Future Internet Socio-Economics – Challenges and Perspectives

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Abstract. Socio-economics aims to understand the interplay between the society, economy, markets, institutions, self-interest, and moral commitments. It is a multi-disciplinary field using methods from economics, psychology, sociology, history, and even anthropology. Socio-economics of networks have been studied for over 30 years, but mostly in the context of social networks instead of the underlying communication networks. The aim of this paper is to present and discuss challenges and perspectives related to "socio-economic" issues in the Future Internet. It is hoped that this will lead to new insights on how to structure the architecture and services in the Internet of the future.

Key words: Socio-economics, Future Internet, networks, users, providers, business models, pricing, QoS, trust, user identity and privacy, content, creative commons, customer usage behaviour, P2P content distribution models, standardization, universal service, anywhere-anytime, business models, regulations, value chains, system customization, externalities, Internet governance, bandwidth markets, network neutrality

1 Introduction

The Future Internet Assembly (FIA) is a European initiative that has recently been established with the goal to shape the Internet of the future (cf. [9], [10]). This initiative, which is backed by a number of European research projects under the EU Seventh Framework Programme (FP7), follows similar activities in the US (GENI [12], FIND [13]), Japan (Akari [14]), and Korea (Future Internet Forum [15]). Other countries and regions may follow with their own initiatives. Over the past decades, the Internet has grown and evolved to unprecedented size. However, its architecture is still based on the original design principles for

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an academic network in a “friendly” environment. Since then, the Internet has changed enormously both in size and in the way it is being used. In addition to the academic usage, the Internet is now used as a business platform and has also become a central part of social life. The types of applications running “over” the Internet exhibit more and more variety and put new requirements to the network providers for how to run and manage their networks.

With the increasing number of users and providers joining and new services being deployed on top of the Internet every day, the future Internet is facing problems, including but not limited to issues like scalability and address space limitation. To address these problems, possible solutions like those envisioned by the projects of the FIA and the Future Internet initatives world-wide range from evolutionary to revolutionary approaches. However, far reaching technological innovations can only be successfully deployed, if their non-technical issues and business potential are taken into account. Any new technology, no matter how excellent, can only succeed in the market if it satisfies, in a sustainable way, the needs of current or potential future users.

Therefore, the aim of this paper is to focus on the *socio-economic* challenges and perspectives related to the Future Internet. The overall socio-economic context is an important one, as it can significantly boost or hamper the success of an innovation – issues include the “degree of mobility” in the life-style, the balance of “privacy vs. sharing”, the need for security, the importance ascribed to health, and the distribution of wealth. The impact of new technologies on various segments of society such as the young or the elderly has to be appraised with the aim of maximizing benefits for the users.

The remainder of this paper is organized as follows. Section 2 outlines general socio-economic aspects which are of interest with respect to the Future Internet. Furthermore, Section 3 provides different positions and research orientations highlighting the socio-economic challenges that are faced by the Internet of the future, while Section 4 identifies possible perspectives that can be gained and describes the possible integration paths towards the Future Internet. Finally, Section 5 concludes this paper.

2 General Aspects

Future Internet socio-economics as presented in this paper studies the relationship between any sort of economic activity and the social life of users. Here, economic activity refers to networking in the sense of Internet-based communications and telecommunications based on lower-level network and telecommunication services as well as application-based services, while the users mainly includes private customers of such services and providers offering such services. Important socio-economic aspects of the future Internet include markets of Internet Service Providers (ISPs) and Telecommunication Providers, ISP peering agreements and/or transit contracts, as well as customer usage behaviors and selections of content. A study of all these aspects needs to address emerging and disruptive technologies, which effect the user/customer to provider relation, and has to include investigations of (European) regulations for the e-services market and security regulations, as well as the physical environment of e-services in terms of availability – world-wide vs. highly focused (cities) – and dependability for commercial services, in order to be able to determine (if possible) the economic growth, providers' revenue maximization, and customers' benefits.

