' aggressive intolerance for environmentally destructive practices in the world brings global pressure to bear which forces offending countries to stop. Eco-networking enables people around the world to collaborate to evoke global change and to bring awareness to parts of the world in urgent need.

Individuals and online eco-communities use innovative web-based tools and applications, which have become vital in global disaster relief. Mobile platforms, computational linguistics, geospatial technologies and visual analytics are used to power early warning for rapid response to complex emergencies and rescue efforts. Instead of commercially vested interests, these are humanitarian driven and therefore are open-source and free.

Social networking tools have become core to dealing with global catastrophes by quickly mobilizing help in the global community and through the rapid conveyance of short bytes of communications and information to distressed places. Developments in internet infrastructures now make it possible to have global 24/7 network even when a countries' landline, mobile phone satellite infrastructures have been devastated.

By 2016 the global demand for bandwidth will quadruple. This internet growth is being met by a transoceanic building surge. The new cabling information system has far greater bandwidth and enough redundancy to overcome the physical vulnerabilities of the old one. The key uncertainties relating to the internet infrastructure have been resolved so that remote regions and developing countries are now successfully connected. A global internet has become intrinsic to creating a green world environment in which all countries are inter-connected and connected equally.

Vignette for Scenario 2: A Day in a Green Life

Leonora's internal clock has been programmed to wake her up naturally – she abandoned energy consuming alarm clocks long ago. She adjusts the pillows behind her back and sits up in bed as she points to the blank wall in front of her to open up her agenda. She contemplates her schedule for the day. Some of the entries are highlighted which indicates these activities involve green choices she'll need to make at certain points in the day. Entries in bold indicate where in the globe she'll 'be'. Since her first appointment is pending confirmation, Leonora clicks on the entry to open communications to see whether her architect from across the globe will be available to meet with her to discuss the final touches to her eco-house. He has left a one word sound byte message – "no".

Before greeting the day, Leonora takes a moment to breathe in gratitude for her beautiful new home. Even though it's a high-grade eco-house and was constructed entirely from natural and recycled materials, it's beautiful and aesthetically pleasing. She had gone all out on it and spared no expense to ensure that it was truly a zero-carbon house. Toilets are flushed by a rainwater system and a combined heat and power system turns wood chips into electricity and hot water. The sloping roof echoes the contours of nearby hills and catches rainwater that is used both for drinking and to cool the house. A combination of solar and wind keeps her warm or cool depending on the temperature outside.

Although the entire house is wired up with an innovative energy monitoring system and with sophisticated electronic gadgets to keep her zero-carbon life on track, she was careful not to indulge in frivolous energy consuming technologies. She kept her technology needs simple and as low carbon as possible. She figured she basically only needed three things: high speed broadband connectivity, an environmentally friendly all encompassing hand-held mobile device – the one she had looked like a Chanel compact – and lots of surfaces to project onto. She'd tossed everything else out long ago. That hadn't been easy, but living in a global green society wasn't easy either. There were always constant trade-offs to be made – like for example, the cup of coffee she'd love to have right now, but wouldn't because of the impact global warming had on coffee production.

Leonora fills a mug with rainwater and throws in a few organic hibiscus flower petals and goes into her studio to begin her day. First, she checks the status of the energy consumption in the house on the digital monitoring system to make sure everything is within the targets she's set. These are the one's she goes by because they're considerably lower than those set by government regulations. She scrolls down the list projected on the glass panel in front of her desk to the second item and feels a wave of procrastination. She's been commissioned to develop a global-wide awareness campaign to get the message across to all societies and cultures that it'll take more than technology to fix the planet. It's a massive project but with Ewittering, social networking, video-tele-voice conferencing she'll be able to collaborate with everyone on the globe she needs to and won't even need to leave home.

Leonora decides that she can put off doing the project planning until tomorrow. The sun is out and she feels like doing something fun. However right now, low-carbon fun isn't very appealing. She could do with a break from a zero carbon and 100% work life. She closes the file and points to her carbon-account file and checks her balance and laughs. She's not called a digital native for nothing! Her continual reduction of material goods combined with a monthly surplus of carbon credit, on top of which the reward credits she gained for actions of positive environmental impact have provided her with a very healthy balance. Normally, she would acquiesce to the requests to sell credits to those who haven't been able to live within their carbon quota. But this time, she is tempted to spend it on herself. There's always the temptation to buy yet another intelligent sensing gadget for the house or for herself. However, what she really wants is to hop on a plane and visit her parents and family two continents away. Definitely not a low-carbon activity and it would seriously deplete her balance. What the heck – she definitely earned it and it'd been years since she'd been on an airplane.

Leonora decides to go shopping to buy something new to wear for the trip. Because of the environmental impact of new clothing, she occasionally indulges in buying a vintage piece. After showering, Leonora throws her dirty clothes into the laundry basket and notes the gauge indicating the soil level. Before she leaves the house she checks the refrigerator monitor, which shows that the amount of energy being used is out of proportion to the food she has in it. She quickly adjusts it and hopes that it hasn't already registered on the home monitoring system. If it has, she will face a penalty. As she passes the e-garbage bins in the garden she notices a flashing light on one of them. The cleaning lady must have put something wrong into it – an error that would also carry a penalty. Leonora decides not to use up carbon credit by driving her hybrid car. Instead, she walks the four blocks to the station where she'll zip around the Ecopolis in electric powered pods. Armed with her intelligent carbon-debit card she is ready to shop!

Scenario 3: Commercial big brother – an authoritarian consumer and political world

Overall theme and context

The internet becomes predominantly a commercial channel for entertainment, retail commerce and advertising. This is mainly directed by the large internet players and the largest companies in Fast-moving consumer goods, retail, advertising, media publishing, being dependent on their funding. Several governments outside the OECD endorse this to push consumerism as an economic goal for themselves, with the proviso that they may censor any political dissent. Future internet technology is shaped to fit the needs of this commercial, social and political role. Large, key players hold the purse strings while governments generally take a back seat and users are relatively passive. Privacy virtually disappears as the internet is shaped by targeted advertising needs to support commercial sales. In some developing countries and with certain types of governments, censorship increases.

Hypothesis

Strategic alliances form between the largest content providers and the dominant internet service providers to maximize consumer revenues. Governments are strongly under the influence of the business conglomerates and so do little or nothing to protect consumers (eg as in allowing high rates charged by US cable and telecoms carriers, TV broadcasters and mobile operators today but getting worse). In certain countries, governments are only interested in political dominance of the internet, allowing free commerce to reign as long as it is apolitical, only building a strong consumer segment, not giving a platform for political dissent. This leads to internet fragmentation at some levels.

Scenario

Development of a consumer media internet is the major thrust. Between 2012 and 2017, the internet becomes popular as a replacement for broadcast TV, offering an interactive consumer channel. In this commercial internet world, content providers and ISPs increasingly market a range of consumer offerings through controlled internet spaces, most often with walled gardens for TV shows, games, etc linked to retail offerings for everything from supermarket shopping to houses. The offerings are more like cable TV or satellite tiered bundles of options than conventional internet access of a freely selective nature.

Such domains are created to maintain user lock-in, effectively closing the network to open access. User privacy effectively ends as commercial concerns can exchange data on every transaction without hindrance. Where restrictions exist, data is stored and exchanged in those countries where privacy laws are ineffective as there are no international agreements that guarantee internet security and privacy.

This form of internet is driven by three ‘carrier’ infrastructure industries:

- Extensions of current internet players – ISPs, search engines plus social networking sites all rolled into one, who carry the above media services and link to sales websites to make their profits.
- Fixed and mobile telecommunications incumbents globally, who develop into national ISP and media brokers to the main content providers, also with their own ‘walled garden’ media products.
- Cloud computing, with hosting sites for applications created by individual enterprises to operate their business and to store vast silos of data, as well as for common ‘productivity tools’ for individuals rented out as a service by the major software vendors.

Early on there are two layers of internet industry structure. First is an upper layer which comprises the large players in retail goods and services, the media industry (especially music), news and advertising. The lower layer consists of an amorphous set of internet service providers of several kinds, players in services such as search, as well as the basic internet and processing provision. They offer network connectivity, processing power and data storage with the necessary infrastructure. However by 2015, these two layers have begun to coalesce.

Thus the older model favoured by telecom incumbents (both fixed and mobile) becomes the norm, that of vertical dominance across the two layers with no off-network access. Most often, such players are re-badged telecoms operators who expand from mobile into internet, sometimes also taking over Wireless ISPs that give alternative mobile access, which is then followed by a phase of acquiring internet content providers. Thus we observe two paths to consolidation: first are the older incumbents from telecoms and

mobile buying content properties nationally then regionally; second, in parallel, are the 'global incumbent internet players' from the upper layer, buying out national and global content properties, and also moving down into software, radio-based networks and even some device hardware, browsers and operating systems. Both routes are building what the market recognizes as the main categories into quintuple plays (TV/audio, VoIP, data/internet services, applets/contents libraries, cloud computing/storage) in which all is paid for in a bundle.

These major consumer culture, communications and internet players merge during a period of strong consolidation into some three massive global players from around 2020. They operate the global market through tacit collaboration. Consequently, using the internet slowly comes to mean being tied into this small range of content providers and ISPs, where the customer pays for all usages. Open free use of the internet and independent websites tends to shrink.

Moreover the incumbent telecoms operators offer ISP services combined with their WAN networks, now commonly labelled as 'NGN'. Thus the new fibre infrastructure is often subsidized by nervous national governments who have been led to believe that closing the digital divide means installing fibre '*near* to the home'. This move solves the incumbent telecoms operators' capital requirements while cementing their network control. The coming of the internet forced them to abandon plain vanilla voice and mobile protocols that are not IP-based. But they have overcome the revenue shortfall by offering much richer fare, with loss-leaders on IP communications (eg VoIP and video calls) via the internet as the way to attract customers to their media channels and advertising.

Such players also leverage security fears to retain power over individuals. They propose that crime, piracy, terror, and other negatives will always be common elements in an *open* system, and that it can never be protected by governments or anyone else. Their closed systems are highlighted as the only answer. Altogether the industry has little interest in user privacy or protection from fraud and in fact may hinder its investigation and forced cessation, if it can do so covertly.

After 2017, as its success as a consumer channel is replicated globally, the internet reduces by 2025 effectively to one major application above all others – TV – because it sells while entertaining. Even by 2015 more than 12 billion devices globally – approaching two TV-capable devices for every person on the planet – are capable of connecting to 500 billion hours of content from broadcast TV, stored and live video. 'TV-everywhere' was aimed at being more personal, social, ubiquitous and informative. It was in fact just more TV. Mundane in quality, it still jumped out of the box or off the wall, to be watched whenever, wherever, because TV remained at the centre of most people's lives. Viewers were connected continually to the screen in a growing number of ways. In response an explosion of content for mobile internet, devices filled the media markets as video came to the internet. By 2015, 95% of all IP traffic is already video and 60% of all video is consumed by viewers over IP networks.

Around 2017 an internet TV entertainment centre ('i-Tec') really takes off globally, as prices fall to mass affordability, so it becomes the main TV device in-home. Kept ultra simple and easy to use, this internet TV does not act like a PC but brings a new kind of TV experience with 4-wall 3D-HDTV-projection for complete immersion and shared viewing experiences with others. Augmented reality places each viewer in a world of immersion, if required with all the other people in the room watching television as if in a simulated 3D scene. These devices are driven by an internet gateway for live presence projections, broadcast, stored video and personal content all blended together. Programmes offer alternative endings with in-programme branching and scripts for 'viewer' participation to which the theatrical characters then react. Thus the differences between passive TV watching and video gaming blur.

Most internet device makers (including the mobile handset makers) are gradually absorbed by global players. There are few independents as the largest internet players have launched their own ecosystems of software and applications for a range of tied consumer devices, so they can maintain exclusive deals.

In parallel, between 2010 and 2020, a new world economy begins to emerge, returning more towards the balance of 1800, as Europe and the USA struggle to survive, becoming lesser players in the emerging world market. Impacts of recession make a flawed recovery for the EU and USA, which then stagnate – especially as their banks become highly reluctant to lend to the real economy, so that GDP growth goes

slightly negative after 2015. Within the EU, any growth is regional and so patchy – being driven by local governments, with high economic migration of workers to those regions with work.