Traditionally the field of telecommunications is strictly regulated, as opposed to the Internet. When Internet and telecommunications merge towards the Networks of the Future, the required minimum set of regulatory constraints must be defined (*e.g.*, issues like privacy, dependability, or neutrality). Therefore, a view on policy and governance of the network itself is especially prominent today with regard to address assignment and network neutrality. To create the basis for new socio-economic opportunities, efficient solutions on critical issues like security, mobility, quality-of-service and economical use of energy are demanded. These requirements will ask for innovations on the network layer with focus on topics such as network virtualization, embedded network management capability, functionally rich communication paths and networks of information.

There are several trends that can be observed over the last 30 years of Internet use. Stakeholders responsible for governance have changed from governments and academics to businesses trying to extract commercial value, where connectivity (ISPs) run as a commercial activity rather than by governments and academics. Moreover, trust between users has reduced dramatically with many users not knowing how to protect themselves and new service models requiring a proper performance level to give an acceptable user experience. Original developers were concerned with large scale system failures but now face quite different attacks, therefore, increasing the necessity of social and legal considerations of participating in "connecting" endpoints.

Drawing the appropriate conclusions from the mutual dependence of these technical issues with the non-technical driving forces will be the key for deployment of Future Internet innovations. However, as all these technical and non-technical drivers are various, manifold, heterogeneous, it is difficult to draw weighed requirements from each of the drivers in such a complex system of meshed relationships (see Fig. 1). Similarly, it is very difficult to appraise the individual contribution of each specific driver to the overall success or failure of an innovation.

3 Challenges

Based on the above considerations, socio-economics challenges can be identified in all domains of the Future Internet including the areas of networks, services, and content. In the following, Section 3.1 discusses the economic challenge faced by all three areas, addressing issues such as who pays, along with consideration for costs, pricing, and benefits. Furthermore, Section 3.2 presents the social challenge with respect to a universal and trustworthy Internet service. Finally, Section 3.3 outlines important socio-economic aspects related to content services provided over the Internet.

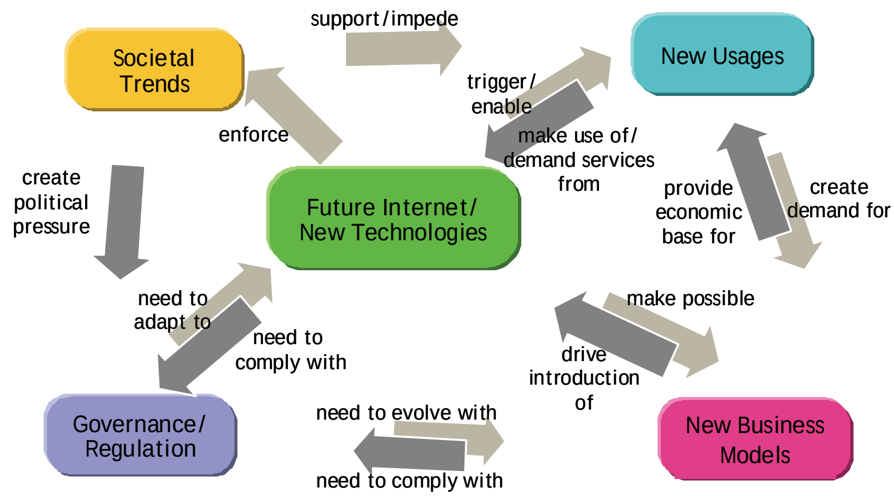

Fig. 1. Complex relationship between technical and non-technical driving forces of the Future Internet

3.1 A Healthy Internet Ecosystem?

There are many indications that today's Internet technology – combined with the pricing schemes that it supports – does not align well with economics and results in a number of inefficiencies. For instance it is criticized that it does not promote enough competition at the interconnection level, does not generate incentives for network expansion, and the revenue streams generated favor only certain stakeholders in the value chain, creating incentives for network operators to interfere with user applications without the consent of the users.