In contrast, the developing world recovers fairly quickly, becoming the centre of real growth. Prosperity for these economies soars as credit is available for expansion, especially in China and India, and all Asia generally as well as Latin America. The number of users in the developing world expands quickly with consumerism. With the greater subscriber numbers in the developing world comes greater dominance by commercial players based in Asia and Latin America.

Through the efforts of content providers and the other types of major players, DRM (digital rights management) becomes embedded in hardware as much as in software. For instance, when a smartphone is updated to allow custom ringtones, and users create their own, the copyright automatically reverts to the phone manufacturer through firmware, or software embedded in the hardware which sends all custom ringtones back to the hardware supplier's website.

Often close links are carefully built between the commercial players, eg the popular media moguls, and governments, and sometimes the two are the same. Overall, governments tend to regard the internet as a tool for commercial use, aimed at consumers. As such they tend to leave it alone as it will stimulate consumption and thus the economy. Regulation of competition is relaxed, allowing large concentrations of market power to be built up without hindrance, so competition suffers as market dominators swell in size.

This sometimes goes further. Some governments see the internet as a way of containing dissent. In their countries, in return for being allowed to operate commercial services, the major internet players agree to block whatever is deemed unsuitable by ruling governments, such as dissident and controversial websites and politically embarrassing content. Effectively, alliances are created between internet commerce and some governments for political repression. In these countries, software called 'No-Worry', pre-installed by law in user devices (mobile handsets and PCs), internet servers and international gateways, performs censorship/website blocking/email trapping/VoIP eavesdropping. Without such censoring controls, the internet is viewed by such governments as too much of a risk, as a tool for dissent. The aim of these governments is to keep the internet world as a popular culture channel for online video marketing of consumer brands as much as possible, with suitably bland entertainment material. Overall the result is to fracture the internet nationally by country and political regime to some extent, with islands of freedom in an enlarging sea of different restrictions. At the information access level, this leads to internet fragmentation, as access is not globally identical.

On the other hand, ideas of digital inclusion and exclusion are not explicitly considered – except as far as they exclude customers from buying pursuits, eg catalogue shopping. Ideas of media literacy are not seen as important, except implicitly in driving uptake of different digital technologies across the markets. Personal take-up is closely tracked, with analyses of attitudinal categorization, featuring demographic profiles of internet users and non-users, for each service, with individual proofing and freely exchanged credit histories, buying patterns and character typing. Those who are technology resisters, hesitators and economizers are identified, with the goal of engaging them as much as possible far more in the digital market. The underlying aim is to introduce mechanisms of involuntary use of the internet and additional payment for services that may not have been knowingly requested.

Also, banks absolve themselves of all responsibilities for online fraud and force their customers to take 'transaction insurance' against the banks' own security weaknesses. This becomes a major revenue stream in a world where physical banks are scarce, online banking is the norm and the internet's security is so poor that it is easy to steal an individual's identity and credit details from the online databases of retailers and banks. As some of the fraudulent funds find their way into the coffers of the political parties in certain countries, international measures can never be agreed somehow, while national security measures are rarely implemented. The porous nature of the internet ensures that even in those countries that do have security measures in place, major fraud problems are rife as sophisticated attacks come in internationally over an infrastructure that is little changed since 2000.

Real technology advances are few. They are largely aimed at consumer gadgets and efficient management of multi-channel lumpy rich asymmetric media flows, with millisecond on-demand provisioning and peak

download management. Mobile bitstreams move beyond 200 Mbps globally by 2020 for rich immersion 3D HDTV, in what is termed '4G', with pockets of 1 to 2 Gbps, termed ELTE (Even Longer Term Evolution). Much use is made of edge caching for video plus a lower rate narrowband channel for mobile handsets. Thus internet engineering builds on the current status quo - not a "next-gen" internet. Instead, the original internet architecture remains in place to 2020 and beyond, continually refined. Refinements take the form of updates to IPv6 in some countries and some whole regions, in a piecemeal fashion. A form of semantic web slowly becomes a new element over the decade following, 2025 to 2035.

Essentially the future internet remains as one whole network as there is little interest in fragmenting into many networks – although effectively this exists at a user level with bundling for walled gardens and content censorship. The old model is able to scale up and with a few extensions is suited to the key purposes of its commercial operators – a platform to sell some limited advances in consumer entertainment. Moreover a single network model is useful for the key activity in the internet business – taking over competitors by buying them out, then adding their network operations. The last thing a buyer wants to do is to waste capital and time on merging incompatible networks, let alone those designed for different content standards so backward compatibility is at a premium.

Slow consolidation then moves towards a duopoly worldwide by 2025, having two vertical players in network connectivity, content/services including cloud computing and storage services. The two incumbents are also major players into other adjacent domains such as retail and logistics as well as advertising agencies and print publishing. The main functions of the internet are then:

- Tracking preferences and profiling individuals for consumer marketing purposes and for some types of political monitoring in some countries.
- TV and radio entertainment channels.
- Social networking, driven and supported by commercial ends.
- Sales pipe for retail FMCG, with e-payments.
- Controlled news, as well as mobile magazines – sports, etc.
- Music and video sales, via downloads and streaming.
- Advertising.
- Semi–officially condoned fraud.

Vignette for Scenario 3: family life across the globe

In a run down 'new town' built in the 1970s outside Paris, aged couple Maude and husband Emile live out the remaining years of their life on a state pension.[11] Their main contact with the outside world in their high rise block of run down small apartments is through television, which is a backplane wall projector, on a monthly subscription. The 2D TV is also used for their mundane supermarket shopping – at least what they can afford to order from one of the supermarket warehouse chains that delivers. Such services are important when you are old, when the lifts are often broken and you live on the fifteenth floor. They are so poor that they only have one TV wall. Their neighbours with unemployment benefits and jobs in the spreading grey economy (the only source of work for half of France's population under 25) have four all-TV walls as well as the ceiling and floor in 3D for immersion adventures, with alternative story branches for endings.

Maude and Emile rarely go out as it is quite dangerous, perhaps once a week to get any other shopping. Their three children have all emigrated, seeking work in the factories, restaurants and offices in Eastern Europe where there are still vestiges of a competitive manufacturing economy. The children make contact rarely. When they do, this is via the TV as well, which acts as a simple videophone but is expensive. The couple also to speak to their other relations via the TV wall and play even some simple games together such as a form of video *boules*, as well as watching over 500 channels, mostly mediocre, such as quiz shows, repeats of soaps and reality TV. Better quality is available from the few massive videostores which

[11] According to the UN, 25% of France will be over 70 in 2015. Chris Giles, 'Ageing populations will pile on pain in the future', *Financial Times*, 29 December 2009.

offer 'BesTV@home' downloads at prices beyond the couple's means. The few videos they have are stored in their personal 'online lockbox' on the internet cloud.

All such services are run by two large global operators – Horizon Bluedam and Bella VistaMex – who offer the S-Web access for TV channels, and telecommunications. Being the largest internet players, they have launched their own ecosystems of software and applications which have become the de facto global standards. The internet is based on a limited form of semantic web platform, the S-Web. In France this connection is usually via fibre optics, with the two operators constantly struggling to control the access network inside each building –and thus the customer. The couple have not consciously chosen how they use their internet access – it is just how it is presented to them. They vaguely remember a former time when it seemed there was more you could do yourself on the internet, but now games and shopping are just like TV programming. This is said to be much safer from the internet scams that grew out of control a decade ago. They can still recall when their neighbour had her 'digital identity' stolen – it took her two years to recover.

Now, all is done via the simple remote control for the TV. This device is also their mobile-TV phone for when they go out, although they rarely use it, as it is pay-per-call, not included in the monthly flat rate subscription they use for TV access in the home. The government some years ago had ideas of using the internet as a channel for public services – health bulletins and even health monitoring and some through-life-educational services – but these died out as the first attempts were cheaply designed, vaguely marketed and had little take up. Moreover the duopoly objected to their channels being competed against even by such weak material. Their large campaign contributions to the major political parties ensured that such public service efforts across Europe soon died out.

We now move to Asia. It is the evening of the day in the monsoon season in 2025. Parents sit in a group and watch their children play outside a row of small houses. A dozen children between eight and ten all have mobile devices on their wrists with gestural and immersion capabilities. They feel and see themselves in 'self-bubbles' of images seen through virtual world glasses, which enable immersion in an imaginary world, yet to see all around them – landing on a strange planet in which their friends are monsters or members of their group, also in outlandish space garb. Here, a rapid growth Asian economy has made radio broadband internet coverage universal. It is mostly used for participatory entertainment and family communications. Serving content on the internet is only available here to large corporates for the delivery of their various 'walled gardens' of fairly mundane entertainment material and consumer services. All is strongly monitored by governments. However, the choice in this country is in some ways wider than Europe, as the global duopoly have to offer access via the S-web to certain media players, strongly attached to the government. These are the former state owned enterprises that demand their share and will not be sold off to the duopoly, as has happened in Europe. JollySun Online is one such independent walled garden player, offering retail access to its tied supermarket chain, as well as media, in local dialects, from its own animation studios. But it uses the proprietary global standards for applications set by the duopoly.

Scenario 4: Power to the People - emergence of the e-Demos

Overall theme and context

The internet advances in a phased manner, as ordinary people have a wide choice of easy to use tools to build a set of cooperative and commercial spaces for their own use as a safe environment. They build a Digitally Connected Society (but not digitally controlled) from a grass roots level upwards so user and e-consumer rights rule. Thus the theme is one of evolution spanning three general stages: the explosion of differences; the great convergence; the emergence of an 'e-Demos'.

Hypotheses

Using self-built "cooperative solutions", power over the internet migrates to the people – so user and e-consumer rights rule, as they build their own environments and applications. People take the initiative, but in no organized way to start with. They push back against the status quo and demand their own way for the internet and to close the digital divide with human engineering. Governments and large corporations are not the drivers, but are rather those who react to a newly shaped popular movement using its internet. The path of internet development is marked by complexity and the unexpected patterns of emergence. People break free of pre-existing and institutionalized identities.

In the public sector, the availability of easy, reasonably secure and functional tools builds new communities with common political and policy interests. Party affiliations and party control of political agendas are subverted by the emergence of new alignments around global policy challenges and issues, civil/private sector affiliations, etc. Increasingly, these affiliations cross national boundaries. Critically, they have transformed both societal discourse and regulation. Discourse has been reshaped by the increasing role of citizen groups as repositories of trusted – if not always trustworthy – information, fuelled deliberately or otherwise by the wide availability of public and private-sector information and the proliferation of data-mashing tools, eg as for data.gov.uk. These groups become increasingly active as policy agents in their own right. A movement towards increased reliance on self- and co-regulatory activity set in motion by eGovernment initiatives and the better regulatory agenda deepens, into "Demos 2.0".

In the private sector, the initial changes triggered by e-commerce and the increasing importance of 'platform' competition drive a progression from 'client-server' models in which ICT is treated as individual capital (consumers purchase their own hard- and software on an individual basis, and take primary responsibility for security, technological currency and quality of service) to an 'access-based' model in which customers contract for the flow of services from ICT hardware, software and operation, increasingly in conjunction with communications.

Scenario

People no longer wish to wait for governments and technologists to decide what the internet of the future should look like and for academics to pontificate on the pros and cons of online communities. They react against government attempts to use the internet for their control and as a way to cut the cost of government. Spontaneously they progressively decide to take matters into their own hands and push hard for the internet they require to support the services they need and want.

The financial meltdown which triggered the recession makes it imperative that ordinary people find new ways to earn, invest, control and manage money. So a next internet is an essential component to drive GDP and employment, as a job accessor, job creator, job migrator. Increased numbers of occupations and of workers are internet dependent worldwide, with radical new employment, business and consumer/prosumer models. These make it possible for users to demand new technologically-enabled ways to earn a living, conduct business - and for consumerism to expand globally.

Ordinary people therefore demand an internet that will enable them to 'take charge' of the events that are having a tremendous impact on the lives of their generation and on future ones. Thus they demand a free and open internet environment in which they can have diverse, easily programmable devices that can connect to any system/device, for any content, service or application they choose. This demands a new level of technology access, aimed at the ordinary person.

Freedom extends to the choice of whatever network they wish to connect to. In the online world, the consumer also demands and gets freedom because new business models, with flexible, low cost and a steady stream of new services favour the consumer and their rights.

The drivers for this lie in personal assertion, expressed in political movements for such causes as the environment as social awareness grows generally. Society as a whole drives a strong demand for "User & E-consumer Rights" – for transparency, trust, fraud-resistance, protection and fair, honest governance rules. Social attitudes focus on community building and bridging gaps in a highly multi-ethnic global society.