The Internet is founded on the simple premise of resource sharing. Shared communication links are more efficient than dedicated connections that lie idle much of the time. Hence the rules applied for sharing are extremely vital for the healthy operation of the Internet ecosystem and directly affect the value of the network to its users. This fact presents a great number of challenges to the Internet research community which can only be addressed by merging the disciplines of computer science and economics. The key question is: what is wrong with today's Internet sharing technologies? Are these consistent with economics? More specifically, since TCP is the dominant sharing technology, is TCP sensible from an economic point of view? Are deep packet inspection (DPI) boxes good or bad for the Internet community? Which network sharing technologies justify the end-to-end (E2E) paradigm from an economics perspective? What is required to make peer-to-peer (P2P) a blessing instead of a curse? Are there bad applications or just inefficient combinations of sharing technologies and pricing schemes?

There is no simple answer to these questions as they are very closely related. It relates to the right definition of the nervous system of the network, i.e. the information (the economic signals) that should be generated by the network in order to allow for building the appropriate mechanisms on top of that. And all this should be incentive compatible, i.e. the network should have the incentive to offer this information, and the users should have the incentive to choose and deploy the rest of the mechanisms that would base their operation and decisions on this information. Then the right pricing structures will prevail – for interconnection and for charging application traffic. At the resulting equilibrium, which is again an economics concept, the complete ecosystem will benefit. It is hence clear that designing the right nervous system maximizes the chances to lead to a good equilibrium. But is this existent in today's Internet? Are all these issues about ineffective pricing systems, networks that police selfishly user applications, and weak incentives for network expansion natural to occur or because a bad network nervous system is in place right now?

The well discussed case of P2P traffic generated the amazing spiral of tussles between network operators and users. Network providers offered several pricing schemes but flat-rate prevailed. P2P users took advantage of that and by increasing the number of their parallel TCP connections absorbed all the bandwidth of the network making performance dismal for the traditional interactive web-browsing users. Then network providers added capacity, but this got into the black hole since almost all of it was again used by the P2P traffic. Therefore, the P2P users were considered as a curse for the network. But were they doing something wrong? Not really, since they were just operating according to the rules of the game. Finally, the operators decided to control this gas-like ever expanding P2P traffic using volume caps. This improved the situation but created other bad side-effects, since it was throttling down the interactive fraction of the traffic as well. Hence, a more refined control on the application traffic was needed and so the operators started to deploy DPI boxes. These on one hand improved the traffic situation since they only throttled P2P traffic. But on the other hand, these boxes became a tool to deploy other discrimination policies like killing VoIP traffic and degrading performance for traffic from competing networks and applications. Therefore, the users reacted by encrypting their traffic to stop DPI boxes overwriting their TCP connections and networks made DPI boxes smarter to overcome this problem. And this will continue...

It is clear that this network policy is not fixing the problem, it is rather trying to hide it. But what is the real problem? TCP seems to be definitely part of it, since it does not take into account the overall connection activity over time. And combined with a poor pricing scheme it provides the incentives for P2P users to open as many connections as possible. Ideally, a good flow control scheme for P2P traffic would detect the times that demand for bandwidth by interactive users is high and push most of its transmissions at times that this demand will be lower. Such a strategy would make everybody better off. But unfortunately TCP is not equipped to behave like that.

So what is needed for all this to work better? Some recent research indicates that the basic technology that must be deployed by network operators is congestion signaling in a way that this information is visible by the networks themselves. Today congestion signals exist in the form of lost packets, but these are known only at the edges of the network and are invisible to the network itself. Network signaling technologies have been designed that allow this information to flow in an incentive compatible way throughout the Internet. Then pricing structures based on congestion volume will provide for the incentives that the right congestion control algorithms will be deployed by the end systems. Using this new nervous system each application will be charged for the cost it imposes on the rest of the applications that share the Internet. Pushing the information about true cost back to the economic agents that are responsible may be the necessary and sufficient condition we need according to economics. Then each agent (including the network operators) will be driven by the right incentives to make the appropriate actions and choices, in a completely distributed fashion. In this new context BitTorrent will be a blessing instead of a curse because it actually helps balancing load better and discover unused capacity for the network operator.