Thus there is a shift in requirements to open outwards, to expand the range of contacts, and participate in new (online) communities, for more intensive participatory lifestyles. This builds up against a demographic background of an ageing and already elderly population, dispersed families and single unit families who are generally more politically astute and active.

The advance is led by ordinary people who first build spaces for social interaction, then markets, information spaces, etc as well as a new range of much easier-to-use tools. These destroy the skills barriers to entry. Self-help means self-building and sharing the benefits. By employing these few simple open source tools, they build secure spaces which are resistant to malware, scams, phishing, etc and to commercial intrusion – spam, pop-ups, cookies, etc.

New directions in services and ways of using the internet may largely come from the developing world, starting from Asia and spreading further out into the developing world. Asian/Latin American/African cultures have a community spirit that can be more strongly catalysed by "new web" / "next web" technology. For example, most ordinary people would have their own custom mixes of public and private news feeds that they may share, mixing family news with everyday news events that may touch their circle.

This will make the internet into a platform based on a lowest common denominator device – the mobile phone – as the people where it originates do not have fixed networks and cannot afford laptops, etc. It thus pushes growth of the universal open source smart phone at very low cost, in high volume (ie 4-5 billion unit sales).

The fruits of technical measures for limiting the risks of online activity spread through informal social networks. They stimulate the first collective awareness and security measures. Strong conventions of acceptable behaviour with informal and collaborative innovation push back the boundaries of commercial markets and coercive regulation alike.

In this Connected Society, a new range of 'currencies' from money to knowledge, to time to participation in shared endeavour appears. The richness of this linkage produces a network with dense local clustering. Clustering locally tends to mitigate the dangerous shocks of the high-speed financial networks, prevalent in the 2010s, so they propagate less and only slowly. The emergent 'wisdom of crowds' invests in a local economy lowering the risk from high speed financial disruptions of a global financial machine.

Businesses develops into two major types of firm – large infrastructure operators, regulated as public utilities, including knowledge, financial and natural monopoly services and secondly highly competitive and operationally networked small-scale enterprises, with modest profits usually, and making them sensitive both to evolving consumer needs and bottom-up innovation.

Ultimately, a messy, inefficient and highly diverse society populates the internet having learned to trust a degree of managed chaos. It is impossible to control individual internet behaviour and equally impossible to ignore it. This produces the dynamics of the global internet society that can amplify the impact of even a tiny group. The only possible strategy is to continually experience and sample the diversity of new developments. Such developments are then supported or resisted according to their contributions to the general good, as part of a benign cooperative network in which malicious actions are quite effectively attenuated by withdrawing cooperation.

Vignette for Scenario 4: A morning in one family

The Brand family awakes at different times as the day begins. The children were up late in cyberspace, tending their friends in social networks and working together on a computer-game interface to the family home. This game transformed information from the meters and sensors around the home into a game-scape. All the utilities and services in the home – heating, water and electricity, entertainment and information in- and out-flows and the ordering and delivery of food, clothing, etc were to some degree automated and to a larger degree charged on a congestion basis. The cost of power, for example, varied with the demands of other households in the local area – each home had its own co-generation capability, and the metering system monitored and analysed use in order to time purchases from and sales to the grid, control power utilization and switch off unneeded appliances to maximum advantage. This information was shared with other nearby houses to ensure efficiency at the community level – in other words to balance load through active management of both supply and demand while ensuring that supplies and demands were located as close together as possible. The system also accepted reports from the transport grid, to know when household members would return and when they should leave in the morning. The game designed by local children awarded points on the basis of each household's contribution, which could be exchanged for an unending array of services in the local community or more broadly. Despite their late night, the children were up with the lark and chatting eagerly as they planned the day: meeting their friends at the neighbourhood school in the morning and travelling virtually together to their sister school in Mexico in the afternoon, to conduct an experiment in water conservation and purification. The parents slept until the traffic computer, having analysed the developing patterns of congestion on the communications and transport grid and communicated with their colleagues' systems, decided that the time was right to wake them. Last of all to appear in the kitchen were the grandparents,

who were preparing to spend the day (virtually) in University, teaching classes in the morning and taking them in the afternoon.

The Brand family felt that eating together was very important – so important in fact that twice a week they linked up for lunch as well, sharing the meal with a changing menu of relatives and friends. But this morning, things did not go as planned. One of the grandmothers had developed a fever during the night, and the health monitoring system had ordered bed rest and delivered some medication. No sooner had they digested this news than the Refrigerator cleared its throat: "I'm sorry to disturb you, but a situation has arisen. A fire last night knocked out a digital switch and left three families without connection to any of the national grids or cloud services. This will take several days to repair; would you mind if 20% of the house capacity were shared to keep them going until then?" Of course, the family agreed, but one of the children pointed out that this was the fourth such outage in as many weeks, and that as a result their own quality of service was beginning to suffer – he had lost the chance to participate in a field trip to compete in a v-soccer game against the Shanghai School team, and had been docked 10% because his last assignment was corrupted. The family decided to take the matter further. They contacted their neighbours, and passed a resolution to renegotiate the local cloud service contract in order to require the local loud utility to install a redundant array of digital switches. As they were about to depart, the oldest daughter announced that she would probably be late home, as she was rehearsing a play at a friend's house after school. Her mother objected that she'd begun to make a habit of these rehearsals, and remarked suspiciously that there had been no sign of her practicing her lines at home. Claire replied – well, we are still writing the play – each of us brings what we wrote, and we discuss the text and staging in the school studio. Her father offers to let her use his virtual studio space to host her friends in avatar before he returns home. Instead of resisting, Claire's eyes light up; her father has access to a members-only creative cloud, with state of the art rendering engines and enhanced-bandwidth immersive interfaces which can be used to finalize the staging and lighting and to make improvements to the Fourth Life pad designed by her new boyfriend and romantic lead, to which the cast repairs during breaks in the production process.

Comparing the scenarios

If we compare the scenarios, what we see is a range of socio-economic forces, combined with politico-commercial and ecological pressures which will shape the internet in terms of uses and offerings through reflecting our lifestyles. For instance in Scenario 3, a compliant ageing population, the jobless condition of a significant proportion of the rest of the population in Europe combined with the market power of the major players, turns the internet into an escapist channel for entertainment. Thus its prime function is easily served by large commercial interests and a *laissez-faire* political regime, so it becomes little more than a retail shopping channel with mundane programming.

The range of technological development and its directions are also quite different. In a green world, real-time monitoring of all phases of life is necessary and the internet provides a strong communications channel for this, while in a commercially oriented closed world, technology practically stands still to conserve current revenue streams.

Moreover, the scenarios demonstrate a range of trust, security and privacy issues, which in all cases have been raised in comparison with today but by very different means. In the more optimistic scenarios, this has been combated by going to the root of the problem and changing how internet authentication, authorization and access control works.

The internet also shapes global cultural norms. In an environmentally protective scenario, an eco-conscious internet culture arises, through social networking which enables people to feel a global inter-connectedness. The feeling of being part of a greater whole inspires eco-socionets to broaden their vision globally to collectively rally globally and so spread environmental consciousness – live simply so that others can live. This changes political outlooks, so a perception that the governmental focus on regulatory and commercial environments excludes addressing the climate crisis at a global level as if saving the planet has become secondary.

The range of affordability to obtain global reach, also has to be quite different to the USA or Western Europe. The next internet should be designed for reaching the very poor majority, ie an internet for those on less than US$3 per day, and perhaps down to €1 per day. This would require further examination of:

- How it would be paid for – business architectures in a low cost electronic economy with models of basic value exchanges for payments for infrastructure and services.
- Cultural models, for acceptance and take-up.
- Environmental impact comparisons, positive and negative for ecologically challenged economies.

A further point is whether the scenarios set out above are useful as standalone portraits. Simply comparing the discussions of potential future realities of each ignores the possibility of taking a hybrid of several at once. Thus, for instance Scenario 1 could evolve with climate change into Scenario 2. With civil unrest and reaction to poor economic and social conditions, Scenario 3 might be overturned at some point and then enter the second phase of Scenario 4, of an electronic democracy, because it opens doors to employment and a mobilizing populist platform for a more caring state.

The next step in the study is to begin to explore the implications of these alternative scenarios. This means that we consider the tendencies within the scenarios for different applications to be demanded, ie given the circumstances found in each scenario, what kinds of applications will most be needed by the people.

Appendix E. Needs analysis for the future internet

In this appendix we examine the needs for the future internet through a consideration of the services demanded by its users. The aim in doing this is to match the social and cultural needs with engineering requirements. The central premise is that needs identify the functional requirements of users, which, when specified in detail, will define the overall architecture and specific technology solutions.

First, we examine general requirements in terms of core drivers, socio-economic trends and user perspectives. Then for each scenario, we identify possible outcomes for certain chosen socio-economic trajectories. Next, we distil the resulting requirements into a set of design principles and functional requirements. We then discuss which of the functional requirements could met in a future internet, and which encapsulated in enabling services above the future internet layer.

Collected needs for a future internet

Here we draw together the strands of needs analysis, first, at a general level of the main drivers, then in terms of the main trends at socio-economic level, and then from the perspective of the three main user segments.

Main drivers

The conclusions on future needs and directions, arising from the first round of the Delphi survey, the Brussels workshop and from scenarios and environmental scanning, lead to a model of a future internet through its services for users in the EU and beyond. The needs may be classed in several main groups of drivers but having different ranges of impact while some may also overlap to give needs for:

- Social relationships including the family, but extended to new mobile circles
- Social welfare and inclusion, including government/administration access
- Working efficiently and conveniently for all sizes of firm
- Education, training and adult through-life re-education
- Self-actualization which includes creativity, personalization, self improvement with reskilling
- Environmental affects, positive and negative at personal to planetary levels
- Ageing population support, for living and working – including the above two
- Health and disability support, also with a strong emphasis on ageing support
- Transport, mobility and transport substitution (includes vocational and educational needs, especially for ageing).
- Leisure in the widest sense - shopping, games, infotainment, socializing, etc.
- Security at several granularities and levels– individual, group, nation – for personal physical survival/protection, data protection, financial protection.

Summary of trends due to socio-economic, technological, psychological and human interface factors

A summary of the impacts of the trends – evolutionary and disruptive – gleaned from environmental scanning, through the workshop and Delphi survey is summarized in the table below as the functional requirements of a future internet. Against the main trends given in each socio-economic category are the implications for the functional requirements of a new internet architecture, identifying potential modifications of the current design. The general consensus is that the foundation of our future world will be some form of electronic economy and society, a progressive development of today's internet.

Table A.1Summary of impacts of trends on requirements for internet for each driver

Economic: Formation of internet economy	
Trend (at requirements level)	**Implications for Functional Requirements**
Realization of internet dependence forces search for greater trust with: ▪ Expectancy of effective security - for trading, banking, emergency services, medical real time, etc ▪ Expectancy of greater reliability ▪ More oversight of governance and regulation ▪ Greater protection of identity	▪ Much higher security levels ▪ Enhanced management ▪ Non-stop operation: o Enhanced resilience o Protection from cyber-attacks ▪ Guaranteed performance ▪ Channel for public participation in its own governance for wider / deeper participation
Prosperity-based demand for internet usage	▪ Low cost of access, ie access device and connection ▪ Ease of use (linked to educational and e-literacy levels) ▪ Enhanced trust by consumers and business
Developing nations will become dominant in gross GDP between 2035 and 2050 – so highest growth markets in user numbers and GDP	Design for the developing world: ▪ Costs match local PPP ▪ Suits local conditions ▪ Ease of use (linked to educational and e-literacy levels) ▪ Enhanced trust – for societies of distrust
Specialist internet environments as dependency rises for economic and cultural communities	▪ Separation of network elements for economic and security reasons with national and regional subsets ▪ Support for closed user groups (eg emergency services)
Environmental damage awareness	▪ Sustainable installation and operation ▪ Minimal disruption to natural ecology
Social - Arrival of an internet- based society	
Constant contact and interaction globally – the loss of location and distance	▪ Mobility of contact ▪ Ubiquity – pervasive communications ▪ Protection from cyber attack
Fear of internet intrusion – identity theft, invasion of privacy, etc	Privacy Stronger data protection Protection of (digital) identity with minimal exposure
The internet will be a partial mirror of society - a host of cultural enclaves rather than a single cultural and mental model	▪ Enable diversity ▪ Enable individual expression ▪ Open technology
Internet becomes a significant social interaction platform – a social channel – move away from technical to social uses	Present more complex human signs and markers (visual, audio, gestural)
Shift from the internet of PCs, via an 'internet of things', to an internet of persons.	▪ Pervasive communications for people
▪ Avoid social exclusion due to the internet ▪ The norms of internet usages ('netiquette') spread as everyday social interactions	▪ Internet as infrastructure to facilitate social interaction ▪ Exclusion capabilities of technologies identified ▪ Interface and usage technologies work for inclusion, against exclusion (not so much determined by whether physically on the internet or not) ▪ Support netiquette
Reflect social norms of acceptable behaviour	▪ Ability to set constraints on behaviours, activities and capabilities ▪ Flexibility to evolve with society ▪ Specify requirements from a social standpoint
Social interaction between people's behaviour and internet norms generate the new applications.	▪ Ability for future socializing applications to be shaped collectively ▪ Flexible for personalization on a large scale

Trend to move away from no, or little, liability to seek liability for malicious behaviour, lack of duty of care, negligence, etc	Potential to include laws and policies internationally and for national legislation
Environment seen as responsibility of all	Sustainable installation and operation - minimal disruption to natural ecology
Psychological- internet use shaped by individual view- fears and desires	
Trend (at requirements level)	**Implications for Functional Requirements**
Humanity in internet use and communication: ▪ Less technocentric ▪ Higher demand for electronic forms of communications and socializing	▪ High ease of use ▪ Ergonomic design ▪ Human engineering incorporated ▪ Respond to need for other's presence and belonging with an immediacy of contact - electronically 'together' ▪ Socionets and informal collaboration environments as basis of operations
Personalization – a personal world of familiar objects, ways of doing things, reactions – adaptable to each person, a companion that goes with you and adapts to where you are, who you are	High interfacing adaptability for different models of interaction (eg as big a change as Browser/Web with graphics vs. textline interface)
Confirmation of self through technology usages: ▪ Give value to self esteem – formation of a rewarding 'can-do' environment ▪ Aspirational satisfaction ▪ Individual creativity and discovery	▪ Availability of services at level of a naïve–user's degree of expertise ▪ Open application acceptance ▪ Ease of remote hosting and launch of applications ▪ Positive user experience
▪ Protect privacy of self ▪ Control over use of communication – eg social contact only when chosen	▪ Limited disclosure ▪ Control of personal access ▪ Minimal details of identity revealed
▪ Search for trust - comfortable to be reliant on internet and have high dependence ▪ Prevent intrusion/harm ▪ Search for a safe world – with predictability of behaviour	▪ Prevention of attacks ▪ High reliability ▪ Guaranteed performance ▪ Support during failure ▪ Safeguard identity ▪ Mobility of familiar interface ▪ Reliability, privacy and security
Open to all (ages, education, class) - inclusive	▪ Individual personalization ▪ Human interfaces which are truly intuitive
Counter technophobia: ▪ Avoid exclusion due to technophobia or alienation ▪ Optimism about use of technology (rather than fear/rejection),	▪ Ease of understanding, ease of use ▪ Flexible – in user terms – ie open to diverse customization and subjective personalization for individual needs
Technological – both barriers and accelerators for an internet world	
As new technology enables new possibilities, there is a counter trend – a fear of disruptive advances – so resistance/ may grow against moves to a new generation of fundamental internet technology	▪ Evolutionary mode of development ▪ Ability to conserve continuity of service during changes of technology
User pressures towards becoming a 'social' network and less to remaining with simple technical usage produces a counter–trend to the above – the evolution of a more sophisticated internet, technically advanced using various innovations	Include advances which aid cross layer and cross- application working : ▪ State management ▪ Multicast ▪ Resource management ▪ Identity ▪ Personal data management
Apparently simple but very large scale trends toward the new user technologies, of the Internet of things and RFID, etc	▪ Capability for sensing and sensors ▪ Far more interactions with the physical world
Trend currently to question level of intelligence of the current internet and location of intelligence (outside/inside)	Flexible structures for emerging models of processing, storage and communications balances
An emerging trend today (but still weak) is to move away from traditional PC/server model of a semi-balance of control of processing and data (with the internet as connector) between client and server towards more centralized distributions of processing (eg Software as a service, SaaS - all is on the server - and Cloud computing with thin clients).	Must anticipate future impacts on internet engineering of different processing balance in client-server-data transport, both for a distributed and for centrally controlled: ▪ Anticipate move to thin clients etc, implying less user control and more centralized operation, for emerging models of processing and storage architecture ▪ However a more creative freedom in applications, with user defined structures implies that user control of services and information must be maintained
A stronger trend is that overall, the storage capacity attached to the internet is currently expanding fast. (NB In looking at past storage, processing and network transport models, for the way in which we transport data, internet history is less relevant as the future flows will be so large and the network topology may be quite different)	Anticipate new ratios of network communications capacity to storage capacity - quite different to that of 30 years ago as storage growing fastest.

Make internet function the way it should function as a socio-economic highway network- replace stalled networking advances in NGN, IMS, QoS etc, even IPv6	Accept internet advances in networking areas have run into the sand (eg NGN, IMS, QoS IPv6 etc). Is a clean slate required and is it feasible?
Human Interface	
▪ Trend toward a non-technical user base who demand easier-to-use interfaces (as in the graphical browser Mosaic for the world-wide web, which drove the web take-off) ▪ Strong pressures towards interfaces which are non-exclusionary for those with special needs- ie for the disabled, those unable to read/write etc- and crucial for e-inclusion more generally	Build on concept of a human interface to the environment into the internet, ie to include social and psychological factors, extending from the basic idea of the HCI (which is limited and specific). This embraces idea of the user "experience" (from MIT Media Lab)
Progressive realization (driven by Apple and its followers, Netscape, etc) that the discipline of human interface design impacts all aspects of ICTs, especially internet engineering.	Functional requirements for relevant human-computer interface (HCI) parameters, eg: ▪ Intuitive, universal metaphors ▪ Low e-literacy level required ▪ High comprehensibility – and immediacy - graphics based ▪ Concentration levels and enhances attention span ▪ Optimal information speeds (for optic nerves, etc.) ▪ Low distraction

Three further questions with design implications emerge from the above section, based on how to build and maintain *trust* on the internet through the human interface:

- How to facilitate relationships through the internet, linked to how to value emotions. More cynically, how to make money from emotions?
- Personalization – "my" personal network over the internet – what it means, and how can it be attained.
- The strength of desires for immediacy – and what does 'immediacy' mean? What engineering requirements does this immediacy imply for rich media interactions?

Requirement for the user viewpoint – three user views

We can also take these inputs and rework them to reflect the perspectives of three main user types: 1. Government; 2. Industry – both business users in general and the internet industry players (who could be also classed separately); 3. Consumer. These have overlapping but distinct needs and expectancies of desirable characteristics of the future internet. All user types will profit from ease of use, security and humanized interfaces, with competitive provision of services. Governments want legal interception and an affordable internet if they are to deal with all classes of citizens while consumers also need the latter. Industry wants for the internet as a lever for accumulating market power and control, as a channel for proprietary content, and for global reach, on both its inward supply chain and its distribution sides. There are also conflicts in the desirable attributes between user segments. For instance, while consumers want tools for self expression and open unfettered use, industry players aim at control of the customer, by restricting access to only their own services and content. In Figure E1, the main hoped-for characteristics for each user segment are summarized, with the overlaps.

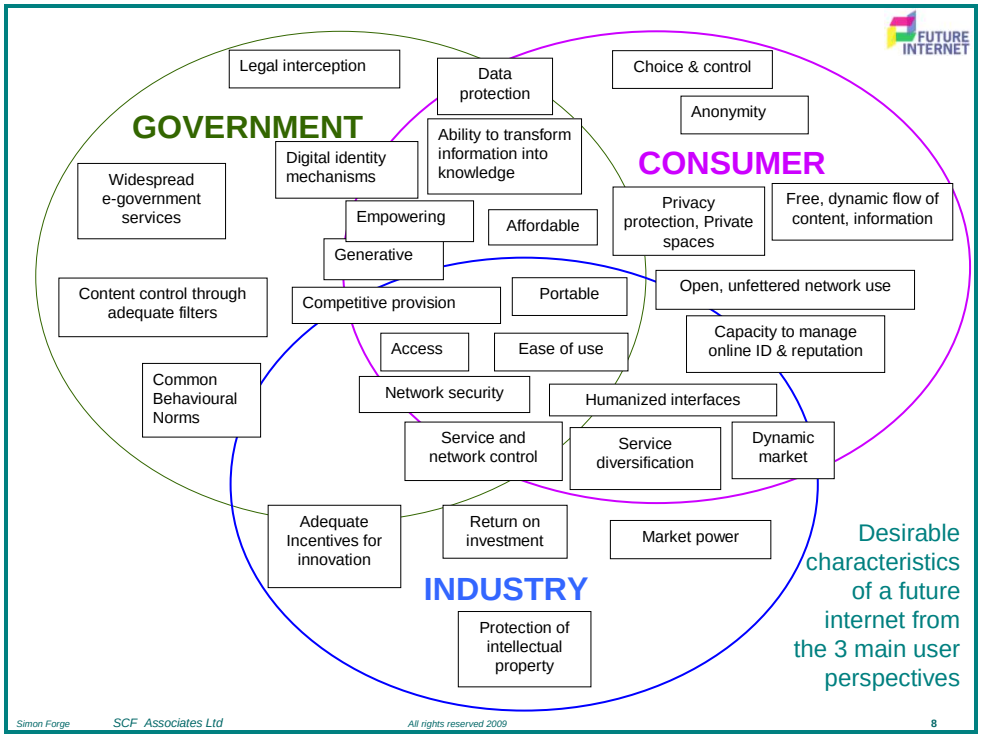


Figure A.23 Desirable internet characteristics expected by various communities of users

Equally interesting are the *undesirable* directions in which a future internet may go by user segment and these are also diverse, even conflicting but with overlaps. While industry fears for its returns on investment, governments fear the digital divide and the loss of control. Consumers fear infringements on their privacy. The main fears over characteristics for each user segment following the information gathered so far are summarized below, with the overlaps.

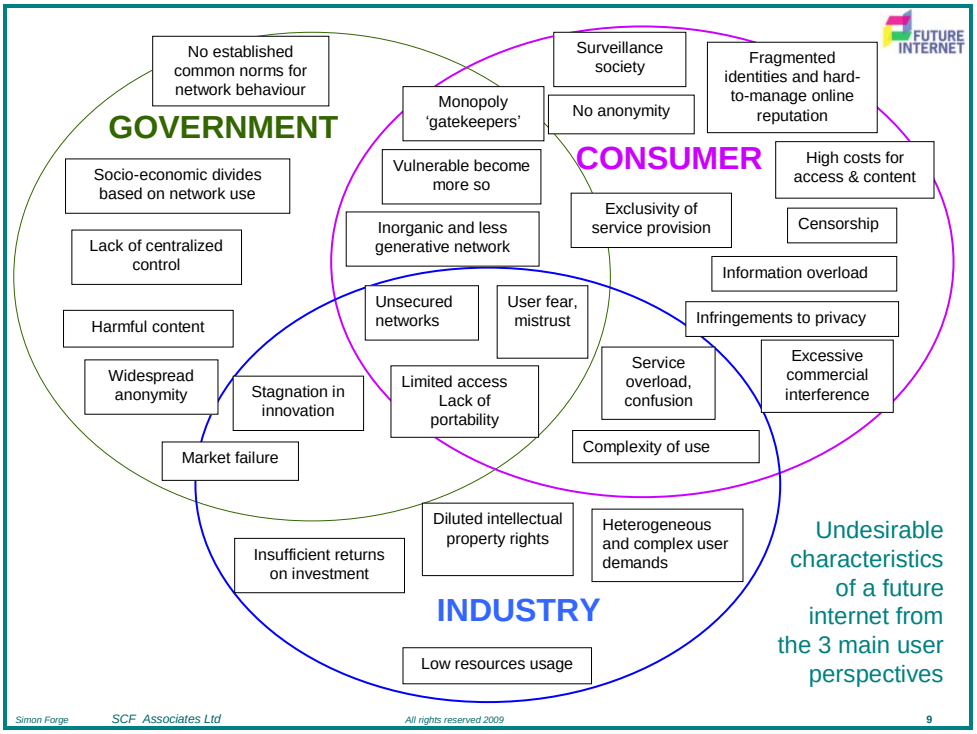


Figure A.24 Three perspectives on the major internet characteristics feared by user communities

Drawing together the strands of needs analysis with scenarios

The next step is to analyse the needs for the future internet leading on to the internet services it should provide to its users. Behind needs stand the motivations for higher level goals, such as self realization through self improvement. For instance, a motivation for self-gratification drives the need for entertainment services. To do this, we use the scenarios as inputs as well as the findings from Chapter 2, including the Delphi survey results and the initial needs workshop, to identify the demand side requirements. Elucidating needs from the scenarios requires identifying the patterns of lifestyles with their services and from these the applications, content and networking that satisfy those needs. The attributes of services with applications and content can then be used to shape design requirements for a future internet.