3.2 The Social Challenge of a Universal and Trustworthy Internet

Besides the economic dimension, the future Internet faces an important social challenge. The current Internet penetration has reached 20% worldwide and should reach 30% by 2015 and 50% by 2020. Broadband access to telecommunication network capacity and services must be guaranteed "anywhere-anytime" to universally exploit Internet, present and future, which is becoming a fundamental service that communities use and rely upon. As such, the Future Internet shall be able – among others – to support daily life in developed countries such as within developing countries. Telecommunication infrastructures must be conceived to guarantee access to the Future Internet also where currently it is poor.

However, the IP address space is depleting fast with only 15% left and expected to be exhausted by 2010. This may not only be the end of the E2E model, but also the end of the Internet itself. To fix this problem of the current Internet is a big and large-scale task and challenge. With virtually unlimited address space, the new Internet Protocol IPv6 has been designed to cater for the many deployment scenarios, starting with an extension of the packet technology and, therefore, supporting IPv4 with transition models to keep IPv4 working even for ever, and then to cater for new uses and new models that require a combination of features that were not tightly designed or scalable in IPv4 like IP mobility, E2E connectivity, E2E services, and ad hoc services; to the extreme scenario where IP becomes a commodity service enabling lowest cost deployment of large-scale sensor networks, RFID, IP in the car, to any imaginable scenario where networking adds value to commodity.

With the Internet getting more and more universal, the issue of trust in users and services will become a key challenge in the Future Internet. The Internet nowadays has 1 billion users that access to more than 30 billion pages, most of them basically static, and only 30% of them are built by companies. However the number of public web services is only around 30.000 [16] since most of the services are in-house and, therefore, restricted to close environments. It is clear that in this context trust is easy to manage. However, as mobile, wireless, optical, and broadband communication infrastructures become even bigger and more interdependent, the number of Web services is expected to grow exponentially in the years to come. In particular, more companies will publish their offers as services accessible through the Web inspired by the success of examples like Amazon, eBay, and Yahoo. Moreover, the Web 2.0 has popularized concepts such as mash-ups and RSS and thereby illustrated comparatively simple means for business networking and business flexibility. Additionally, efforts to turn the Web into a general platform for accessing and interconnecting arbitrary devices and services are maturing and may turn billions of diverse devices such as household appliances into accessible Web services. Finally, humans may act as "mechanical Turks" acting like a Web service to acquire the input data required to perform a certain requested task. These trends lead to a future Internet of billions of services in a network of equals – large enterprises, SMEs, and citizens – in which these services will be indistinctively produced or consumed by "prosumers".

In this new context trust will become a major issue and Web 2.0 technologies are already starting to support trust and reputation within and between computers and humans. The use of technologies like FOAF (Friend Of A Friend) in the field of services will allow SW agents, and humans, to gain information on the reliability and reputation of a service. For example, if a known and used service (*e.g.*, a flight booking service) has been combined successfully with a geographical location service, it is important that the user is able to gain any information on the newly introduced service.

3.3 Socio-Economic Aspects of Content Production and System Customization

Finally, content is becoming more and more important for the Future (Media) Internet, including technologies for content manipulation and transmission, as well as content creation. Content itself sometimes acts as a technology driver. For example, today content is created on multiple devices, largely self-organized by communities and centered on aggregators. Business models, human machine interfaces, and the cultural implications affect the technological success. Content is also increasingly responsible for the definition of technology standards, leading to synergies between different delivery platforms and different media forms. Know-how on cameras, recorders, production equipment, and displays are the "vanished sciences" for Europe.

Increased customisation is an opportunity to empower consumers through greater choice and for innovative providers to create new business models and associated revenue streams. However, customisation also exposes existing business models to additional risks. Consumers will exploit technologies in ways that cannot be envisaged and in some cases new usage will break existing business models either legally or illegally. In the music industry it can be seen that the cost of manufacture and distribution of digital music reduced to zero and that IT networks actually destroy value, with faster networks destroying value more efficiently. In addition, the Internet's ability to increase the level of indirection from real-world consequences (*e.g.*, criminal prosecution) through anonymity and limited regulation means that normal emotions (*e.g.*, fear) used to temper unacceptable behaviour and risk taking, are experienced to a lesser degree than similar face-to-face interactions (*e.g.*, steeling a CD from a shop compared to downloading an illegal MP3).