Elucidating needs from scenarios

The derivation of services from the scenarios, via the needs follows the path below:

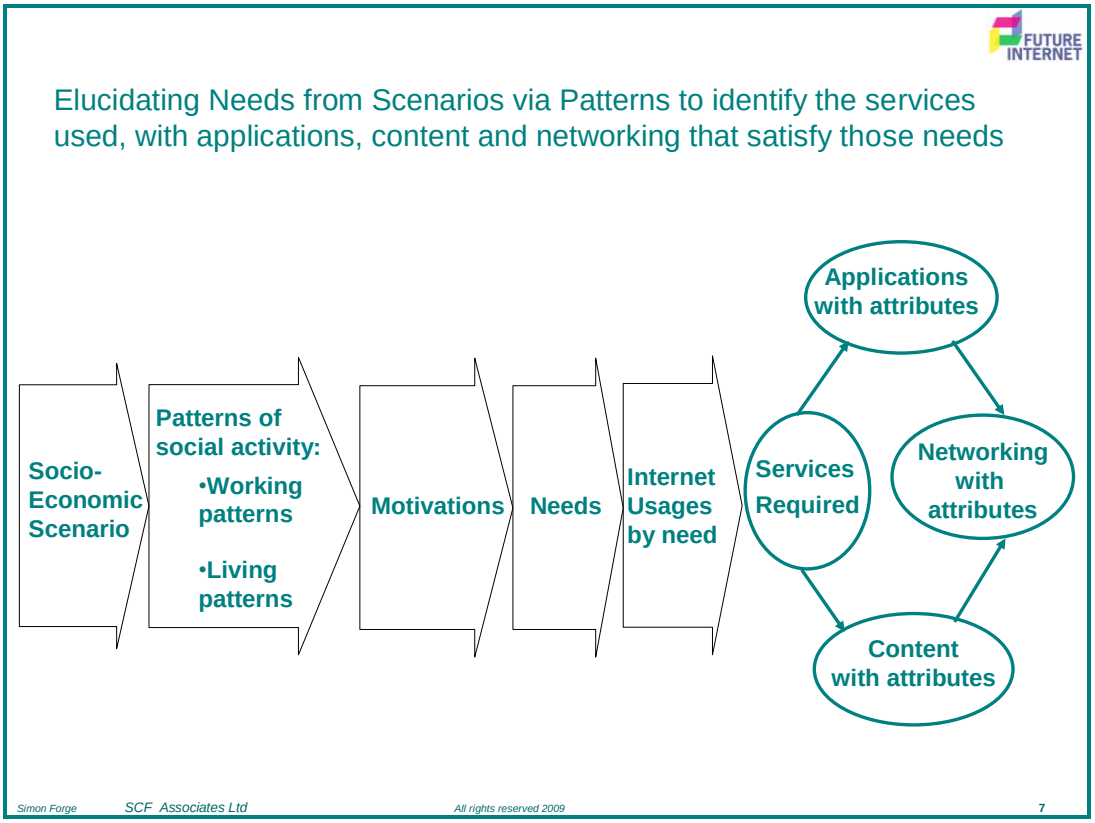


Figure A.25 Elucidating needs from scenarios

The tables below summarize the analysis through motivations and uses to the attributes required for each scenario. The columns to the right, on content services and internet network layer services, are preliminary suggestions for the kinds of features, services and characteristics that are implied by the analyses of socioeconomic needs. These have been derived by desk research and environmental scanning of potential future services. The methodology follows that employed in previous studies for the European Commission.[12]

[12] Eg see http://fms.jrc.ec.europa.eu/pages/about.htm

Table A.2 Mapping from scenarios to needs to application, content and network infrastructure services

Scenario 1	Socio-economic patterns	Motivations	Needs	Applications - service - usages required	Application attributes:security, affordability, etc	Content services	Internet network layer services
Smooth trip - the knowledge-based internet economy **Optimistic, with the internet as an economic development driver for a knowledge economy**	**Economic context** EU has competitive position in world markets achieved with stable growth through trade based on knowledge work, reskilling an ageing workforce to be competitive. Intelligent usage of ICTs to help, not hinder, efficiency.	Self gratification and assertion	Control of several 'worlds', (often with remote presence or proxies for presence)	Transactional capability: ▪ Individual ▪ Business ▪ Peer- peer ▪ Spontaneous	▪ Assured completion & delivery ▪ Security ▪ Privacy ▪ Robustness ▪ Audit ▪ Tracking	Internet business services – eg m-commerce	Hi speed data access (10-100 Mbps or higher), asymmetric. Low speed secure transaction & authentication, low speed 100- kbps – 10Mbps
				Seamless Integration of multiple networks and technologies with location and parameter handover	▪ Seamless ▪ Automatic ▪ Transparent ▪ No latency ▪ No UI affect	Underlying comms-infrastructure with Integration service	Hi speed network management and configuration 10Mbps- 1Gps
	Social patterns ▪ Highly motivated ▪ Status through achievements ▪ Outward seeking ▪ Single parent family on the rise			Time management	▪ Agenda functions ▪ Multiple task control for dialogues & transactions	▪ Personal news services including global news ▪ Reminders and diaries ▪ Agents and proxy services	▪ Multimedia transport 10Mbps – 100Mbps
	Working Patterns ▪ Knowledge work ▪ Reskilling constantly ▪ Mobile working ▪ Portfolio workers ▪ High proportion of active population work (>85%) Aging population but more in work (less and later retirement)		Control of Disruption	▪ Management of unexpected events ▪ Reaction management	▪ Multiple task control for dialogues & transactions ▪ Security ▪ Robustness	▪ Agents and proxy services ▪ Personal alerts service ▪ Personalized events service	▪ Mixed media, 1- 100 Mbps
	Living patterns ▪ Merging work and play ▪ Multiple environments to be controlled (work/family/external social) ▪ Self assertion through knowledge acquisition ▪ High disposable income sets many realizable goals ▪ Autonomy continues on much later for older workers as better		Control of self development & improvement	▪ Distance learning with mobile education and training	▪ Portability of educational/ creative environment	Educational applications Creative applications (design)	
		Self gratification/ stress relief	▪ Escapism ▪ Entertainment ▪ Relaxation ▪ Distraction	Provision of entertainment for relaxation	Ease of use Fashion Advance of general availability	Entertainment services –TV, sport, games, music, gambling, quizzes, etc	Mixed media, 1 Gbps
			▪ Personality assertion	▪ Personalization	▪ Ease of use ▪ Affordability	▪ Personalized environments	▪

	health and medical treatment ▪ Health monitoring is common for all	**Security**	▪ **Alerting** ▪ **Assurance of safety**	▪ **Security services** ▪ **Health services (down to personal level monitoring and robot surgery)** ▪ **Emergency services** ▪ **Location enabled applications**	**Reliability- no failures, false alarms and 24 x 7 availability**	**Security and privacy including for location services**	▪ **High speed communications for monitoring, alerts and treatment 100Mbps – 1GBps** ▪ **Autonomic working for security and life-dependent networks**
		Mobility with Portability	**Ubiquitous access – home, work, inside, outside**	**Good high speed access**	**Security Transparency**	**Underlying comms-infrastructure with integration service and high data rates**	**10-100 Mbps**
			▪ **Accessibility of services and info** ▪ **Portability of personal environment**	▪ **Application group with adaptation by location** **Location enabled applications**	▪ **Common services platform in handset** ▪ **Compensation for limits in delivery networks and personal situation**	**Provision of personal environment and chosen services from any location**	**10-100 Mbps multimedia isochronous**
		Belonging	▪ **Group communication** ▪ **Group identification** ▪ **Socialization**	**Comms services**	**Multi-party Privacy**	▪ **Personalized environments** ▪ **Social networking** ▪ **Dating services**	▪ **High speed comms eg for (group) video calls**
		Identity	**Establish who am I? Special needs (disability, educational, etc)**	**Security authentication services**	▪ **Individual autonomy** ▪ **Control private information -identity theft** ▪ **Protect from state abuse** ▪ **Meet demands from those with disabilities**	**Secure information and transaction services**	
			Where am I?	**Location service = Location enabled applications**		**Identify Location** ▪ **To self** ▪ **To others** ▪ **Block location**	

Scenario 2	Socio-economic patterns	Motivations	Needs	Applications - service - usages required	Application attributes:security, affordability, etc	Content services	Internet network layer services
Internet supports the green internet economy	**Economic Context** ▪ New ecological industries drive economy ▪ Future is bright despite climate challenges ▪ Pressure for immediate and effective action ▪ Race to be first low-carbon economy.	**Safety and security (includes assured reliability)**	▪ **Assurance of safety** ▪ **Alerting** ▪ **Self monitoring**	▪ **Security /emergency services** ▪ **Real-time control of 'smart' industries (eg electricity)** ▪ **Internet of things** ▪ **Climatic monitoring- sensor networks and processing** ▪ **Location enabled applications**	▪ **Reliability with autonomic capability for failover and self repair** ▪ **Attack resistance** ▪ **Large scale and rapidly scaleable** ▪ **Real time**	▪ **Security data** ▪ **Physical environment data** ▪ **Personal info (with privacy)** ▪ **Visualization and virtual presence**	▪ **Rapid reaction autonomics 10M-10Gbps** ▪ **Real-time** ▪ **Disaster back-up networks via satellite and long range (LF) radio** ▪ **Large scale real-time control and monitoring**
Global warming and internet society are linked	**Social patterns** ▪ Seeking balance with nature ▪ Use of group for support ▪ Self reliance	▪ **Belonging - to a group for support** ▪ **Self-dependence for emergencies**	▪ **Reliance on self with support from group** ▪ **Group identification** ▪ **Socialization**	▪ **Communications services** ▪ **Monitoring, scanning, carbon accounting.**	▪ **High reliability – non-stop** ▪ **Multi-party** ▪ **Privacy**	▪ **Personalized environments** ▪ **Social networking** **Emergency services machine to machine (eg monitoring)**	▪ **High speed comms eg for (group) video calls**
Constrained by environment and by natural catastrophes	**Working Patterns** ▪ Substitution mechanisms of ICTs for high active population in work (>85%) ▪ Aging	**Mobility with Portability**	▪ **Ubiquitous access – home, work, inside, outside** ▪ **Accessibility of services and info** ▪ **Portability of personal environment**	▪ **Good high speed access** ▪ **Application group with adaptation by location** ▪ **Location enabled applications**	▪ **Security** ▪ **Transparency** ▪ **Common services platform in handset** ▪ **Compensation for limits in delivery networks and personal situation**	▪ **Underlying Comms-infrastructure with Integration service and high data rates** ▪ **Personal environment and chosen services from any location.**	**10-100 Mbps multimedia isochronous**
Constrained by environment and by natural catastrophes	**Living patterns** ▪ Merging everyday life and planetary husbandry	**Self realization and assertion**	▪ **Control of multiple responsibilities, (often with remote presence or proxies for presence)** ▪ **Control of Disruption** ▪ **Control of self development** ▪ **& improvement**	**Transactional capability:** ▪ **Individual** ▪ **Business** ▪ **Peer- peer** ▪ **Spontaneous** ▪ **Management of unexpected events** ▪ **Reaction management** ▪ **Distance learning with mobile education and training**	▪ **Assured completion & delivery** ▪ **Security** ▪ **Privacy** ▪ **Robustness** ▪ **Audit & Track** ▪ **Multiple task control for dialogues & transactions** ▪ **Security** ▪ **Robustness** ▪ **Portability of educational/ creative environment**	▪ **Internet business services – eg m-commerce** ▪ **Agents and proxy services** ▪ **Personal alerts service** ▪ **Personalized events service** ▪ **Educational applications** ▪ **Creative applications (design)**	▪ **Hi speed data access 10- 100 Mbps, asymmetric** ▪ **Low speed secure transaction & authentication, low speed 100- kbps – 10Mbps** ▪ **Multimedia downloads/ streaming and interactive education, 10-100MBps**