Of course today customisation is limited, and in fact the most successful business models focus of controlling all of the pillars of the supply chain (like iTunes) rather than offering flexibility. Even with limited flexibility significant threats exist to some industries, especially businesses dependant upon value creation from digital information assets. A new foundation for ICT services may be needed for economic sustainability of the Future Internet. Many challenges exist that require real innovation. For example, how can business models evolve to support underlying notions of value and value creation in the new marketplaces, and the role of ICT as potentially a utility (*e.g.*, the utility of interoperability services) and value enabler? How can stakeholders assess and mitigate economic threats introduced by greater customisation in service offerings? How can the service economy provide the right amount of choice and customisation to avoid monopolies and to support economic growth? These are all challenging questions that need to be answered for the Future Internet to become a successful technology.

4 Perspectives

Based on the above challenges, this section outlines new insights and perspectives and tries to describes a possible integration paths towards the Future Internet. Section 4.1 outlines the need for multi-stake-holder societal control through Internet Governance. Furthermore, Section 4.2 presents implications of generations X, Y, and to-be based on the expected evolution of user behaviour. Finally, Section 4.3 discusses the question of one or multiple Internets as potential paths to a global Future Internet.

4.1 The Need for Internet Governance

The governance aspect will become an important part of the future Internet, in particular if it comes to issues with a public policy component addressing aspects like privacy, security, freedom of expression, intellectual property rights, and data protection. The term "Internet Governance" emerged in the early 1990s to describe elements of the management of critical Internet resources, in particular the domain name system (DNS), but also IP addresses, root servers, and Internet Protocols. It was based on a conceptual understanding of self regulation and private sector leadership, of "Governance without Government". One concrete result of this discussion was the establishment of the "Internet Corporation for Assigned Names and Numbers" (ICANN) in 1998.

In 2002, when the UN World Summit on the Information Society (WSIS) started, Internet Governance became the issue of very controversial diplomatic negotiations. The government of the Peoples Republic of China argued that private sector leadership was good for one million Internet users but governmental leadership would be needed for one billion Internet users. The controversy "private sector leadership vs. governmental leadership" led to the establishment of the UN Working Group on Internet Governance (WGIG). WGIG defined "Internet Governance" as the development and application by governments, the private sector and civil society, in their respective roles, of shared principles, norms, rules, decision-making procedures, and programs that shape the evolution and use of the Internet.

WGIG rejected the idea of one "single leading Internet organization" but proposed a concept of "Multistakholderism" and a "Multilayer Multiplayer Mechanism" (M3) where the various stakeholders are involved according to their specific roles and responsibilities. Stakeholders should enhance their cooperation via better communication, coordination and collaboration (C3). As a result, the Internet Governance Forum (IGF) was established as a UN led innovative multistakeholder discussion platform without a decision making capacity. Multistakholderism should be taken as a guiding principle for NGN governance, including the governance of the ONS and the "Internet of Things".

4.2 Expected Evolution of User Behaviour

In order to guarantee the success of the Future Internet design, the end users' behavior needs to be characterized. Therefore, it is important to analyze the current usage trends as well as to infer the end users' expectations. Taking a look at today's Internet usage, it is easy to realize that multiple applications/services (*e.g.*, social networks, P2P, streaming, gaming, voice, videoconference) are being used from multiple end users' devices (*e.g.*, PC, game consoles, mobile phones, PDAs). Of course all these services are not used by the same population segments; in particular, the following well known generations are identified: the Generation X mainly uses Web and e-Mail applications from a PC, while the Generation Y is characterized to be all day connected to access any service; therefore, this generation mainly values the reliability and ubiquity of the connectivity as a service itself. Moreover, it seems that a new generation of people born in the 21st century can be distinguished, being its main attribute their capability to adapt to continuous changes and their wide knowledge of the technology; this new generation will be ready to use new advanced network services, able to meet the new applications performance requirements that could be expected in the future.

From a technical perspective, the Internet traffic analysis is a powerful tool to really know the evolution of the users' preferences as well as their impact on the global amount of traffic that must be carried on Future Networks. Taking into account the IP traffic study reported in [11], the amount of traffic that needs more than best effort capabilities is growing up.