Scenario 3	Socio-economic patterns	Motivations	Needs	Applications -service -usages required	Application attributes:security, affordability, etc	Content services	Internet network layer services
Internet – a commercial channel for entertainment, retail commerce & advertising	**Economic Scenario** ▪ Consumer economy ▪ Dominant service providers ▪ High proportion of unemployed ▪ Large grey economy as substitute ▪ Increasing wealth gaps rich/poor	**Self gratification / stress relief**	▪ **Escapism** ▪ **Relaxation** ▪ **Distraction** ▪ **Instant gratification**	▪ **Provision of entertainment for relaxation** ▪ **Personalization**	▪ **Ease of use** ▪ **Affordability** ▪ **General availability** ▪ **Protect from scams**	▪ **Entertainment services –TV, sport, gambling, gaming, music, quizzes, horoscopes, etc** ▪ **Personalized entertainment environments**	**Mixed media, 1- 100 Mbps (-1GHz) for streaming and download**
Commercial big brother in a controlled consumer and political world	**Social patterns** ▪ Weakly motivated socialization (family breakdown) ▪ Low social mobility ▪ Aging demography – largely ignored	**Belonging (weak)**	▪ **Comfort through surrogate socialization via media** ▪ **Weak group communication**	▪ **Immersion – type shared entertainment services** ▪ **Comms services**	▪ **Multi-party comms** ▪ **Multi-media** ▪ **Low –cost** ▪ **High definition/ resolution imaging**	▪ **Personalized shared entertainment environments** ▪ **Dating services**	▪ **High speed comms eg for group video calls**
Constrained by environment and by natural catastrophes	**Working Patterns** ▪ Traditional low-wage service jobs, with some industrial jobs, in EU. ▪ Unemployed form part of work-patterns ▪ Aging population in retirement ▪ Few knowledge workers	**Economic Survival**	▪ **Find work and financial security in a difficult job market - few opportunities**	▪ **Basic contact for employment search** ▪ **Access to unemployment and pension benefits services**	▪ **Simplicity** ▪ **Low cost**	▪ **Internet business services (basic)**	▪ **Low speed secure transaction & authentication, low speed 100- kbps – 10Mbps**
Constrained by commercial interests & government censorship	**Living patterns** ▪ Entertainment/ escapism ▪ Separate work and play ▪ Low disposable income sets many barriers ▪ Political control of content, some countries ▪ Little self assertion through knowledge acquisition	**Identity**	▪ **Establish - who am I? through consumerist pursuits and accumulation** ▪ **Relieve stress**	▪ **Provision of entertainment for creating own world for establishing identity**	▪ **Control of private information** ▪ **Control of personal entertainment environment** ▪ **Low cost** ▪ **Easy to use** ▪ **Protect from identity theft**	▪ **Entertainment services** ▪ **Personalized entertainment environments**	**Mixed media, 1- 100 Mbps (-1GHz) for streaming and download**

Scenario 4	Socio-economic patterns	Motivations	Needs	Applications -service -usages required	Application attributes:security, affordability, etc	Content services	Internet network layer services
Power to the people: cooperative solutions give power to the people	**Economic Scenario** ▪ The financial meltdown and recession makes people find new ways to earn, invest, control and manage the economy and society ▪ Knowledge economy ▪ eDemos supplements government and acts as regulator	**Self realization and assertion (combined with Economic Survival motivations)**	**Control of several 'worlds', (often with remote presence or proxies for presence)**	**Transactional capability:** ▪ **Individual** ▪ **Business** ▪ **Peer- peer** ▪ **Spontaneous**	▪ **Assured completion & delivery** ▪ **Security** ▪ **Privacy** ▪ **Robustness** ▪ **Audit** ▪ **Tracking**	**Internet business services –** **eg m-commerce**	**Hi speed data access 10-100 Mbps, asymmetric** **Low speed secure transaction & authentication, low speed 100- kbps – 10Mbps**
User and e-consumer rights rule. Openness, expanded participation create e-communities	**Social patterns** ▪ Shift in social attitudes, bridging gaps in a highly multi-ethnic society ▪ High electronic cohesion ▪ Strong and weak social networks - rise in social, political, global conscious, for awareness and action	▪ **Belonging (combined with individualization and focus on community building)**	▪ **Group identification** ▪ **Socialization** ▪ **Trust, protection, fair, honest governance rules**	▪ **Communications services with high security and privacy for high trust** ▪ **Participation services (political, social group forming)**	▪ **High reliability – non-stop** ▪ **Multi-party** ▪ **Privacy** ▪ **Strong security**	▪ **Personalized environments** ▪ **Social networking** **Emergency services**	▪ **High speed comms eg for (group) video calls**
The internet advances in a phases as people have a choice of easy to use tools	**Working Patterns** ▪ Employment via the internet – job access, creation, migration is internet dependent. ▪ New business and consumer models ▪ Work and leisure coalesce as work from wherever is possible	**Mobility with Portability**	▪ **Ubiquitous access – home, work, inside, outside** ▪ **Accessibility of services and info** ▪ **Portability of personal environment**	▪ **Good high speed access** ▪ **Application group with adaptation by location** ▪ **Location enabled applications**	▪ **Security** ▪ **Transparency** ▪ **Common services platform in handset** ▪ **Compensation for limits in delivery networks and personal situation**	▪ **Underlying Comms-infrastructure with Integration service and high data rates** ▪ **Provision of personal environment and chosen services from any location.**	**10-100 Mbps multimedia isochronous**
People build cooperative & commercial spaces for safe environment	**Living patterns** ▪ Popular movements over the internet for political control ▪ Strong self assertion through knowledge acquisition	**Identity (combined with Safety and security and reliability)**	▪ **Establish - who am I? through group, entrepreneurial and political pursuits** ▪ **Assurance of safety** **Self operating in emergency**	▪ **Provision of entertainment for creating own world for establishing identity** ▪ **Security and emergency services**	▪ **Control of private information** ▪ **Control of personal entertainment environment** ▪ **Easy to use** ▪ **Protect from identity theft**	▪ **Entertainment services** ▪ **Personalized entertainment environments** ▪ **Visualization and virtual presence**	▪ **Mixed media, 1- 100 Mbps (- 1GHz) for streaming and download** ▪ **Disaster back-up networks via satellite and long range (LF) radio** ▪ **Autonomic**

The terms used under motivation may require further explanation:

Explanation of terms used in the motivation classification:

- **Self realization and assertion – the need to create an entity of self, through actions which prove self both inwardly and by recognition in a wider, outside world**
- **Self gratification / stress relief – the need to amuse /distract and perhaps relax against stress of workstyle/ lifestyle, to reward self.**
- **Safety and security – the need for protection and support to be safe, in a world where physical calamities due to climate change, or malicious actions such as cybercrime and violent crime are present, requiring a need to filter contacts and to maintain communication to summon help or for information, while preserving privacy. This also requires consistent, known, expected behaviour for long term persistent objects.**
- **Mobility with Portability – the need for support for a lifestyle and workstyle which involves continual transport across different geographic environments, mainly home, street, office and vehicle situations. This includes the requirement for continuity of experience to re-assure – manifested in the transport of the living/working mobile environment with complete continuity and maintenance of context, in order to take the lifestyle and its support mechanisms wherever the user may be.**
- **Belonging – the need for emotional support by forming part of a supporting community who have concern for the self, often in the long term (not transitory)**
- **Identity – the need for a definition of self, through actions, artefacts, styles of living**
- **Economic survival – the need to provide for self and family at a basic financial level (including access to social welfare benefits not just employment but unemployment and retirement).**

User segmentation by scenario

In looking at needs it is also useful to identify the types of end-user as this indicates likely forms of use of the internet. Such analysis can come from the scenarios. For each, we can identify certain groups who probably would form the mass of users, for both the business and consumer populations (who would also use e-government). This is shown below for the EU:

Table A.3 Future internet end-user segmentation - business and consumers

Scenario	Main user segments (may overlap)	Main types of usage
1 Smooth – knowledge economy ▪ Complex segmentation with high disposable income drives very different needs profiles ▪ Highly sophisticated and varied use of ICTs	1. Knowledge workers (largest worker segment) 2. Single parent & two parent families 3. Single person homes 4. Mobile workers 5. Children 6. Aged and working 7. Infirm/ disabled and working 8. Aged/infirm not working 9. SMEs 10. Corporates and multinationals – inside EU and global footprint 11. Machine to machine (Internet of Things)	1. Teleworking, contact, social***** 2. Social, education, entertainment 3. Social, entertainment 4. Teleworking, social, education 5. Entertainment, Social, education 6. Teleworking, education, social 7. Teleworking, education, social 8. Entertainment, social, education 9. Complete business support** 10. Main business support** 11. Consumer and industrial control **Social** includes e-government access ****Business support** includes e-government access
2 Green worlds ▪ Simpler segmentation and lower disposable income for most people so demands converge ▪ Highly specific uses of ICTs for environmental purposes	1. Machine to machine (Internet of Things) 2. Knowledge workers (largest worker segment) 3. Families and children 4. Aged / infirm /disabled, working/ not working 5. SMEs, corporates and multinationals – inside EU and footprint outside EU	1. Industrial-environmental control 2. Teleworking, contact, social 3. Social*, education, entertainment 4. Teleworking, social*, education, Entertainment 5. Complete business support**
3 Commercial dominance Strong segmentation defined by large differences in total and disposable income and in the degree of usage of ICTs with fragmentation of EU into regions of growth and decline	1. Unemployed (up to 20% of active population), 2. Working - on low or minimum wage 3. Workers who have downshifted (to a lesser career) probably have family, more technophobic 4. Aged/infirm/disabled not working 5. SMEs, corporates and multinationals – inside EU and global footprint	1. Entertainment 2. Entertainment, social* 3. Entertainment, social* 4. Entertainment social 5. Limited business support**
4 Emergence of the e-Demos Sophisticated and varied use of ICTs	1. Knowledge and mobile workers 2. Families and Children 3. Aged/ Infirm/ disabled and working 4. Aged/infirm not working 5. SMEs 6. Corporates and multinationals – inside EU and global footprint 7. Machine to machine	1. Teleworking, contact, social*, education 2. Social*, education, entertainment 3. Teleworking, education, social, entertainment 4. Social*, education, entertainment 5. Complete business support** 6. Main business support** 7. Consumer and industrial control

Each scenario has a different characteristic requirement in terms of support services required for the set of applications in demand, such as searches, location identification, messaging, data accesses, traffic volumes, and relative types of traffic (eg uplink/downlink, delay tolerant, etc). Traffic patterns can be examined for the numbers of users of each type and then the overall patterns analysed in more detail for applications, enabling services, traffic volumes, etc.

Requirements distilled from the above

Initial requirements drawn from the above can be gathered from the various user viewpoints. First, behind any design of a large system should stand certain major principles that emerge to form the more detailed design requirements.

Fundamental principles in design requirements

Principles behind a future design given below are based on the premise of the internet becoming a ubiquitous, universal channel for socializing, and creative expression for all as well as a non-stop global business environment, the largest platform on the planet for employment and trade.

Design Principles for a Future Internet

1. *Human rights – the right to interact safely* on the internet as part of a social environment. This implies protecting an individual's freedom of expression and culture from government or a large organization's censorship of ideas, ie the individual's rights to both security and privacy, with protection of identity and personal transactions (financial, health, etc). This is crucial to engender user trust. It requires a balance of rights – of the citizen/consumer against content providers/ ISPs/network operators, as well as the government and its regulators. It also implies a duty of care to society – avoiding the internet's inherent ability for centralization of control and surveillance.

2. *Accessible – ease of use by all at a basic level*, for global inclusion – intuitive interfacing with no exclusion due high e-literacy requirements and so be equally accessible with confidence to all of society. This means coping with differences in formal education, diverse physical and mental abilities and special needs, as well as any level of e-literacy, to dispel technophobia and rejection. It means designing for the people, for all people. It implies higher overheads in communications and storage from richer interfaces, often integrating multiple senses to produce a fusion between cultural / psychological demands and technologies.