4.3 One or Many Internets?

A critical issue in the current Future Internet research is a proliferation of separate efforts due to the various initiatives world-wide. This may on one hand be good for innovation, as it can produce more ideas. However, if initiatives remain separate throughout the development of the Future Internet, many technologically incompatible Internets could emerge. In contrast to the current global Internet, these separate Internets could cause market fragmentation and even social seclusion. To avoid such adverse possibilities, design and implementation of the global Future Internet should proceed with a growing degree of cooperation between initiatives.

The origin of current initiatives for the Future Internet is largely correlated with the Internet connection density. It seems that people who use the Internet more are those who want to change it. EIFFEL, FIND, AKARI, and FIF are the framework programs of those high-density connection regions for supporting Future Internet research. Most of these frameworks are accompanied by testbed projects so that researchers can conduct large-scale experiments without affecting the current Internet. There have been some investigative interactions between these initiatives, but so far nothing concrete has emerged for future collaboration. Is this simply bureaucracy or a deeper pathogenicity? After two decades of demonstration, the importance of the Internet is now widely acknowledged. This knowledge has long transcended the esoteric circle of researchers and technologists and now spans almost all groups and levels of society. Value usually begets the desire for exclusive control of the value-generating artifact. To summarize the situation, the stakes are high and the stakeholders are many. So, governments, organizations, corporations, and communities could conceivably promote Future Internet research agendas that would allow them independent control over the produced system. The mere separation of Future Internet initiatives, if left unchecked, could become a schism, leading to many incompatible Future Internets.

A market of competing Future Internets might seem beneficial, but technological fights, like the recent battle for the future DVD format, often result in long and expensive stalemates. During such a Future Internet standoff, end-users will be baffled as to which Internet they should join, eventually raising its value and decreasing the value of the other Internets. Equipment manufacturers will either have to choose sides risking a wrong decision, or support all competing technologies and risk creating unstable products. Network operators and service providers will similarly have to gamble on which Internet to support. Even researchers will not know on which area to publish. Competing Future Internets will have difficulties in reaching critical mass and so reaping the benefits of positive network externalities. In the meantime, effort will be duplicated, the market will be fragmented, and cost will increase for all interested parties.

What is then a possible path toward a global Future Internet? A potential plan would initially keep the Future Internet separated to stimulate competition on the generation of concepts. Peer review would also quickly eliminate fundamentally flawed ideas. Then, as surviving ideas move to design, initiatives should collaborate on large-scale, realistic experiments by joining their test-beds. The interconnection of separate test-beds will proceed gradually to construct a global Future Internet test-bed while blurring the borders of separate initiatives. Higher-level stakeholders, like businesses and governments, will increasingly be able to experiment on the global test-bed, without affecting the current Internet. If these experiments demonstrate real socio-economic value, the global test-bed will naturally become the seed of the global Future Internet.

5 Conclusions

As a general conclusion, it can be stated that the end users' behavior is hard to predict due to the wide variety of services and applications being used; however, due to this wide Internet service portfolio, the end users really perceive the value of the connectivity as a service that should be reliable, ubiquitous, secure, neutral, flexible and able to adapt to new traffic performance demands. These attributes will be required to manage the new traffic demands, according to the end users' requests, and also able to provide the reliability and capabilities required to emerging services such as e-health or sensor networks.

Taking into account this brief analysis, it is hard to think on an Internet just based on the vertical integration of the services that could lead to the balkanization of the Internet, since it would not be possible to address the new emerging services and their requirements in such a close environment; in fact, it is proposed to build up an innovation friendly framework able to support the new traffic demands with higher capabilities in both wired and wireless networks, with guaranteed network performance and with open interfaces to allow the end users to show their preferences.

Socio-economic forces could push Future Internet research towards an arena of competing Future Internets. This scenario would hinder further industrial growth and innovation, limit business opportunities, and confuse end-users. To avoid such problems, separate Future Internet initiatives should be encouraged to compete during the concept generation phase and to collaborate during the design and construction phases. Europe has considerable experience in aligning separate efforts, so it should swiftly promote an increasingly cooperative strategy for the development of the Future Internet.

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