3. *Sustainable – building in environmental care* – making telepresence easy to use and trusted could have long-term positive consequences on energy use. In general its own infrastructure should be assessed for its carbon footprint and its architecture will control two key parameters in terms of emissions – how much energy goes into the lifecycle of equipment and in its operation. Both of these depend on the detail of hardware implementation. However ICT hardware design is predicated on the software footprint in terms of MIPS, storage and active memory (RAM) demands. There is also the question of basic design of protocols and their operation, eg constant polling uses energy and generates heat – protocols that avoid this or do it minimally must be designed. Thus all elements from packet switches/routers to operating systems and software applications need to be 'eco-designed' with emissions, heat, toxics, recycling and energy-in-use considerations. For instance, the quiescent power consumption on standby can be of the order of 10% of all energy consumed - can this be cut? As the largest machine on the planet, sustainability becomes a key design parameter.

4. *High reliability – non-stop and self protecting*: This internet system is already the bedrock of our economy and civilization for the next century. Care needs to go into design for crisis management, failover operation, with autonomic features of self-healing, via failure prediction, prevention and automatic recovery at all levels, plus detection and protection from all forms of attack. These risks may vary from defects such as radio packet synchronization and transmitted frequency wander, to physical destruction of any concentrating hub, to server malware attack, to failures in interface compatibility for application level services. Such mechanisms may be drawn from analogues with biological systems and imply a conscience of its status, with self-awareness of resources available, and their performance capacity plus comprehension of context such as load demands. Principles of co-operating automatons, rather than a single system, may be relevant.

5. *Openness to all* – avoidance of lock-in to proprietary constraints. The current internet is a victory of commonality over a sea of proprietary offerings that previously occupied the data communications space (SNA, DNA, Appletalk as well as limited telecommunications standards with heavyweight protocols aimed at a world of incumbent telecoms operators - X25, X32, X400, etc). This insistence on open standards must continue if we are to have a ubiquitous network. One possibility is a common pooling of intellectual property rights in this area – a common pool of future patents for instance. It

also indicates an internet governance open to all, not dominated by a privileged set of countries or governments.

6. *Ubiquity without limit* – coverage wherever people need it and extensible to wherever they are. This implies a radio based access network, probably based more on mobile networks than WiFi or short range protocol (eg Bluetooth) as the mobile networks will cover much of the inhabited planet, indoors and outdoors. (For the rest of the earth's surface, new solutions are needed if they can be made cost effective – eg Low earth orbit satellites of a third generation might form radio links)
7. *Economy* – in terms of infrastructure, energy, protocols and computing effort. The internet of the future will be used by the poorest people on the planet. It should be designed with them in mind, for ultra-low-cost roll-out and operation as it will be shared with them. Progress on economy may not happen all at once but may be a continual erosion of infrastructure cost through two mechanisms. Firstly better engineering from basic principles may be expected and secondly prices of the most used elements of infrastructure tend to fall with volume production.
8. *Adaptable to new user types* - eg to machine-to-machine. This means designing for machines as well as for people – the connections of billions of sensors and actuators over the internet is certain to arrive if reliable, secure working can be achieved. It implies very high volumes of bursty communications, as well as some data streaming for remote processing eg for some form of pattern recognition.
9. *Shareability without limit* – to increase efficiency, lower cost and provide resources and information at any time to anyone, opportunistic networking may be useful. The future may be one in which sharing content between peers, the users, is far more important. But it also implies broadcasting information, especially rich media into environments close to users, to save on network capacity, so that various mechanisms such as embedded caching servers at the edges of the network become attractive. It also implies that some form of global hypervisor, possibly in linked units, may be useful for a form of grid distributed computing or perhaps Cloud computing, especially across multiple service providers. This also requires mechanisms for remote execution of tasks which are efficient and secure, yet use open protocols; mobile agents may be a new chapter for remote execution.
10. *The 'internet' is more than a pure end-to-end transport* connection today. This is linked to the first principle, as future users will require reconsideration of what has traditionally been the boundary of the 'internet', in order to match social and economic development – so an advance from pure networking into certain upper layers is required. This mean what we call the internet technically will advance to what the populace calls the internet today which includes applications, such as the World Wide Web, and some its own applications, such as search engines. What is perhaps interesting is what is missing – for instance the search for performance per se, as this will come with consumer demand. Principles are reduced to the strictly necessary.

Core design requirements

Using the principles above we can focus on a preliminary list of core requirements:

1. *Mobile access*: accommodating technological limits (eg evolution of today's mobile bandwidth for data and the gap with fixed networks' bandwidth). Requirements here could include efficient packet protocols for mobile/fixed operation and suitable new naming and addressing and routing systems, perhaps with distributed directory services for secure operation
2. *Secure usage and transactions*: financial and personal information transactions protected from fraudulent scams and identity theft – with tracing of fraudulent sources and protection from addressing and naming aliasing
3. *Privacy protection for the individual* (to make trust a central pillar) and balanced anonymity: against commercial concerns, spam, etc as much as governments that infringe citizen's human rights. Intrusion such as spam, etc, may be countered with traceable senders for unsolicited material in volume
4. *Openness of basic platforms*: open software, formats, protocols and platform neutrality with non-proprietary standards to avoid lock-in to commercial intellectual property which has proprietary

constraints. The aim is to avoid control by one set of major players (eg ISPs, handset or systems vendors, MNOs, telcos, software publishers, content providers, etc). This openness includes persistence of digital objects for the long term (decades) to be accessible/ interoperable against forced obsolescence through format or operating system changes, etc.

5. *Strong management of several levels*: not just of network and connection but of 'associated' services which impinge on processing within the internet, information passing at the level of the WWW, or what might replace it. At the top level might be requirements to implement internet governance as an embedded set of rules, or policy.
6. *Interfaces for all* (browser-like, eg voice browser, video browser, etc). This may imply human interface advances such as cognitive interfaces that anticipate user needs and augment user e-literacy. For user creativity, there is a need for provision of user level services that are easy to use and integrate - ie hiding complexity and inner workings in a seamless set of utilities and applications to be combined safely by the naïve user.
7. *Support for an Internet of things*: machine to machine communications, with security and privacy, for possibly very large volumes of short transactions plus some long data streams.
8. *Reliability with autonomic structures*: self recovery, self healing with self repair, self optimizing and configuring and self-protecting networks which are disruption tolerant, with failover, diverse routing and back-up resources – anticipate errors and resourcing failures – for non-stop operation through autonomic structures. Requires protocols beyond today's internet.
9. *Resistance to infrastructure attacks*: by ad hoc groups and by forces supported by nation states: structures that inherently have far greater resistance to modern forms of cyber attack
10. *Backwards compatibility for the long term*: able to cope with obsolescence in operating systems, certain applications (eg, e-mail), data formats and media formats, object naming and addressing and the associated metadata This may use mechanisms such as emulation and information formats which are stable over the long term (many decades). This also relies on open standards in document formats, operating systems, APIs and any characterizing interface. It is a key requirement if a distributed grid type layer is to be added.
11. *Low cost of deployment and of operation* in both ecological and financial terms. As the majority of users will be in the developing world design for such conditions will feedback into the EU.

Interestingly, the above indicates that a future internet is likely to require a wider remit for the internet than just networks. It includes domains previously seen more as application areas, such as information access, processing, human interfaces, application enabling services and possibly a security/privacy layer.

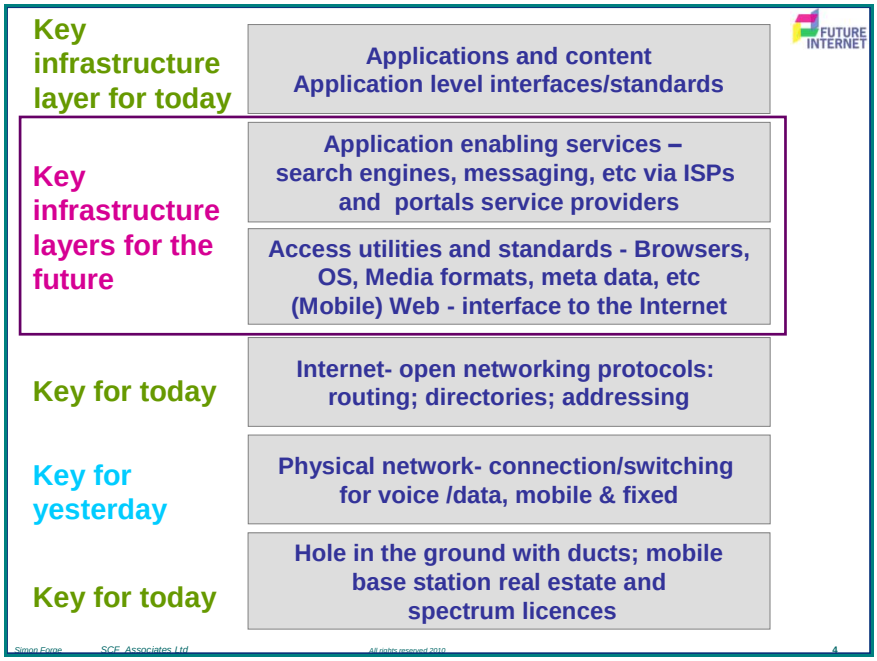


Figure A.26 Future internet infrastructure as a layered architecture

Regulatory requirements and governance for a future internet

A further area when considering requirements is regulation that might be useful to accompany a successful internet infrastructure. As the next internet extends across more areas of everyday life, regulation concerning the internet could be far more than that for existing telecommunications competition and protection of IPR. The question is whether the current legislation in areas of fraud, banking and shopping, etc are already sufficient for extensions into an online world and new models of crime and malfeasance. The concepts of electronic presence, for proof of authenticity and authorization are particular minefields. Protection of the individual and of commerce may well require new legislation for instance for:

- Protection of personal transactions – cyber crime
- Infrastructure protection from cyber attack
- Sustainability – environmental damage limits in design, production and sales of ICTs including Europe-wide network infrastructures
- Spectrum – specifically the creation of an internet commons in the 400- 800 MHz band with release of the digital dividend with DTV for a licence-exempt mobile internet

A question on the probability that it is possible to push today's limits

One further issue should be considered in the needs analysis above and that is whether there is potential for moving forward at all, in the face of industry and technical inertia.[13]

These inertia barriers range from adoption and deployment of IPv6, through battles over net neutrality and quality of service to the failure of many major players, such as the telecoms carriers, to innovate in services, except for those that are relatively trivial, and have found success by accident (eg SMS and ringtones). More significant steps forward (eg VoIP) have been actively opposed.

The limits on extension of the current internet and the level of design goals we may aim for beyond that lead to the conclusion that there is a real dilemma: *Will the current trajectory of internet evolution bring the future internet that users need?*

[13] For instance, see Milton Mueller's comments in response to an article by John Markoff, "Do we need a new internet?", *New York Times*, 14 February 2009: "Memo to John Markoff: There are no "do overs" in history", 28 February 2009, Internet Governance Project.

It may be that continued evolution of the internet as in the past will be insufficient or far too slow in delivering the characteristics that have been specified in this needs analysis. Perhaps we have reached some final limits. So a part of the task here is to examine this hypothesis: has the current form of the internet *really* reached the limit of extensions possible in view of the socio-economic forces driving demand at global levels, for new capabilities? Could an extension of the current form still do as well? Or do we need to start again, building as little as possible on top of the current principles and structure.[14]

Deciding on which way to go here may lie in looking at basic future needs. For instance, one area for improvement is the lack of *intrinsic* security mechanisms for transactions or to guard privacy (despite a wide variety of additional protection layers such as IPSEC, SSL, DNSSEC, etc). We would expect that these will be mandatory features of the next generation internet, not just bolted on afterwards, as today. Thus major functional extensions do indeed appear to be necessary.

[14] The Clean Slate project at Stanford University tends to take this view, criticizing current fundamentals as insufficient.

Appendix F. Workshop programme and results

Workshop 1: Brussels, 9 -10 September 2009

Aims and objectives

The first workshop was conceived as an early "brainstorming" workshop. The objective was to provide early feedback on the initial socio-economic scenarios that had been developed by the study team. A mix of European experts from a variety of disciplines joined the study team and European Commission staff for a full day's workshop.

Results

Needs analysis was the goal of the workshop, as it is a crucial element for design a future internet and major needs were identified as a first analysis:

- **An open internet:** The degree of openness of the (current and future) Internet, the freedom to use it and the values it expresses are important factors.
- **An inclusive but customizable internet:** The threat of possible exclusion for a significant proportion of the EU population, and the effects this might have on dividing European society is a key problem. The whole idea of gaps in society being magnified by technology is entirely unacceptable. The design of an internet which would enable all to participate is far more difficult than it may seem. It confirms the priority of socio-economic and psychological dimensions (eg user interfaces) in any design effort. The internet should be open to participation by all in a technically and socially neutral manner, with no barriers stemming from digital literacy.
- **A multiple and multi-faceted internet**: Based on the issues outlined above, it seems likely that there would be multiple internets in the future, based on preferences and personalization, rather than the single environment we have today.
- **A ubiquitous internet:** The power and success of the future internet lies in ubiquitous, open standards. This is the basis for a next generation of interoperability and technological neutrality. Mobile access is the most common and the most personal form of communication.
- **An internet of European values?** The notion that the internet should express and reflect a common set of European values was endorsed by some participants, but was also seen by others as an intensely political matter. Generally, the future internet should not be designed for technocrats, governments and businesses, but for ordinary European citizens, while protecting their security and privacy and limiting government surveillance and Orwellian-like control.
- **An internet of identities:** Personal identity and identification (for personal and national security) is a key issue. An internet identity layer may be useful, but can be a double-edged sword.
- **A trusted internet:** It was suggested that the internet be re-engineered around this theme. This would imply rethinking security and privacy together with resilience.
- **An internet transparently governed:** how can governments shape technology. A future internet should have a more holistic, participative and transparent governance structure.

- **Who pays for the internet?** The cost of the internet must be properly assessed. Developing nations will be the largest users and their concerns must be included. This has major implications for the engineering and design of a future internet (eg terminal costs).
- **Human rights and the Internet** All aspects of daily life touched by the internet should be obvious to the ordinary user, so that they are aware of who is watching, who is collecting information about them and what is being done with that information.
- **A global internet:** The governance issues will certainly require global coordination and collaboration, especially as the majority of future users will be in the developing world.
- **An innovative internet:** It is vital to stimulate innovation in adjacent internet technologies and application areas, such as health care, environmental sensors, location-based services and universal connectivity. The design of a future internet needs to take account of the vision of the Internet of Things. We expect a far wider view of future internet uses than today's.

Participants

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A full workshop report is available at: http://www.internetfutures.eu/?p=85

Workshop 2: MIT, Cambridge, MA, USA, 15 March 2010

Aims and objectives

The second workshop, kindly hosted by MIT CSAIL, allowed the study to benefit from input from North American experts. The goals were to:

1. Compare four different scenarios, in terms of their social and economic impact in order to better understand which elements from each are the most desirable for a more sustainable (or otherwise better) world.
2. Understand how current technological, social and economic trends would lead to the different scenarios proposed.
3. Understand how policy options (eg network neutrality) impact the emergence of the different scenarios.
4. Articulate what the future priorities for ICT research in internet architectures and infrastructures should be.

Results

A key question asked was where is the money coming from and where is it going to? Who will ultimately benefit commercially? Thus the baseline scenario which is more likely to emerge from the current trends is scenario 3, a commercial dominance for media and entertainment – as the financing is clear. It was also noted that the four scenarios reflect different models of security, privacy and IPR.

The table below highlights the consensus on some main parameters relevant to the different scenarios.

Parameters of evolution	1. Smooth Trip	2. Going Green	3. Commercial Big Brother	4. Power to the people
Internet infrastructure	Based on current architectural principles	Real-time, data driven, mesh, cloud services	Vertically integrated	Ad hoc/mesh, data/user driven
Technological developments	Mobility based No change in archit. principles Interoperability	Sensors Distributed network control	Streaming requires NGN or "clean slate" Walled gardens, specialized nets	Distributed control Online Reputation, Viral adoption Generalized wiki
Security, Privacy and Control	Security from competing private efforts Tradeoffs with anonymity	Sensitive to privacy, data protection	Strong Security, either real or apparent Power to data collectors	Privacy and identity more important than security
Economic models	As varied as possible. Work process evolution. Government and business support.	Natural resources consumption. May need incentives	Entertainment Driven by profits from industry, content and network providers	Distributed, user generated Innovation from the bottom
Social aspects	Social inequality	Globalization key	No social drive	Main social drive
Policy	Data protection Moderate IPR Transparency	Energy, Environment	Strong IPR protection	No IPR protection Open standards Interconnection
Standards	Some tension between open and industrial standards Filter / search technologies key	Need global standards	Competing closed standards may prevail Open standards acceptable	Open or Open source standards Multi-cultural support
Network Neutrality	Important but not strongly enforced	Important but not key	Ignored, just a burden	Key element to enforce

In the conclusions, it was also emphasized that, we need an institutional buffer in order to advance with independent research, This implies a need for government research in the public interest, for the public good, not related to industrial interests but rather targeting bold, multidisciplinary and high-risk initiatives, aimed at clear social values.

Participants

David Clark, Karen Sollins, William Lehr (all MIT CSAIL), John Wroclawski (University of Southern California), Karmen Guevara, Chris Marsden (University of Essex), Andrea Matwyshyn (University of Pennsylvania), David Reed (MIT Media Lab), Atanu Ghosh, Ken Carlberg (SAIC), Michael Geist (University of Ottawa), Eddan Katz (EFF) and Andrew Odlyzko (University of Minnesota).

A full workshop report is available at: http://www.internetfutures.eu/?p=133

Workshop 3: Keio University, Tokyo, Japan, 16 May 2010

Aims and objectives

The overall aim of the workshop was to compare the scenarios in terms of their social and economic impact, with a focus on consumers. The workshop also provided input to the study on the future internet from a Japanese and Asian perspective. There were three specific goals for the workshop:

1. Compare the different scenarios, in terms of their social and economic impact: which elements from each are the most desirable for a more sustainable (or otherwise better) world?
2. How will current technological, social and economic trends lead to the different scenarios proposed? What is the impact of different architectural choices (NGN, clean-slate approaches, non-IP, end-to-end principle, openness, embedded security) in enabling the different scenarios?
3. How will policy options (eg network neutrality) impact on the emergence of the different scenarios? What should be the future priorities for ICT research in internet architectures and infrastructures?

Results

Upper internet layers are becoming more important (ie the network layers become a means to an end, and are no longer what people see as 'the internet'). Social and political elements influence a future Internet and so the Internet may differ, region by region, over the earth. American approach to keep the Internet free might not be accepted by some countries, which have different languages, traditions, religions and customs.

Language diversity is a critical factor to include in a future internet as language diversity and cultural diversity are closely connected, while knowledge is based on languages- eg the number of Chinese Internet users went beyond 400 million last March. Europe has 27 member states and 23 official languages so European experiences must play an important role to make the Internet richer.

Closing the digital divide across society might be possible in Europe, for internet use. But other parts of the world will face more serious divides. How can democracy and a knowledge economy co-exist in a society?

Collective intelligence works well in the e-democracy, but it cannot be applicable to every aspect in social systems. The Market Principle tends to produce gaps between the rich and the poor. Thus the e-democracy scenario is an ideal. Social divides are becoming wider.

Infrastructures have not been evolving since around 2005. Device vendors are becoming fixed (on specific designs for internet access). This is not caused by government interventions, but by controls among the private sector players taking grasp of the upper layers. On the contrary, mass media's quality is going down and fewer people trust it these days. Business models of mass media are losing their edge over traditional media models. Moreover newer internet media and business models are becoming subtle and tricky. Even if you don't have to pay now, you are forced to pay later in other ways or somebody else is paying for you in exchange for your privacy.

The four scenarios seem to be not independent nor be in parallel, but be sequential. Even if the four scenarios were not sequential, each of the four scenarios would appear in the process of Internet evolution. The commercial big brother scenario regards entertainment as "mass opium" with a negative sense. The Japanese game industry is somehow different from European and American. Gaming is a type of information architecture to be used for positive purposes too. It would be possible to assume that going green is somehow automatic.

Prices matter in deployment of new technologies. When we say technological developments, there are new innovative services - to reconstruct existing architectures – and also sustainable services to make existing architectures cheaper and more effective. The latter changes prices rather than technological levels.

The emergence of new technologies is defined by local social trends and contexts. Some services might get popular in one society, but not in another society.

We need to think of psychological and perception aspects of new technologies in our society. New technologies are trying to invade our minds and some of them are malicious. For example, search engines recommend us other possible words. Is this just a convenient technology or an annoying mind controller? Gaming and social networking are technologies to lower our psychological hurdles. We should be aware of penetrating technologies.

On one hand, users sometimes overestimate risks and become afraid of new technologies and systems. On the other hand, they tend to underestimate risks when the services are highly convenient. For example, shopping advantages change the way people give away privacy information. They disclose location information while they hide names. There are gaps between perceptions and behaviours, and the gaps create security holes. Consumer's minds are fragile.

It is often said that human psychology doesn't change, but online communication sometimes does. There are problems on unconscious levels and problems of preconscious mental activity. Individual personal history, digital literacy and other influences change our behaviours.

Participants

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A full workshop report is available at: http://www.internetfutures.eu/?p=118

Workshop 4: Brussels, 17 June 2010

Aims and objectives

The goals of the workshop were:

1. To gain a consensus on those elements from a future internet scenario that would be the most desirable for Europe, to understand how a future internet might be shaped
2. To improve on the scenarios developed so far, by drawing on questions over six key aspects (and possibly additional ones)
3. In order to identify the key priorities for future internet ICT research and policy, to understand technological trends which may lead to the different scenarios

Results

- Community driven innovation should be the key to future internet progress, rather than commercial innovations for companies living off the internet. The latter point is attached to the concept of whether a European framework is required as the basis for an enabling infrastructure with services deployment and creation.
- The internet should be valued in non-monetary terms. Instead of pure business returns, it should be valued as a bringer of support, social cohesion and personal creativity for self-fulfilment and happiness. The relationship between the internet and people should not be one of purely technological or economic dependence. This will require incentive structures for innovation in which whole communities may be involved – a uniquely European approach.
- Generally, no deterministic view can be derived from technology – the internet's future is not technology dependent. It is defined by social, psychological and economic drivers.
- A key question is - what is the role of Government (at all levels) in the internet? The answer is that its role is to assure services are available to citizens, but not to provide the services, nor the infrastructure.
- Most sectors including government, the industrial and service sectors are increasingly internet dependent. Internet policy thus becomes important for the EU.
- A critical problem for the EU would arise if the group of major telecommunications operators defined the next internet. In Europe they already control the internet infrastructure, the networks, and increasingly the services that run over it. The effect of such a powerful oligopoly applying their protected position in a regulatory world to the internet could curtail any future development of the internet in terms of meeting the needs of ordinary users rather than their profits streams. Also we might see dominators from the software and computing industry, who were largely left out of the rise of the current internet industry, seeing this as a second chance to gain a dominant market position, having missed the first round.

- The issue of the internet being used as a way of shifting money around – eg from consumers to the major ISPs - should be distinguished from that of global value creation and distribution of value across the globe. Who will really pay for the future internet should be better understood.
- Today's internet assumes and to some extent enforces an asymmetry of information. While ordinary users give information about themselves (such as websites visited), the major ISP players can use this information to build large databases on consumers and their profiles. Moreover this data can be passed on, eg from content gatherers to those who want to understand the consumer and the effects their ads have on their target consumers. Note that this data is only used by the gatherers and not by its donors. Here technology is most effective in hiding the fact that all this data is being gathered on users.
- There are some strong indirect affects of the internet due to its power more as a medium of intermediation- for instance the aggregation of users into informal networks. It would be highly undesirable to see the internet become like joining in Disneyworld or Home Box office – as if it were just a distributor of entertainments in a 'walled garden' model. What is wanted is a non-exclusivity of engagement, so that access to services is not endangered.
- Perhaps the only way for the EU to have a place in the future formation of the internet is through radio-based mobile internet services, where its expertise in mobile cellular technology could potentially assure an advantage.
- All scenarios converge except for scenario 2. They may form a series. Going green (2) is orthogonal - while scenarios 1, 3 and 4 follow the same logic. It might be possible to put all into one scenario – for a knowledge based economy in which the prosumer pays for goods and services and produces the real value.
- Future research should be multidisciplinary, with a broad focus, on socio-economic and psychological aspects.

Participants

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A full workshop report is available at: http://www.internetfutures.eu/?p=137